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Performance of different shapes of traps in capturing *Bactrocera* spp. (Diptera: Tephritidae) in peach and pear orchards

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ABSTRACT: The role of different shapes of methyl eugenol based traps in peach and pear were studied at Punjab Agricultural University, Ludhiana, India against major fruit fly species i.e. *Bactrocera zonata* (Saunders) and *Bactrocera dorsalis* (Hendel). In this experiment, cylindrical traps, spherical traps, triangular traps and PAU fruit fly traps were used. The results revealed that triangular traps (71.58 males) had captured significantly more population followed by cylindrical traps (38.86 males), PAU fruit fly traps (29.61 males) and spherical traps (21.30 males) in peach; whereas in pear, the number of fruit fly males captured/trap/week were significantly high in triangular traps (127.92 males) as compared to PAU fruit fly traps (55.30 males), cylindrical traps (51.08 males) and spherical traps (42.44 males). The mean percentage of fruit fly damage was also lowest in triangular traps in peach (4.33%) and in pear (6.72%) respectively. However, cost: benefit ratio was quite low in triangular traps in both peach (1:30.86) and pear (1:20.93).

Keywords: Fruit fly, methyl eugenol, peach, pear, trapping

INTRODUCTION

Fruit flies (Diptera: Tephritidae) constitute a group of agricultural pests of global importance that attack a wide range of fruits and vegetables (White and Elson-Harris, 1992). Numerous fruit fly species threaten fruit and vegetable production throughout the world, causing both quantitative and qualitative losses. *Bactrocera zonata* (Saunders) and *Bactrocera dorsalis* (Hendel) are destructive pests of peach and pear, causing upto 80 and 70 per cent infestation respectively. The best way to manage these pests involve traps baited with highly attractive male-specific lure i.e. methyl eugenol (ME; 4-ally l-1, 2-dimethoxy benzene-carboxylate) which is a para-pheromone. In conjunction with this liquid attractant, current "killing" methods include broad-spectrum liquid insecticides, such as malathion (0, 0-dimethyl phosphorodithioate of diethyl mercaptosuccinate) which may pose environmental and worker safety challenges (Singh *et al.*, 2014; 2015). Since adult fruit flies use also visual and olfactory stimuli to locate hosts, traps that combine visual and olfactory cues proved to be most efficient for capturing fruit flies (Prokopy *et al.,* 1993; Alyokhin *et al.,* 2000).The current study compares traps of various shapes having methyl eugenol impregnated with insecticide, for capturing the *Bactrocera* spp. in peach and pear orchards.

MATERIALS AND METHODS

Trap Preparation

Studies on abundance and management of fruit flies were carried out during 2014-15 at Fruit Research Farm, Punjab Agricultural University, Ludhiana (30° 55' N, 75° 54' E), Punjab. In this study, four different shapes of the traps i.e. spherical, cylindrical, triangular and PAU fruit fly (based on empty water bottle) traps as check were used. The traps used in MAT technique were consisted of immersing water absorbable plywood blocks (7.5 cm × 6.0 cm × 2.0 cm) in the solution of ethyl alcohol, methyl eugenol and malathion mixed in a glass jar in the ratio of 6:4:1 (v/v) for 72 hours so that this solution was properly absorbed in the plywood blocks. Four holes were made with the help of a hot electric iron rod on the upper side of the PAU fruit fly trap, spherical trap (yellow plastic ball) and cylindrical trap (a plastic jar) for entry of fruit flies. There was no need for making holes in triangular traps. PAU fruit fly traps and spherical traps were cut from bottom with knife and plywood blocks were hanged inside the traps with two sides of wire coming out from the top of the traps. Tape was used to cover the cut portion of the spherical trap. In cylindrical traps, hole was made on the lid and plywood block was hanged inside the trap with wire coming out from two sides from the top of trap. In triangular traps, hole was made on top of the trap and plywood block

was hanged with the help of wire. The baited traps were hanged with the trees in equidistance @ 4 traps each in one acre area and replicated thrice. The traps were fixed in first week of April i.e.14th Standard Meteorological Week (SMW) in peach orchards and in pear orchards, traps were fixed in third week of June i.e. 25th SMW. The traps were kept in the orchards till the fruit harvesting was over.

Collection of Fruit Flies

In case of PAU fruit fly trap, the lower cut portion of the trap was removed and all the fruit flies trapped were collected in the carry bag after every 7 days. Lower cut potion of the trap was again fixed with the trap. In cylindrical trap, tape was removed and all trapped fruit flies were collected in carry bags and new tape was used to cover the hole. In case of cylindrical trap, lid was removed from upper side and all the fruit flies trapped in the trap were collected in the carry bag. In triangular trap, the sticky sheet was replaced weekly with new sheet and sticky sheet having fruit flies was collected in carry bag. The carry bags were labelled with the marker and fruit flies trapped/trap were counted in the laboratory at weekly interval, when the number of fruit flies was low, but when there were large number of fruit flies, the count were based on weight using electronic weighing machine.

Data Analysis

A sample of 50 fruits at random per treatment collected at weekly interval were sorted out as infested (based on ovipositor puncture) and healthy fruits. Per cent fruit infestation was worked out. Trap catches and per cent fruit infestation were subjected to completely randomized block (CRD) analysis by CPCS1 after suitable conversion of the data (Cheema and Singh 1990).

RESULTS

The results are presented in Tables 1, 2, 3 and Figures 1, 2. Mean population of fruit fly males of *Bactrocera* spp. captured/trap/week in peach orchard using different shapes of fruit fly traps depicted that with triangular traps had more population of fruit flies captured as compared to cylindrical, PAU fruit fly and spherical traps with catch of 71.58, 38.86, 29.61 and 21.30 fruit flies/trap/week, respectively (Table 1). Similar results were found in pear orchard, as triangular traps had significantly more population of fruit flies captured as compared to PAU fruit fly, cylindrical and spherical traps with catch of 127.92, 55.30, 51.08 and 42.44 fruit flies/ trap/week, respectively (Table 2). In peach orchard, the highest mean population was recorded in 18th SMW i.e. 114.75 in triangular traps, 87.75 fruit flies in cylindrical traps and 62.00 in PAU fruit fly traps and in spherical traps, the highest mean population was 71.75 fruit flies in 17th SMW. However, in pear orchard, the highest mean population was recorded in triangular (196.50 males) and PAU fruit fly traps (95.25 males) in 30th SMW, whereas in spherical traps (83.00 males), the highest mean population was recorded in 31st SMW and in cylindrical traps (83.00 males), it was in 33rd SMW. To evaluate the impact of different treatments on capturing of male fruit flies, infested fruits were recorded in both peach and pear. In peach orchard, Pooled mean of all the weekly observations showed that per cent fruit infestation was lowest (4.33%) in triangular traps as compared to PAU fruit fly (5.22%), cylindrical (5.33%) and spherical (5.81%) traps, which was non-significant (Fig. 1). In pear orchard, pooled mean of all the weekly observations showed that per cent fruit infestation was lowest (6.72%)

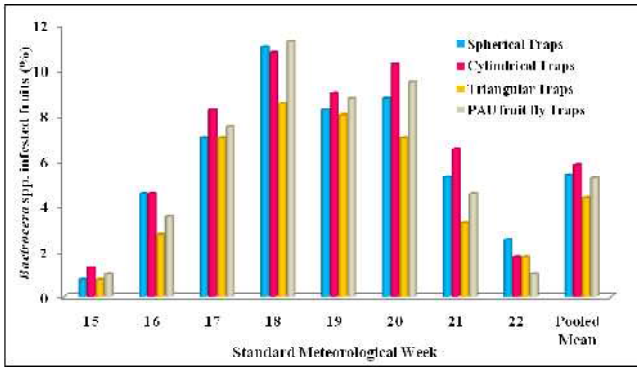

Fig. 1. Per cent *Bactrocera* spp. infested fruits of peach with different shapes of traps from April 2 to June 3, 2014

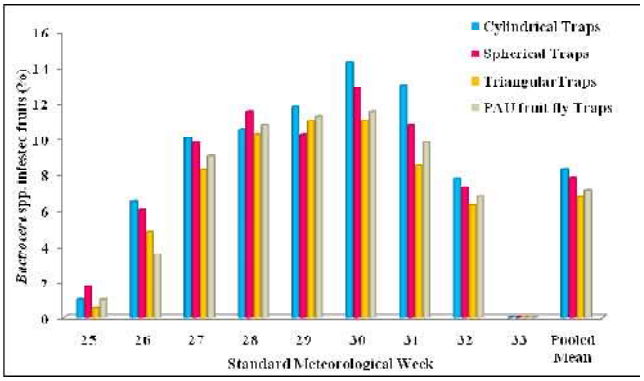

Fig. 2. Per cent *Bactrocera* spp. infested fruits of pear with different shapes of traps from June 18 to August 19, 2014

in triangular traps as was observed in peach compared to PAU fruit fly (7.06%), spherical (7.78%) and cylindrical (8.30%) traps (Fig. 2). The fruit yield was also recorded to measure the cost benefit ratio. In peach, the yield/acre (MT) was significantly high in case of triangular traps (5.10 MT) as compared to PAU fruit fly traps (4.01 MT), spherical traps (3.71 MT) and cylindrical traps (3.35 MT). The net income/acre was highest (Rs. 1,48,200) in triangular traps in comparison to PAU fruit fly traps (Rs. 1,18,700). However, the cost: benefit ratio was quite high in PAU fruit fly traps (1:74.19) to that of 1:30.86 in triangular traps, which was almost 2.5 times more to that of triangular traps. Similar results were found in pear. The yield/acre (MT) was significantly high in case of triangular traps (8.07 MT) as compared to PAU fruit fly traps (6.96 MT), spherical traps (6.07 MT) and cylindrical traps (4.26 MT). The net income/acre was highest (Rs. 1,15,530) in triangular traps in comparison to PAU fruit fly traps (Rs. 1,02,800). However, the cost: benefit ratio was quite high in PAU fruit fly traps (1:64.25) to that of 1:20.93 in triangular traps, which was almost 3 times more to that of triangular traps (Table 3).

DISCUSSION

Boller (1969) reported that spheres might be more attractive as they could be visible by the fruit flies from all direction. The biological basis for the acceptance of spheres over the other shapes may be due to similar shape of the oviposition hosts. Among the different traps, the sticky boards are cheaper, easy to handled and transported. They were good for detection purposes (especially for quarantine aspects) as reported by Kapoor (1993). According to Cornelius *et al.*, (1999), greater number of Oriental fruit fly female were attracted to yellow coloured spheres and rectangular blocks of equivalent surface in guava orchards. Mayer *et al.*, (2000) obtained more trap catch of cherry fruit fly, *Rhagoletis indifferens* Curran on 10 cm red spheres followed by 8 and 12 cm compared to vertical and V oriented yellow rectangles. Stonehouse *et al.* (2002) reported that square and oblong blocks were more effective in attracting *Bactrocera* spp. than round and hexagonal blocks whereas, Khater *et al.* (1996) also observed that the yellow sticky trap was found effective in attracting adult males than females, and mostly during period of low temperature and high humidity. Rajitha and Viraktamath (2005a) reported that in guava, *B. correcta* (Bezzi) was attracted to spheres and cylinders while *B. zonata* to bottle traps. However, *B. dorsalis* did not show any preference to trap shape. Rajitha and Viraktamath (2005b) reported that in mango ecosystem, *B. correcta* and *B. zonata* showed preference to spheres and bottle. Thiyagarajan *et al.,* (2015) opined that in mango and sapota orchards, yellow sticky traps having methyl eugenol and poly pack board of size 30 × 20 cm in a vertically hanging position recorded the maximum number of fruit flies. Bekker *et al.*, (2017) conducted a study to check the efficacy of two commercially available traps i.e. yellow Delta traps and yellow Bucket traps, used

Table 1. Mean population of *Bactrocera* spp. males captured in different shapes of traps in peach.

Treatment	*Mean *Bactrocera* males/trap/week								
	April 9-15 (15)**	April 16-22 (16)	April 23-29 (17)	April 30-May 6 (18)	May 7-13 (19)	May 14-20 (20)	May 21-27 (21)	May 28-June 3 (22)	Pooled Mean
Cylindrical traps	13.50 (3.80)	23.25 (4.92)	74.25 (8.67)	87.75 (9.41)	55.25 (7.48)	49.00 (7.04)	35.00 (5.94)	11.75 (3.56)	38.86 (5.77)
Spherical traps	11.00 (3.46)	24.00 (4.99)	71.75 (8.53)	22.50 (4.78)	15.75 (4.08)	19.75 (4.55)	17.75 (4.32)	9.25 (3.19)	21.30 (4.34)
Triangular traps	28.00 (5.38)	44.75 (6.75)	97.50 (9.92)	114.75 (10.66)	113.00 (10.66)	96.75 (9.88)	75.75 (8.76)	73.75 (8.61)	71.58 (8.00)
PAU fruit fly traps	3.25 (2.05)	14.00 (3.81)	54.00 (7.41)	62.00 (7.94)	40.75 (6.45)	44.00 (7.00)	37.25 (6.17)	11.25 (3.48)	29.61 (5.02)
CD (p=0.05)	(0.44)	(0.74)	(0.30)	(1.48)	(0.89)	(0.70)	(0.88)	(0.87)	(2.52)

*Mean of 4 replications; **SMW-standard meteorological week; Figures in parentheses are $\sqrt{n+1}$ transformation.

Table 2. Mean population of *Bactrocera* spp. males captured in different shapes of traps in pear.

Treatment	*Mean *Bactrocera* males/trap/week									
	June 18-24 (25)**	June 25-July 1 (26)	July 2-8 (27)	July 9-15 (28)	July 16-22 (29)	July 23-29 (30)	July 30-Aug 5 (31)	Aug. 6-12 (32)	Aug. 13-19 (33)	Pooled mean
Cylindrical traps	8.50 (3.01)	8.7 (3.08)	22.00 (4.78)	54.50 (7.43)	66.75 (8.21)	70.00 (8.41)	72.50 (8.55)	73.75 (8.64)	83.00 (9.15)	51.08 (6.83)
Spherical traps	4.25 (2.28)	4.00 (2.22)	13.25 (3.75)	16.25 (4.15)	31.00 (5.64)	76.50 (8.80)	83.00 (9.15)	80.00 (8.99)	73.75 (8.64)	42.44 (6.00)
Triangular traps	43.25 (6.61)	58.00 (7.65)	72.25 (8.53)	65.50 (7.65)	138.25 (11.79)	196.50 (14.05)	193.75 (13.95)	191.75 (13.88)	192.00 (13.89)	127.92 (10.96)
PAU fruit fly traps	4.25 (2.17)	6.50 (2.56)	10.75 (3.36)	40.50 (6.43)	84.50 (9.24)	95.25 (9.80)	93.00 (9.17)	81.50 (9.07)	81.50 (9.07)	55.30 (6.87)
CD (p=0.05)	(1.08)	(1.18)	(0.99)	(2.58)	(0.80)	(0.70)	(2.90)	(0.71)	(0.84)	(2.84)

*Mean of 4 replications; **SMW-standard meteorological week; Figures in parentheses are $\sqrt{n+1}$ transformation.

Table 3. Benefit: Cost ratio of different shapes of traps in different fruit crops.

Treatment	Expenditure, Income and Cost: benefit ratio/acre				
	*Total Expenditure (Rs)	Yield/acre (MT)	Gross income (Rs)	Net income (Rs)	Benefit : Cost ratio
Peach[1]					
Cylindrical traps	1760	3.35	100500	98740	56.10
Spherical traps	1632	3.71	111300	109668	68.20
Triangular traps	4800	5.10	153000	148200	30.86
PAU fruit fly traps	1600	4.01	120300	118700	74.19
Pear[2]					
Cylindrical traps	1760	4.26	63900	62140	35.31
Spherical traps	1632	6.07	91050	89418	54.79
Triangular traps	5520	8.07	121050	115530	20.93
PAU fruit fly traps	1600	6.96	104400	102800	64.25

*Based on 16 traps/acre; [1](Number of trees/acre=72; average weight of fruit =72 g; @ Rs.15/kg fruit); [2](Number of trees/acre=90; average weight of fruit =80 g; @ Rs.30/kg fruit).

for monitoring of *Bactrocera oleae* (Rossi) (olive fruit fly). The yellow Delta traps caught significantly more *B. oleae* than the yellow Bucket traps, as well as significantly more *B. oleae* males than females. *Ceratitis capitata* (Wiedemann) and *Bactrocera biguttula* (Bezzi) were also trapped during the study. For both species, yellow Delta traps caught significantly more individuals than yellow Bucket traps.

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