Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2019; 7(6): 1200-1203

Received: 03-09-2019
Accepted: 07-10-2019

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Eco-friendly management of fruit flies, *Bactrocera* spp. in kinnow mandarin using male annihilation technique in 9 districts of Punjab, India

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Abstract
Fruit flies, *Bactrocera* spp. are important insect-pests of fruit crops throughout the tropical and sub-tropical regions of the world. Keeping in view their severe damage to Kinnow mandarin fruits, trials were carried out in Punjab, India using PAU fruit flies traps at nine locations in seven districts during 2014 to 2017, with an objective to develop eco-friendly technique to manage the fruit flies. In orchards with 16 traps/acre, fruit fly infested fruits were 14.7 per cent as compared to 57.3 per cent in untreated Kinnow mandarin orchards. Mean maximum fruit flies/16 traps were trapped in Patiala (12668 flies) followed by 12597 flies in Ballowal. A total of 66620 male fruit flies were trapped at 9 different locations in 7 districts. In orchards where 16 traps/acre were fixed, the highest per cent infested fruits were observed in Patiala (41% as compared to untreated orchards in Patiala (90%). In orchards with 16 traps/acre, highest number of marketable fruits were recorded in Ludhiana-1 (450 fruits/tree) followed by Ludhiana-2 (420 fruits/tree). In untreated orchards, highest marketable fruits were recorded in Jalandhar (280 fruits/tree) followed by Patiala (215.4 fruits/tree). Thus, successful management of fruit flies in Kinnow orchards can be achieved by fixing PAU Fruit Fly Traps @ 16 traps/acre in the second week of August.

Keywords: Fruit flies, Kinnow mandarin, management, methyl eugenol, Punjab, traps

1. Introduction
Kinnow mandarin is an important fruit crop of Punjab occupying 53.04 thousand ha with 12.46 lac metric ton production [1]. However, tephritid fruit flies, *Bactrocera dorsalis* (Hendel) and *Bactrocera zonata* (Saunders) are the major limiting factors in successful cultivation of Kinnow mandarin as they may cause up to 85 per cent damage to the fruits [2]. These tephritid fruit flies are very difficult to manage as they are polyphagous, multivoltine, adults have high mobility and fecundity, and all the developmental stages like eggs, maggots and pupae are unexposed. Only adults are exposed while eggs and maggots remain protected in the host tissues. Therefore, most of insecticidal treatments utilized for the management of fruit flies are not much effective [3, 4].

Kinnow growers mostly rely on application of insecticides for the management of fruit flies, which disrupts the already fragile ecosystem besides causing numerous hazards to the environment. Thus, the present scenario warrants the need of utilization of integrated approaches for management of fruit flies in fruit crops [5, 6]. The use of traps based on methyl eugenol, a para-pheromone, is the most outstanding technology available among the various strategies available for the management of fruit flies, throughout the tropical and sub-tropical regions of the world. Methyl eugenol, when used together with an insecticide impregnated into a suitable substrate (like a plywood piece), forms the basis of mass killing of fruit flies, a technique commonly known as male annihilation technique (MAT). Methyl eugenol traps @ 4 traps/ acre in mango and guava has been found to be very effective in controlling fruit flies in different parts of India [7].

Trapping efficiency of different types of methyl eugenol-based traps in Kinnow mandarin in Punjab was compared [8]. They found that mineral water bottle traps (103.2 flies/trap) were more efficient as compared to McPhail trap (63.8 flies) and Nomate trap (59.5 flies) during September. Highest number of fruit flies, *Bactrocera* spp. were trapped, resulting in minimum number of maggots per fruits and maximum fruit yield when PAU fruit fly traps were fixed in peach orchards in Punjab @ 16 traps/acre [5]. MAT was also found very effective for monitoring and management of fruit flies, *Bactrocera* spp. on different fruit crops [9, 2, 6, 3, 10].

Most of the research work for the management of fruit flies had been done in the past on various management components [7, 9, 2, 1] including cultural practices, MAT, bait application technique and chemical control but very less control of fruit flies was achieved by applying the individual component Thus, keeping in view the increasing problem of fruit flies on Kinnow fruits in Punjab, a technology has been devised for management of male fruit flies with methyl eugenol-based traps designated as PAU Fruit Fly Traps.

2. Materials and Methods

The trials were conducted in Kinnow mandarin orchards for the management of fruit flies, *Bactrocera* spp. by using methyl eugenol-based MAT technology with PAU Fruit Fly Traps during 2014-2017 at 9 locations in 7 districts. One litre capacity empty mineral water bottles were used to prepare the traps (Plate 1d). The trap was prepared with a plywood dispenser, suspended vertically inside the bottle, aligning with the four vents on the bottle that allow entry of adult male fruit flies inside the bottle. The traps used in this technique consisted of immersing water absorbable plywood pieces (7.5 cm x 6.0 cm x 2.0 cm) in a solution of ethyl alcohol, methyl eugenol and malathion in a glass jar in 6:4:1 (v/v) ratio for 72 hrs [3, 11]. A drill was used to make hole in the plywood block to put wire for hanging on the tree used in the experimental Kinnow block. Subsequently, four holes were made with the help of a hot iron rod on the upper side of the trap for entry of adult fruit flies. Traps were cut from bottom side preferably with a hot knife and plywood piece was hanged inside the bottle with two sides of wire coming out from the top of the traps. Four random holes (3-4 mm diameter) were made at the bottom of the trap with hot iron needle to drain the rain water that may get collected in the trap. Sixteen traps were fixed in oneacre orchard, in each Kinnow orchard along with an untreated control of one-acre area. The traps were hanged with the trees at equidistance, during second week of the August and were kept in the orchards till the completion of fruit harvesting.

Traps were fastened to the Kinnow trees using metallic wires, at a height of 1-1.5 metre from ground level (depending upon the height of tree) particularly at a place receiving no direct sunlight. Red coloured reflecting tape was tied to the tree on which a trap was fixed for easy accessibility of such trees in the orchards for recording observations. The lower cut portion of the trap (lid) was removed and all the fruit flies trapped in the trap were collected in the carry bag after every 7 days. The lower cut portion of the trap was again re-fixed with the trap. The carry bags were labelled with a marker and fruit flies trapped/trap were counted in the laboratory at weekly interval when the number of flies was low but when there was large number of fruit flies, the count of flies was made on weight basis, using electronic weighing balance.

From both the treatments (16 traps/per acre and an untreated control), a sample of 50 Kinnow fruits at random/treatment collected at weekly interval were sorted out as infested (based on the oviposition punctures-Plate 1a, b), fallen infested fruits (Plate 1-c) and healthy fruits. Per cent fruit infestation was worked out. Impact of traps on the number of marketable fruits was also assessed by counting number of marketable fruits from five Kinnow mandarin trees.

3. Results

The consolidated data (Fig. 1) revealed that a total of 66620 male fruit flies were trapped at 9 locations in 7 districts, with a mean trap catch of 7404.2 fruit flies/trap. In orchards with 16 traps/acre, mean fruit fly infested fruits were 14.7 per cent as compared to 57.3 per cent in untreated orchards (Fig. 2). The mean marketable fruits/tree were 344.7 fruits/tree in orchards where 16 traps/acre were fixed as compared to 115.7 fruits/tree in untreated orchards (Fig. 3). The data on the male fruit fly catch at different locations indicated that the highest fruit flies/16 traps were trapped in Patiala (12668 flies) followed by Ballowal (12597 flies) whereas minimum flies trapped were in Faridkot (2196 flies) (Table 1). The results further showed that the highest infested fruits were observed in Jalandhar (25%) followed by 23 per cent in Fazilka, in 16 traps/acre. In untreated orchards, highest infested fruits were recorded in Patiala (90%) followed by 86 per cent in Ludhiana-2. Highest number of marketable fruits/tree was recorded in Ludhiana-1 (450 fruits/tree), in 16 traps/acre whereas in untreated orchards, highest number of marketable fruits were observed in Jalandhar (280 fruits/tree).

Table 1: Location wise efficacy of PAU fruit fly traps in Kinnow in 9 districts of Punjab

Parameter	Fruit flies captured, per cent fruits infested and no. of marketable fruits at different locations								
	Ludhiana 1	Ludhiana 2	Fazilka	Hoshiarpur	Patiala	Faridkot	Ballowal	Jallowal	Jalandhar
	Total fruit flies captured/16 traps								
	8025	7812	10720	5648	12668	2196	12597	3716	3238
Maximum per cent infested fruits									
16 traps/acre	10	12	23	8	41	3.8	3.6	6	25
Control	84	86	72	68	90	10.6	11.4	57	37
Number of marketable fruits/tree									
16 traps/acre	450	420	220	302	364.8	NR	NR	312.7	343.2
Control	70	62	44	38	215.4	NR	NR	100.7	280

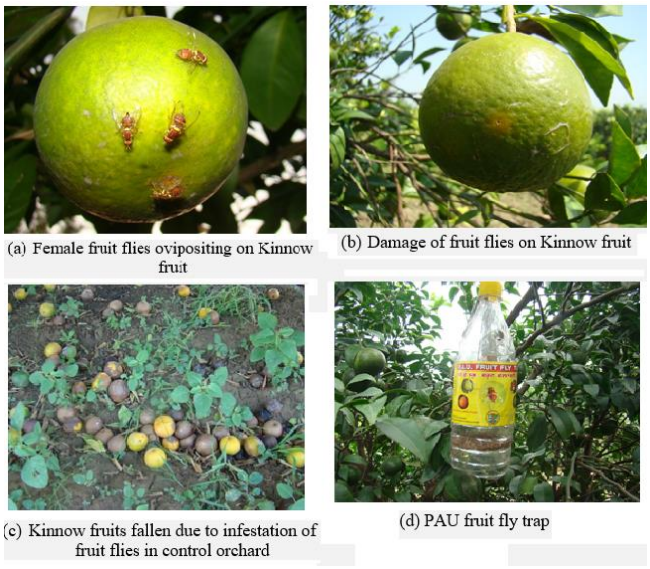

Plate 1: Damage of fruit flies on Kinnow fruits and PAU fruit fly trap

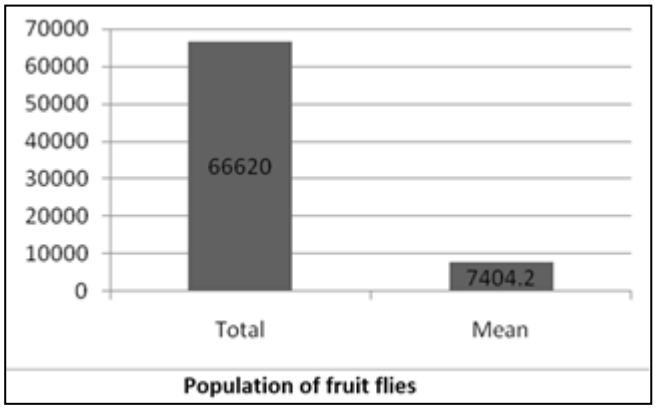

Fig 1: Total fruit flies captured/16 traps

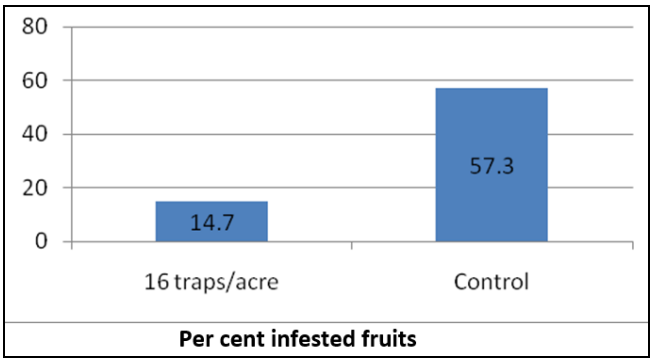

Fig 2: Mean per cent infested fruits

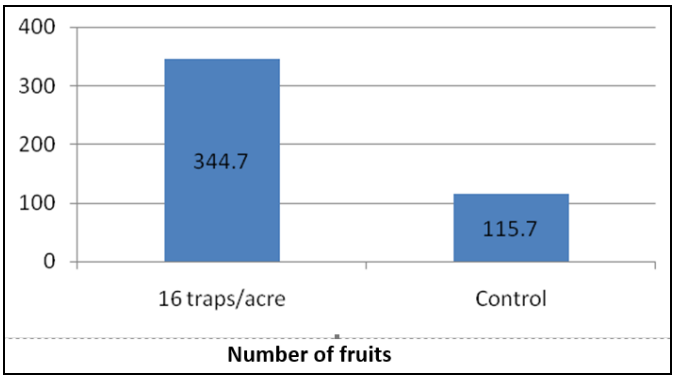

Fig 3: Mean number of marketable fruits/tree

4. Discussion

Fruit flies are insect-pests of international importance, due to their significance in quarantine procedures. Methyl eugenol, a para-pheromone, is used worldwide for monitoring and management of fruit flies, *Bactrocera* spp. One per cent concentration of methyl eugenol was significantly superior to all other treatments for the control of *B. dorsalis* in guava orchard [12]. Monitoring of the population dynamics of *B. dorsalis* using methyl eugenol-based traps was carried out in sweet orange orchards in China. Adults were captured from early July to the end of December in a citrus orchard and peaked in October and early November. Adult population peak coincided with the ripening period of sweet oranges in October [13]. The use of methyl eugenol-based traps for management of fruit flies in citrus has been advocated [14].

Sixteen traps/acre when fixed in peach orchards at Ludhiana had significantly more population of male fruit flies compared to 4, 8 and 12 traps/acre. More the number of males captured, less were the number of maggots/fruit in the field and 16 traps/acre had significantly less number of maggots/fruit as also observed in the present study. They further observed that number of traps had a significant impact on the quality marketable fruits and yield [14]. Bottle trap was found to give significantly higher trap catch followed by cylinder trap, when five traps with different designs (bottle trap, cylinder, sphere, PCI trap and open trap) were used to capture fruit flies in mango in Karnataka [15]. The results on capture of male fruit flies in the present study are comparable with [1] who also found that methyl eugenol traps were effective against *Bactrocera* spp. on mango, guava, sapota and peach in New Delhi, India.

This technique has been successfully used for the eradication and control of several *Bactrocera* species [7, 9] and is also found useful in Punjab on peach, pear, guava and Kinnow [8, 5, 3, 4, 11]. The present findings also showed a significant impact in reducing the damage and increasing the number of quality fruits.

Eradication/suppression campaigns were made by using combination of methyl eugenol and insecticides against *B. dorsalis* [9] but the present findings indicated that 16 traps/acre in Kinnow mandarin orchards were very effective in reducing damage of fruit flies as also reported by [17, 18] in Japan and India, respectively. In the present study, 16 traps/acre were found very effective. In contrast, there are studies where four traps/acre were reported very effective in controlling fruit flies in mango and guava orchards [6] in South India. The variation could be due to the climatic variation and intensity of fruit fly population.

It is concluded that successful eco-friendly management of fruit flies in Kinnow mandarin orchards can be achieved by fixing PAU fruit fly traps @ 16 traps/acre in the second week of August which gives higher number of marketable fruits.

5. Acknowledgements

The authors are thankful to the Director of Research and Director of Extension Education, Punjab Agricultural University, Ludhiana for providing funds and support to conduct adaptive research trials at different locations in Punjab.

6. References

1. Anonymous. Package of Practices for Cultivation of Fruit Crops. Punjab Agricultural University, Ludhiana, 2019, 188.

2. Singh Sandeep, Sharma DR. Integrated pest management for *Bactrocera dorsalis* (Hendel) and *Bactrocera zonata* (Saunders) on Kinnow Mandarin in the Indian Punjab. In: Beatriz Sabater-Munoz, Vera T, Pereira R and Orankanok W (eds). Proceedings of the 9th International Symposium on Fruit Flies of Economic Importance (9th ISFFEI). 12-16 May 2014. Bangkok, Thailand, 2017, 172-183.
3. Singh Sandeep, Sharma DR. Management of fruit flies in rainy season guava through male annihilation technique using methyl eugenol-based traps. Indian Journal of Horticulture. 2013; 70:512-518.
4. Singh Sandeep, Kaur G. Status of fruit flies on fruit crops in Punjab and their integrated management. Plenary lecture. In: Abstracts (Eds: PD Kamala Jayanthi, AK Chakravarthy, T. Raghava and V. Kempraj). Tephritid Seminar 2016-Understanding Tephritids in Toto: Taxonomy, Ecology, Quarantine & Management. May 27, Indian Institute of Horticultural Research, Bengaluru, 2016, 51-52.
5. Singh Sandeep, Sharma DR. Abundance and management of fruit flies on peach through male annihilation technique (MAT) using methyl eugenol based mineral water bottle traps. Journal of Insect Science. 2012; 25:135-143.
6. Verghese A, Shinananda TN, Hegde. Status and area-wide integrated management of mango fruit fly, *Bactrocera dorsalis* (Hendel) in South India. Lead paper. In: Ameta, O.P., Swaminathan, R., Sharma, U.S. and Bajpai, N.K. (eds). National Seminar on Emerging Pest Problems: Biorational Management, Udaipur, 2012, 56-57.
7. Stonehouse JM, Mumford JD, Verghese A, Shukla RP, Satpathy S, Singh HS *et al*. Village-level area-wide fruit fly suppression in India: Bait application and male annihilation at village level and farm level. Crop Protection. 2007; 26:788-93.
8. Singh Sandeep, Sharma DR. Comparison of the trapping efficacy of different types of methyl eugenol-based traps against fruit flies, *Bactrocera* spp. infesting Kinnow mandarin in the Indian Punjab. Journal of Insect Science. 2011; 24:109-114.
9. Vargas RI, Pinero JC, Mau RFL, Jang EB, Klungness LM, McInnis DO *et al*. Area-wide suppression of the Mediterranean fruit fly, *Ceratitis capitata*, and the Oriental fruit fly, *Bactrocera dorsalis*, in Kamuela, Hawaii. Journal of Insect Science. 2010; 10:135 available online: insectscience.org/10.135.
10. Bajaj K, Singh Sandeep. Preference of fruit flies, *Bactrocera* spp. to methyl eugenol based different coloured traps in peach, pear, guava and Kinnow mandarin orchards. The Indian Journal of Agricultural Sciences. (In Press), 2019.
11. Bajaj K, Singh Sandeep. Response of fruit flies, *Bactrocera* spp. (Diptera: Tephritidae) to different shapes of methyl eugenol-based traps in guava orchards of Punjab. Journal of Entomological and Zoological Studies. 2018; 6(2):2435-2438.
12. Makhmoor HD, Singh ST. Effective concentration of methyl eugenol for the control of guava fruit fly, *Dacus dorsalis* Hendel in guava orchards. Annals of Plant Protection Science. 1998; 6:165-169.
13. Han P, Wang X, Niu CY, Dong YC, Zhu JQ. Population dynamics, phenology, and overwintering of *Bactrocera dorsalis* (Diptera: Tephritidae) in Hubei Province, China. Journal of Pest Science. 2011; 84:289-295.
14. Kumar NKK, Sharma DR. Fruit pests of Citrus. Lead lecture. In: Souvenir and Abstracts. National Dialogue on Citrus Improvement, Production and Utilization. February 27-29. National Research Centre for Citrus, Nagpur, 2012, 203-209.
15. Chandaragi M, Sugandhi R, Vinay Kumar, MM, Uppar V. Evaluation of different trap designs for capture of fruit flies in mango orchard. In: Abstracts. International Conference on Entomology. February 17-19. Punjabi University, Patiala, 2012, 28.
16. Sharma K. Fruit fly management at Indian Agricultural Research Institute for production of organic fruits with male annihilation technique. Abstracts. International Conference on Entomology. February 17-19. Punjabi University, Patiala, 2012, 82.
17. Koyama J, Tureja T, Tanaka K. Eradication of the Oriental fruit fly (Diptera: Tephritidae) from the Okinawa Islands by a male annihilation method. Journal of Economic Entomology. 1984; 77:468-472.
18. Viraktamath S, Ravikumar C. Management of fruit flies through mass trapping in guava at Dharwad. Pest Management in Horticultural Ecosystem. 2006; 12:137-142.