Int.J.Curr.Microbiol.App.Sci (2021) *10*(03): 990-1005

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 10 Number 02 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1003.126

Evaluation of Modified Cost Effective Trap Designs to enhance the Trapping Efficiency of Fruit Flies in Snake Gourd Ecosystem

L. Sowmiya[1*], M. Chandrasekaran[2] and R. P. Soundararajan[2]

[1]Anbil Dharmalingam Agricultural College and Research Institute,
[2]Horticultural College and Research Institute for Women, Tamil Nadu Agricultural University, Tiruchirappalli-620 027, Tamil Nadu, India

**Corresponding author*

Keywords

Snake gourd, Fruit fly, Trap design, Cue lure, Methyl eugenol

Article Info

Accepted:
10 February 2021
Available Online:
10 March 2021

A B S T R A C T

Snake gourd, *Trichosanthes anguina* L., is a yearly climber in the family cucurbitaceae has huge health benefits against blood pressure, heart disease, rheumatism and psoriasis. Fruit flies (Tephritidae: Diptera) are one of the most interesting group of insects also called it as 'peacock flies' due to their habit of vibrating their wings and rank among the world most serious pest in cucurbit ecosystem. It infests nearly 70 host plants; among these snake gourd, bitter gourd, muskmelon and snap melon are the most preferred host. Apart from insecticide spray, traps are important tool for the monitoring and mass trapping of fruit flies. Vegetable growers find difficulties in purchasing the commercial traps because of its cost and local availability. Hence, in order to provide the better management of fruit flies the present investigation was focused on developing cost effective cum easily available traps with maximum trapping efficiency. The experiment was conducted in farmer's field at Kumaravadi village, Tiruchirappalli during January to March 2020. Totally seven numbers of traps were designed and taken for evaluation along with standard bottle trap as check. To assess the dynamics of *Z. cucurbitae* and *B. dorsalis* both the lures *viz*., cue lure and methyl eugenol were placed in trap designs and the population of trapping was recorded periodically. The finding indicated that the bottle trap half cut model was identified as the good design in fruit fly trapping with the mean catches and trapping efficiency of 16.39 fruit flies/trap/week and 19.67-24.10 followed by vertical cylindrical trap (13.94 fruit flies, 17.05-19.88%), horizontal cylindrical trap (11.83 fruit flies, 15.08-16.27%), cylindrical bucket trap (9.89 fruit flies, 12.70-13.39%) and standard bottle trap (8.22 fruit flies, 10.24-11.48%) in cue lure material. Likewise, in methyl eugenol attractant, bottle trap half cut model trapped more fruit flies (15.28 numbers) followed by vertical cylindrical trap (12.83 numbers), horizontal cylindrical trap (10.61 numbers), cylindrical bucket trap (8.50 numbers) and standard bottle trap (6.67 numbers) with the trapping efficiency of 21.54-28.03%, 18.85-21.97%, 16.15-16.67%, 12.12-13.46% and 9.09-10.68%, respectively. The minimum numbers of fruit fly catches were observed in bottle trap two opening model with the trapping efficiency of 7.83-9.51% and 6.82-8.46%, coconut shell trap (5.42-7.87% and 3.79-6.54%) and bulb trap (3.01-6.23% and 1.52-4.62%). The hierarchy of varied designs on trapping efficiency is in the order of bottle trap half cut model > vertical cylindrical trap > horizontal cylindrical trap > cylindrical bucket trap > bottle trap two opening model > coconut shell trap > bulb trap. The trapped fruit flies in designed traps were significantly had a positive correlation with minimum and maximum temperature, wind speed, rainfall and negative with relative humidity.

Introduction

Fruit flies (Tephritidae: Diptera) are polyphagous pest, comprised of 4352 species and 483 genera. Among these, 250 species were economically important and 39 species recorded in India (Kapoor, 2002; Vargas *et al.*, 1989). The species *viz*., *Zeugodacus cucurbitae* Coquillett, *Bactrocera dorsalis* Hendel, *B. zonata* Saunders, *B. correcta* Bezzi, *B. diversa* Coquillett and *B. latifrons* Hendel are predominant in India (Kapoor, 2005). Snake gourd (*Trichosanthes anguina* L.) belongs to the family cucurbitaceae; is originated from India and regionally called it as serpent gourd, viper gourd, club gourd, snake squash, chichinda, padwal and pudalangai (Deepa devi, 2017). The yield is highly influenced by the major insect pests *viz*., melon fruit fly (*Z. cucurbitae* Coquillett), snake gourd semilooper (*Diaphania indica* Saunders), pumpkin beetle (*Aulacophora foevicollis* Lucas, *A. cincta* Fabricius, *A. intermedia* Jacobi) and aphids (*Aphis gosypi* Glover). Among these, melon fruit fly, *Z. cucurbitae* causes severe damage and yield losses varied upto 30 to 60% in different hosts (Dhillon *et al.,* 2005). Adult females lay eggs inside the fruit pulp upto 2 to 4 mm deep and maggots feed in the pulp portion of the fruit. The infested fruit starts decayed turns to rotten, deformed, and unfit for consumption (Nasiruddin *et al.,* 2004). The fruit flies are mainly controlled by spraying of insecticides, but they all toxic to environment and unsuitable for human health (Pedigo, 2008). Nevertheless, the use of insecticide for fruit fly management tends to negative impact on environment and increases the cost of production. Field sterilization and use of traps are the best management techniques with minimal effort, eco-friendly and high specificity (Sureshbabu and Viraktamath, 2003). The parapheromones *viz*., Methyl eugenol (4-allyl-1, 2-dimethoxy benzene carboxylate) and Cue-lure [4- (p-acetoxyphenyl) - 2-butanone] were used for trapping of *B. dorsalis* and *Z. cucurbitae* fruit flies. 90 per cent of the Dacinae fruit flies are strongly attracted to either cue-lure or methyl eugenol or raspberry ketone (Hardy, 1979). Apart from the olfactory stimulus, visual cues of shapes and colour are the dependent factor for attraction (Katsoyannos, 1989). The parapheromone traps are excellent tool in reducing the population of fruit flies in snake gourd ecosystem. In farmer's situation, due to lack of awareness, availability and knowledge on its mechanism of trapping all paves way to move towards the spraying of insecticides. Considering these key limitations, this present investigation was framed to develop locally available, cost effective trap designs for the efficient eco-friendly management of fruit flies in snake gourd ecosystem.

Materials and Methods

The field experiment on "Evaluation of various trap designs on its trapping efficiency of fruit flies" was carried out in the farmer's field location at Kumaravadi village, Vaiyampatti block, Tiruchirappalli district, Tamil Nadu during January to March 2020. Totally seven types of traps were designed by using locally available low cost inputs. The efficiency of these designs/models on the trapping of fruit flies is compared with the standard NIPHM design of pet bottle trap to assess its increased or decreased performance on trapping of fruit flies over check. Traps were evaluated by following Randomized Block Design with three replications in snake gourd ecosystem.

Designing procedure of varied models of Fruit fly traps

Horizontal cylindrical trap

Transparent mylar sheet was used to design the horizontal cylindrical trap. The sheet of 22

cm length and 16 cm breadth was rolled to make a cylindrical shape and the cut portion was sealed with transparent cellophane tape. The plastic petri plates with 9 cm diameter were placed in either side of the opening portion for closing purpose. Four spherical shaped holes (1.5 cm dia.) were made at the height of 4 cm from the top in either side as an entryway for fruit flies. Attractant lure material in wick system was hung in the centre of the trap using thread. The trapped fruit flies were collected by removing the petriplates in one side and again fit it as such (Plate 1).

Bottle trap two opening model

The disposed transparent mineral water bottle with the capacity of 1.5 L is used for making trap. Two bottles were taken to prepare one trap. In one bottle, the mid-portion of bottle with the length of 15 cm alone cut with a knife and separated. It gives the cylinder shape with the openings in both sides. The removed bottom portions of two bottles were used to pluck and cover in inverted way in the openings present in the main cylindrical part in both the sides. Five numbers of small holes with 1.0 cm dia. were made in the lateral concave areas as an entry hole, where the inverted bottom portion plucked. The lure was hung from the top mid portion of the trap as attractant material by using thread. The top opening mouth portion of the water bottle with the length of 6 cm was inserted in the mid bottom side of the cylindrical portion to increase the trapping efficiency and the outer open permanently glued and closed by using 7 cm dia. mylar film sheet. The fruit flies were easily removed by rotating the screw top mouth portion of bottle fitted at the bottom (Plate 2).

Cylindrical bucket trap

The trap is prepared by commercially available transparent plastic container measuring 12 cm height and 14 cm diameter. The top portion of the container was sealed with transparent sheet. Two square shaped fruit fly entry way (1.5 cm^2) were made in the mid opposite side of the container. A hole is made in the centre of the top lid area of the container for hanging of lure in wick system for fly attraction (Plate 3).

Vertical cylindrical trap

The commercially available transparent plastic containers of 13 cm height and 8 cm diameter were used. The bottom portion of the two containers were merged together and a hole with 2 cm dia. is made in that attached portion. In the top container's lid two parallel holes were made with the size of 1.5 cm dia. as an entry way for fruit flies. In the centre of the lid a small hole was created to hang the lure in cotton wick. The fruit flies attracted by the lure are entered through the perforations present in the top container lid and move towards the bottom container via the hole present in the top and bottom merged mid septal portion of the containers. The trapped fruit flies present in the bottom container were easily collected by opening the screw lid (Plate 4).

Bulb trap

The disposed plastic base LED bulbs are modified and evaluated as a trap by removing the inner panel components (chip + wire + capacitor + electrolysis) except lamp outer cover and housing. In a lamp holder region perforated holes is present in the entire portion. Four square shaped holes (1.0 cm^2) were made in the already existing perforations in all four directions. Lure was hung inside the lamp via the mid of top holder by making small hole at a height of 7 cm from the centre. The trapped fruit flies were collected easily by detaching the rotating bottom milky white housing portion of the bulb (Plate 5).

Coconut shell trap

The main aim of using coconut shell as a trap design is due to its eco-friendly nature and its easy availability in farm and home. The coconut was cut into two equal halves with 12 cm height and 9 cm diameter and the outer and inner regions was cleaned then used for the preparation of trap model (Plate 6).

Three spherical shaped holes (1.0 cm dia.) were created using drilling machine in the eye like sprouting scares already present on the shell. The banana slice smeared with 1 g powdered chlorpyrifos 10 G granule in one side of the slice and kept the applied portion placed in bottom shell in reverse position instead of lure impregnated cotton wick. After placing the attractant, top and bottom portion of the shell was attached together by using cellophane tape. Tie wire is used as a holding material for entire shell trap by making it as triangular shape and thread was tied in the bottom of the holding area. The trapped fruit flies entered through the holes made in top shell and trapped flies reach the banana slice region were collected by detaching the bottom shell by removing the cellophane tape and fitted as such after taking each observation.

Bottle trap half cut model

The disposed transparent plastic mineral water bottle having 1 L capacity was taken to modify it as bottle trap half cut model. The bottle was cut into 2/3rd portion at a height of 10 cm from the top and kept it in inverted position in inner side of the bottom portion of the bottle. The edges of the top and bottom portion were linked together by using a tie wire and opened top portion was covered, glued and sealed with transparent sheets. Three square shaped (1.5 cm^2) entry slits were provided at a height of 9 cm from the bottom. Lure component was hung inside the bottle from mid top by using thread (Plate 7).

Standard bottle trap

The standard trap was prepared as per the guidelines given in the NIPHM website, for the preparation the disposed transparent mineral water bottle with 1 liter capacity is taken and modified. The trap designed by making three square shaped (1.5 cm^2) entry holes at a height of 10 cm from the screw lid in equal distances with a sharp knife (Plate 8).

Small hole was made in the centre of the screw lid and thread was inserted for hanging of attractant lure and the trap was tied and hung in the field.

Lure preparation and placement of lure in traps

The fruit fly attractant materials were prepared by using commercially available cue lure and methyl eugenol lure. The para pheromone attractant was prepared by mixing of cue lure or methyl eugenol, ethanol and malathion 50 EC in the rate of 6:4:2.

The cotton wick (2.5 x 1 cm) was impregnated in the prepared para pheromonal attractants for 24 hours and then used to keep in the centre portion of the trap near the entryway of fruit flies. In coconut shell trap, 1 g powdered chlorpyrifos 10 G granule is applied in one side of banana slice is used as attractant source. During the entire experimental period, the attractant material was changed in every week. The position of traps were changed randomly to avoid the positional effect.

Statistical analysis

The trapping populations of fruit flies were collected at weekly intervals and the species were identified and categorized. The percent trapping efficiency of varied traps/ models were calculated by using the formula by (Divya *et al.,* 2019).

$$Trapping\ efficiency\ (\%) = \frac{\begin{matrix}Number\ of\ fruit\ flies \\ trapped/trap/week\end{matrix}}{\begin{matrix}Total\ number\ of\ fruit\ flies \\ trapped/trap/week\end{matrix}}\ X\ 100$$

The data on number of fruit flies trapped were statistically analysed by one factor analysis RBD with AGRES software after square root transformation. The trapping efficiency of designed traps was analysed using one factor analysis RBD with AGRES software after arcsine transformation. The mean values were compared by Least Significant Difference. The meteorological parameters *viz.*, maximum temperature, minimum temperature, relative humidity, rainfall maximum wind speed and minimum wind speed during the entire experimental period were collected from NASA ARC POWER website. The weather parameters were summarized into weekly averages and correlation and regression analysis were made with trapped fruit flies in varied designed traps. The correlation and regression analysis was worked out using MS Excel software.

Results and Discussion

Performance of designed traps in cue lure attractant

The pheromones *viz*., cue lure and methyl eugenol lures were commonly used as a attractant for trapping of the fruit flies *viz*., Z. *cucurbitae* and *B. dorsalis*, respectively. Trap designs of varied size and shape are important criteria in increasing the trapping population of fruit flies. The response of *Z. cucurbitae* in low cost designed traps along with standard check in cue lure para pheromone attractant is given in Table 1. Trapping of fruit flies in varied models with cue lure attractant indicated that bottle trap half cut model was found to be good and it catches significantly more number of fruit flies compared to other traps. The number of flies collected in bottle trap half cut model varied between 13.33 to 20.00 fruit flies/trap/week during 4th to 9th SMW. The standard bottle trap was significantly on par with cylindrical bucket trap and bottle trap two opening model in 6th SMW with the fruit fly catches of 6.67, 8.00 and 5.33 respectively. On comparing the designed traps, fly catches above the standard bottle traps are *viz*., bottle trap half cut model, vertical cylindrical trap, horizontal cylindrical trap and cylindrical bucket trap were performs well in fruit fly trapping and attracted significantly more number of fruit flies, whereas bottle trap half cut model, coconut shell trap and bulb trap were considered as low in trapping (Fig. 1).

The percent trapping efficiency of bottle trap half cut model in cue lure attractant was 19.67-24.10, it was followed by vertical cylindrical trap (17.05-19.88), horizontal cylindrical trap (15.08-16.27), cylindrical bucket trap (12.70-13.39), standard bottle trap (10.24-11.48), bottle trap two opening model (7.83-9.51), coconut shell trap (5.42-7.87) and bulb trap (3.01-6.23) (Fig. 2). The present finding is in confirmity with Manoj *et al.*, (2020) that cylindrical shape is performed better in trapping rather than other models, which captured *Z. cucurbitae* male fruit flies (6.5 adults/ trap/ day) than conical (3.08 adults/trap/day) and spherical shaped trap (1.67 adults/ trap/ day) in snake gourd. Both cue lure and methyl eugenol impregnated wooden disk placed in cylindrical jar trap has attracted maximum number of fruit fly catches as per the report of Divya *et al.*, (2019) in pumpkin and bottle gourd field.

Performance of designed traps in methyl eugenol lure attractant

The results of the varied designed traps placed with methyl eugenol as para pheromonal lure attractant shown that, bottle trap half cut

model attracted the maximum number of 12.33 to 18.67 fruit flies/trap throughout the study period. The vertical cylindrical trap and horizontal cylindrical trap the captured fruit flies seems to be within a range of 9.67 to 16.33 and 7.33 to 14.00 numbers/trap, respectively.

The standard bottle trap also performs statistically equal with cylindrical bucket trap and bottle trap two opening model in 4th and 5th SMW which was next followed by coconut shell trap and bulb trap.

Comparing the percent trapping efficiency with standard trap the bottle trap half cut model (21.54-28.03), vertical cylindrical trap (18.85-21.97), horizontal cylindrical trap (16.15-16.67), cylindrical bucket trap (12.12-13.46), standard bottle trap (9.09-10.68) were seems to be higher in number of catches/ trap. On the other hand bottle trap two opening model, coconut shell trap and bulb trap were registered minimum percent trapping of fruit flies (1.52-8.46) in trapping compared to standard bottle trap (9.09-10.68) (Fig. 3).

The result obtained in this investigation was supported by the earlier findings of Rajitha and Viraktamath (2005) that cylindrical and bottle traps attracted more number of *B. correcta* in guava orchard in Dharwad, Karnataka. In contrast, the findings of Chandaragi *et al.,* (2012) revealed bottle trap attracted significantly higher number of fruit fly catches than sphere, PCI and open trap (Table 3 and 4).

Venkatachalam *et al.,* (2014) also suggested that the vertical cylindrical trap is more effective in trapping the fruit flies in mango ecosystem in Kanyakumari region of Tamil Nadu. Similarly, Bajaj and Singh (2018) also endowed *B. zonata* and *B. dorsalis* were captured in triangular traps followed by PAU fruit fly trap, cylindrical traps and spherical traps in guava orchard, Punjab.

Correlation between fruit fly catches in designed traps in relation with weather parameters

The trap catches of fruit flies in all the models of traps are positively correlated with maximum and minimum temperature and negative correlation with relative humidity. In particular the seven models taken for evaluation the models identified for good trapping efficiency *viz.,* bottle trap half cut model, vertical cylindrical trap, horizontal cylindrical trap, cylindrical bucket trap are had a high positive correlation range of (r= +0.895 to +0.905) with the negative relationship of traps with relative humidity (r= -0.833 to -0.850), when compared with other traps like bottle trap two opening model, coconut shell trap, bulb trap and a stand check model which registered a positive correlation with temperature and rainfall at a range of (r= +0.858 to +0.896) and negative impact of relative humidity (r= -0.801 to -0.847). Considering the wind speed relevant with the trapped population it is highly positive with the fruit fly trapping efficiency irrespective of all trap designs (r= +0.160 to +0.260). The relationship of trapped fruit fly population and abiotic factors are in conformity with Laskar and Chatterjee (2010) on *Z. cucurbitae* fruit fly trapping in cue lure traps were positive correlation with minimum (r= +0.7596) and maximum temperature (r= +0.7376), rainfall (r= +0.4367), maximum relative humidity (r= -0.4249) was negatively correlated in foot hills of Himalaya (Table 5). Kate *et al.,* (2009) and Ghule *et al.,* (2014) also recorded the same results in Gujarat and West Bengal locations.

Ghule and Jha (2014) also entrusted the same relationship in maggot occurrence in pointed gourd that maximum temperature (r = +0.905), minimum temperature (r = +0.824) temperature and rainfall (r = +0.564) were positive correlation, but maximum relative humidity (r = -0.691) has negative correlation (Table 6).

Table.1 Trapping of fruit flies in different trap designs using cue lure as attractant material

S.No	Trap Design	Weekly observation (No. of insects trapped / cue lure trap)*						
		4th SMW#	5th SMW	6th SMW	7th SMW	8th SMW	9th SMW	Mean
1	Bulb trap	1.67 (1.46)^{h}	2.33 (1.68)^{h}	2.67 (1.77)^{g}	3.67 (2.11)^{h}	5.67 (2.48)^{h}	6.33 (2.61)^{h}	3.72 (2.05)^{h}
2	Cylindrical bucket trap	7.33 (2.80)^{d}	8.00 (2.91)^{d}	8.00 (2.97)^{d}	10.67 (3.38)^{d}	12.00 (3.53)^{d}	13.33 (3.81)^{d}	9.89 (3.22)^{d}
3	Coconut shell trap	3.00 (1.86)^{g}	3.67 (2.04)^{g}	4.00 (2.11)^{f}	5.00 (2.64)^{g}	7.00 (2.73)^{g}	8.00 (2.91)^{g}	5.11 (2.37)^{g}
4	Horizontal cylindrical trap	9.00 (3.08)^{c}	9.67 (3.19)^{c}	10.00 (3.24)^{c}	12.67 (3.63)^{c}	14.33 (3.85)^{c}	15.33 (4.02)^{c}	11.83 (3.51)^{c}
5	Bottle trap two opening model	4.33 (2.20)^{f}	5.00 (2.34)^{f}	5.33 (2.41)^{e}	6.67 (2.73)^{f}	8.67 (3.03)^{f}	9.67 (3.24)^{f}	6.61 (2.67)^{f}
6	Bottle trap half cut model	13.33 (3.72)^{a}	14.00 (3.81)^{a}	14.33 (3.85)^{a}	17.33 (4.22)^{a}	19.33 (4.45)^{a}	20.00 (4.53)^{a}	16.39 (4.11)^{a}
7	Vertical cylindrical trap	11.00 (3.39)^{b}	11.67 (3.49)^{b}	12.00 (3.53)^{b}	15.00 (3.93)^{b}	16.67 (4.14)^{b}	17.33 (4.22)^{b}	13.94 (3.80)^{b}
8	Standard bottle trap	5.67 (2.48)^{e}	6.33 (2.61)^{e}	6.67 (2.73)^{de}	8.67 (3.13)^{e}	10.33 (3.28)^{e}	11.67 (3.63)^{e}	8.22 (2.95)^{e}
SE(d)		0.08	0.12	0.13	0.12	0.10	0.10	-
CD (p=0.05)		0.17	0.25	0.27	0.26	0.23	0.22	-
CV (%)		3.79	5.25	5.49	4.71	3.77	3.53	-

*Mean of three replications /#SMW – Standard Meteorological Week

Figures in parentheses are √x+0.5 transformed values

Values in the column followed by same letters are not different statistically, (p=0.05) by LSD

Table.2 Percentage of fruit flies collected in various traps of cue lure attractant

Trap design (2020)	Fruit fly efficiency of various designs (%)					
	4th SMW# (22 January–28 January)	5th SMW (29 January-4 February)	6th SMW (05 February- 11 February)	7th SMW (12 February- 18 February)	8th SMW (19 February-25 February)	9th SMW (26 February-04 March)
Bulb trap	3.01 (10.80)^{h}	3.85 (12.03)^{h}	4.23 (12.56)^{h}	4.60 (13.06)^{h}	6.03 (14.81)^{h}	6.23 (15.03)^{h}
Cylindrical bucket trap	13.25 (21.77)^{d}	13.19 (21.71)^{d}	12.70 (21.30)^{d}	13.39 (21.88)^{d}	12.77 (21.36)^{d}	13.11 (21.65)^{d}
Coconut shell trap	5.42 (14.08)^{g}	6.04 (14.82)^{g}	6.35 (15.17)^{g}	6.28 (15.09)^{g}	7.45 (16.37)^{g}	7.87 (16.81)^{g}
Horizontal cylindrical trap	16.27 (24.17)^{c}	15.93 (23.92)^{c}	15.87 (23.87)^{c}	15.90 (23.89)^{c}	15.25 (23.38)^{c}	15.08 (23.25)^{c}
Bottle trap two opening model	7.83 (16.78)^{f}	8.24 (17.20)^{f}	8.47 (17.42)^{f}	8.37 (17.32)^{f}	9.22 (18.17)^{f}	9.51 (18.44)^{f}
Bottle trap half cut model	24.10 (29.73)^{a}	23.08 (29.05)^{a}	22.75 (28.83)^{a}	21.76 (28.15)^{a}	20.57 (27.32)^{a}	19.67 (26.69)^{a}
Vertical cylindrical trap	19.88 (26.84)^{b}	19.23 (26.37)^{b}	19.05 (26.24)^{b}	18.83 (26.08)^{b}	17.73 (25.27)^{b}	17.05 (24.76)^{b}
Standard bottle trap	10.24 (19.13)^{e}	10.44 (19.32)^{e}	10.58 (19.44)^{e}	10.88 (19.71)^{e}	10.99 (19.81)^{e}	11.48 (20.25)^{e}
SE(d)	0.29	0.17	0.28	0.20	0.31	0.19
CD (p=0.05)	0.63	0.37	0.62	0.42	0.67	0.40
CV (%)	1.75	1.03	1.72	1.16	1.84	1.10

*Mean of three replications/ #SMW – Standard Meteorological Week
Figures in parentheses are arcsine transformed values
Values in the column followed by same letters are not different statistically, (p=0.05) by LSD

Table.3 Trapping of fruit flies in different trap designs using methyl eugenol as attractant

S.No	Trap Design	Weekly observation (No. of insects trapped / methyl eugenol trap)*						
		4th SMW#	5th SMW	6th SMW	7th SMW	8th SMW	9th SMW	Mean
1	Bulb trap	0.67 (1.05)^{g}	1.33 (1.34)^{g}	1.67 (1.46)^{h}	2.67 (1.77)^{h}	3.00 (1.86)^{h}	4.00 (2.11)^{h}	2.22 (1.65)^{h}
2	Cylindrical bucket trap	5.33 (2.41)^{d}	6.67 (2.68)^{d}	7.67 (2.86)^{d}	9.33 (3.13)^{d}	10.33 (3.29)^{d}	11.67 (3.49)^{d}	8.50 (3.00)^{d}
3	Coconut shell trap	1.67 (1.46)^{f}	2.67 (1.77)^{f}	2.67 (1.77)^{g}	4.00 (2.11)^{g}	4.67 (2.27)^{g}	5.67 (2.48)^{g}	3.56 (2.01)^{g}
4	Horizontal cylindrical trap	7.33 (2.80)^{c}	8.67 (3.03)^{c}	9.67 (3.19)^{c}	11.33 (3.44)^{c}	12.67 (3.63)^{c}	14.00 (3.81)^{c}	10.61 (3.33)^{c}
5	Bottle trap two opening model	3.00 (1.86)^{e}	4.00 (2.11)^{e}	4.67 (2.27)^{f}	5.67 (2.48)^{f}	6.33 (2.61)^{f}	7.33 (2.79)^{f}	5.17 (2.38)^{f}
6	Bottle trap half cut method	12.33 (3.58)^{a}	13.00 (3.67)^{a}	14.00 (3.81)^{a}	16.00 (4.06)^{a}	17.67 (4.26)^{a}	18.67 (4.38)^{a}	15.28 (3.97)^{a}
7	Vertical cylindrical trap	9.67 (3.19)^{b}	10.67 (3.34)^{b}	11.67 (3.48)^{b}	13.67 (3.76)^{b}	15.00 (3.94)^{b}	16.33 (4.10)^{b}	12.83 (3.65)^{b}
8	Bottle trap (check)	4.00 (2.11)^{de}	5.33 (2.41)^{de}	6.00 (2.54)^{e}	7.33 (2.79)^{e}	8.33 (2.97)^{e}	9.00 (3.08)^{e}	6.67 (2.68)^{e}
SE(d)		0.16	0.19	0.13	0.13	0.13	0.12	-
CD (p=0.05)		0.35	0.40	0.27	0.29	0.27	0.26	-
CV (%)		8.68	1.13	5.83	5.57	5.00	4.49	-

*Mean of three replications/ #SMW – Standard Meteorological Week
Figures in parentheses are √x+0.5 transformed
Values in the column followed by same letters are not different statistically, (p=0.05) by LSD

Table.4 Percentage of fruit flies collected in various traps of methyl eugenol attractant

Trap design (2020)	Fruit fly efficiency of various designs (%)					
	4th SMW# (22 January– 28 January)	5th SMW (29 January- 4 February)	6th SMW (05 February- 11 February)	7th SMW (12 February- 18 February)	8th SMW (19 February- 25 February)	9th SMW (26 February- 04 March)
Bulb trap	1.52 (8.16)^{h}	2.55 (10.05)^{h}	2.87 (10.58)^{h}	3.81 (17.98)^{h}	3.85 (12.03)^{h}	4.62 (13.07)^{h}
Cylindrical bucket trap	12.12 (20.81)^{d}	12.74 (21.34)^{d}	13.22 (21.74)^{d}	13.33 (21.83)^{d}	13.25 (21.77)^{d}	13.46 (21.94)^{d}
Coconut shell trap	3.79 (11.95)^{g}	5.10 (13.68)^{g}	4.60 (13.05)^{g}	5.71 (14.43)^{g}	5.98 (14.75)^{g}	6.54 (15.39)^{g}
Horizontal cylindrical trap	16.67 (24.47)^{c}	16.56 (24.40)^{c}	16.67 (24.48)^{c}	16.19 (24.11)^{c}	16.24 (24.15)^{c}	16.15 (24.09)^{c}
Bottle trap two opening model	6.82 (15.69)^{f}	7.64 (16.58)^{f}	8.05 (17.00)^{f}	8.10 (17.05)^{f}	8.12 (17.07)^{f}	8.46 (17.42)^{f}
Bottle trap half cut model	28.03 (32.28)^{a}	24.84 (30.22)^{a}	24.14 (29.76)^{a}	22.86 (28.90)^{a}	22.65 (28.76)^{a}	21.54 (28.00)^{a}
Vertical cylindrical trap	21.97 (28.30)^{b}	20.38 (27.19)^{b}	20.11 (27.00)^{b}	19.52 (26.58)^{b}	19.23 (26.37)^{b}	18.85 (26.09)^{b}
Standard bottle trap	9.09 (18.04)^{e}	10.19 (19.08)^{e}	10.34 (19.22)^{e}	10.48 (19.35)^{e}	10.68 (19.54)^{e}	10.38 (19.27)^{e}
SE(d)	0.18	0.18	0.19	0.33	0.27	0.22
CD (p=0.05)	0.38	0.40	0.40	0.71	0.57	0.47
CV (%)	1.08	1.13	1.14	1.97	1.59	1.30

*Mean of three replications/ #SMW – Standard Meteorological Week
Figures in parentheses are arcsine transformed values
Values in the column followed by same letters are not different statistically, (p=0.05) by LSD

Table.5 Correlation between weather parameters and fruit fly trap catches in varied trap designs with cue lure attractant

Weather Parameters	Designed traps in cue lure attractant							
	Bulb trap	Cylindrical bucket trap	Coconut shell trap	Horizontal cylindrical trap	Bottle trap two opening model	Bottle trap half cut model	Vertical cylindrical trap	Standard bottle trap
Maximum temperature (ºC)	0.860	0.902	0.858	0.904	0.870	0.895	0.905	0.896
Minimum temperature (ºC)	0.802	0.743	0.824	0.735	0.804	0.708	0.701	0.786
Rainfall (mm)	0.751	0.661	0.724	0.698	0.723	0.723	0.710	0.683
Relative humidity (%)	-0.801	-0.850	-0.806	-0.849	-0.816	-0.833	-0.845	-0.847
Maximum wind speed (m/s)	0.250	0.160	0.208	0.222	0.215	0.260	0.254	0.182
Minimum wind speed (m/s)	0.198	0.209	0.162	0.249	0.186	0.290	0.289	0.189

Table.6 Correlation between weather parameters and fruit fly trap catches in varied trap designs with methyl eugenol lure attractant

Weather Parameters	Trap designs with methyl eugenol attractant							
	Bulb trap	Cylindrical bucket trap	Coconut shell trap	Horizontal cylindrical trap	Bottle trap two opening model	Bottle trap half cut model	Vertical cylindrical trap	Standard bottle trap
Maximum temperature (ºC)	0.957	0.957	0.940	0.946	0.958	0.918	0.939	0.954
Minimum temperature (ºC)	0.817	0.803	0.795	0.808	0.822	0.771	0.789	0.777
Rainfall (mm)	0.583	0.639	0.623	0.660	0.626	0.702	0.665	0.674
Relative humidity (%)	-0.928	-0.921	-0.892	-0.906	-0.924	-0.872	-0.899	-0.905
Maximum wind speed (m/s)	0.107	0.198	0.115	0.209	0.178	0.255	0.214	0.243
Minimum wind speed (m/s)	0.078	0.131	0.092	0.141	0.096	0.233	0.180	0.154

Plate.1 Horizontal cylindrical trap

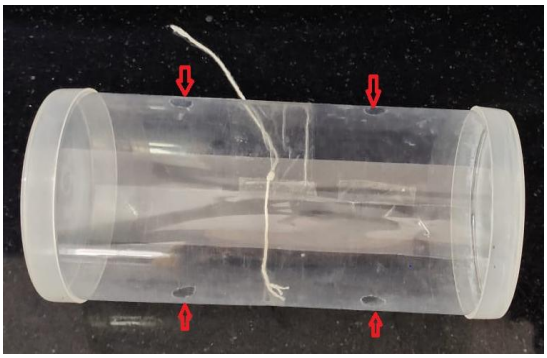


Plate.2 Bottle trap two opening model

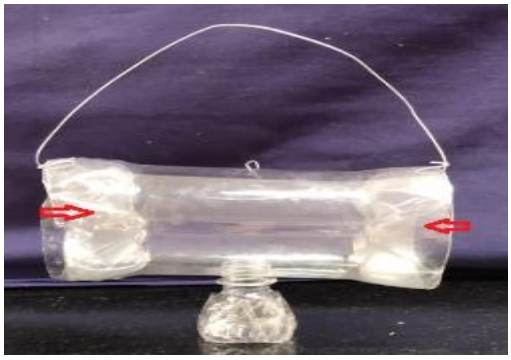


Plate.3 Cylindrical bucket trap

Plate.4 Vertical cylindrical trap

Plate.5 Bulb trap

Plate.6 Coconut shell trap

Plate.7 Bottle trap half cut model

Plate.8 Standard bottle trap

Fig.1 Mean trap catches of fruit flies in designed traps

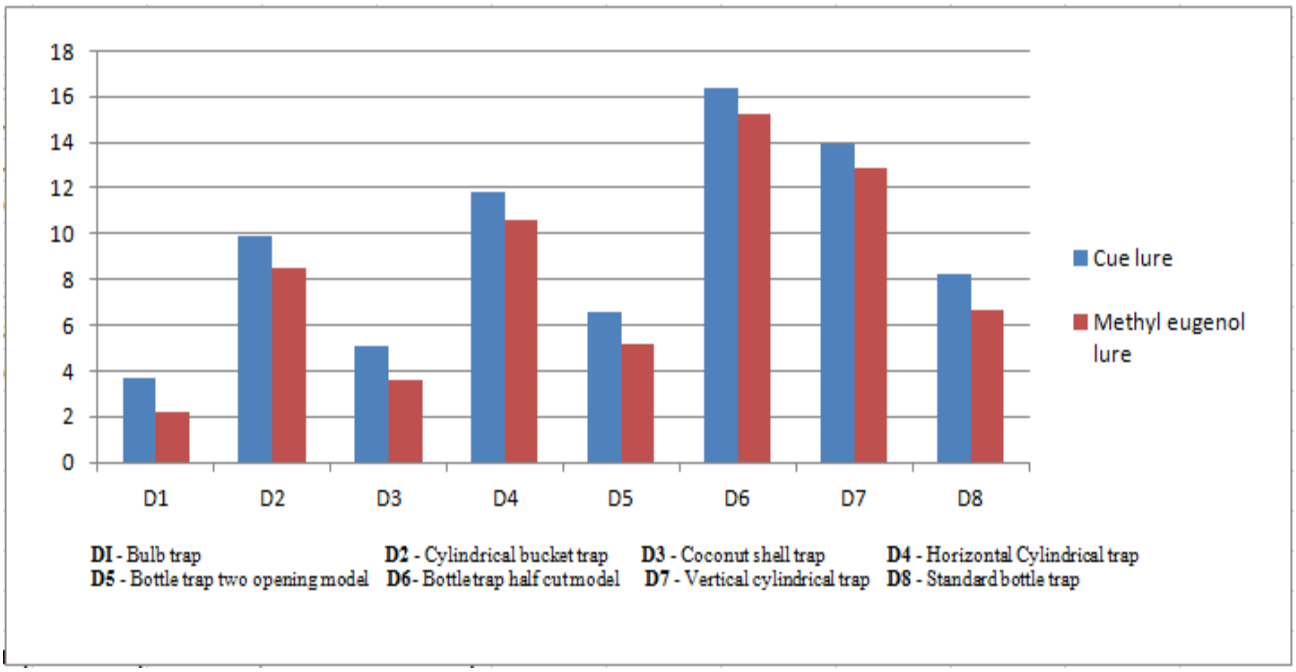


Fig.2 Designed trap efficiency in cue lure attractant

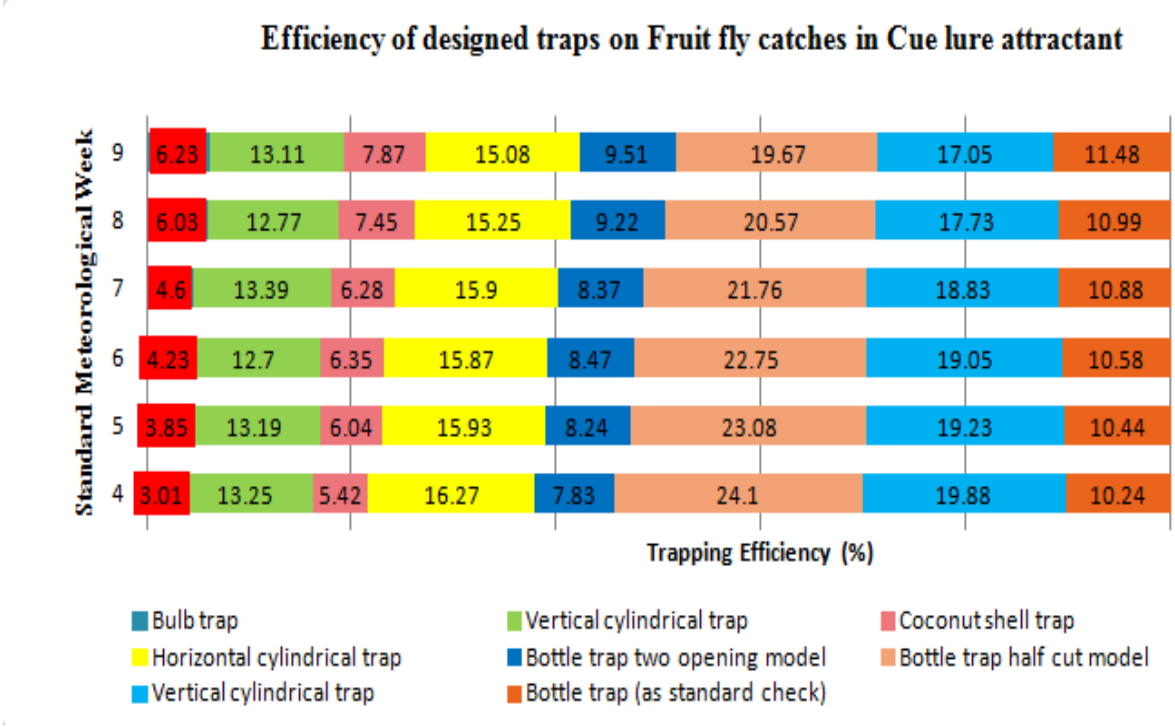
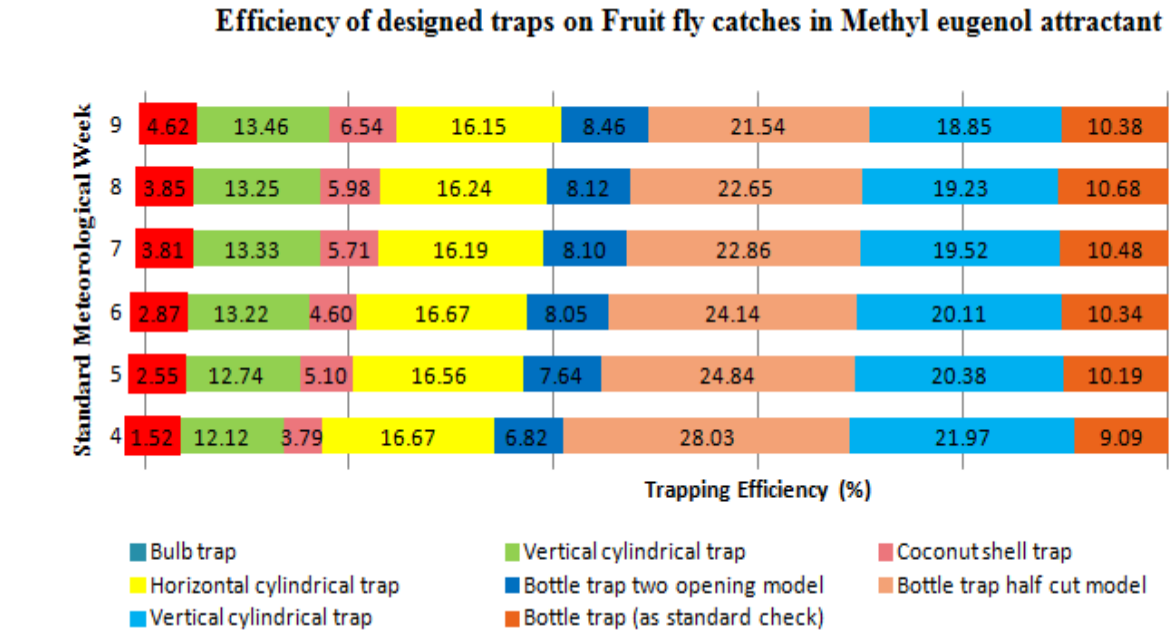


Fig.3 Designed trap efficiency in methyl eugenol attractant



The traps baited with methyl eugenol lure the results of the correlations study indicated that the trapped catches of fruit fly had significant and positively correlation with a range of maximum temperature (r= 0.918 to 0.957), minimum temperature (r= 0.771 to 0.822) and

rainfall (r= 0.583 to 0.702), non-significantly positive with minimum (r= 0.078 to 0.233) and maximum wind speed (r= 0.107 to 0.243), while relative humidity (r= -0.872 to -0.928) had significant negative correlation irrespective of all trap designs evaluated (Table 6). This finding was in tune with the results obtained the traps baited with cue lure.

It indicates that irrespective of the nature of attractants the impact of abiotic factors on the trapping efficiency of fruit flies are same in position.

The impact of abiotic factors registered in the present experimental results are also in accordance with the previous reports of Das *et al.*, (2017) that *B. zonata* has positive correlation with maximum temperature (0.543), minimum temperature (0.192) and rainfall (0.017) but negatively correlated with morning relative humidity (-0.241) and afternoon humidity (-0.215) during April - May months in mango orchard, Nadia, West Bengal.

The study related to increase the fruit fly catches and trapping efficiency revealed that the performance of designed traps are in hierarchy of bottle trap half cut model > vertical cylindrical trap > horizontal cylindrical trap > cylindrical bucket trap > standard bottle trap > bottle trap two opening model > coconut shell trap > bulb trap in both cue lure and methyl eugenol attractant.

In both the attractants, bottle trap half cut model, vertical cylindrical trap, horizontal cylindrical trap and cylindrical bucket trap are the good in trapping efficiency and the traps *viz*., bottle trap two opening model, coconut shell trap and bulb trap were least in performance in trap catches.

The weather parameters *viz*., maximum temperature, minimum temperature and rainfall has significantly positive correlation with trapped fruit flies in designed traps, maximum wind speed and minimum wind speed were non-significant and positive, whereas relative humidity was negatively correlated.

Acknowledgement

The authors are thankful to the Department of Plant Protection, ADAC&RI, TNAU, Tiruchirappalli for granting the permission to carry out the experiment in farmer's field. The Tamil Nadu State Council for Science and Technology (TNSCST) is duly acknowledged for their support under the student project scheme 2019-20.

References

Bajaj, K., and Singh, S. 2018. Response of fruit flies, *Bactrocera spp*. (Diptera: Tephritidae) to different shapes of methyl eugenol based traps in guava orchard of Punjab. Journal of Economic Entomology, 6(2): 2435-2438.

Chandaragi, M., Sugandhi, R., Kumar, V.M.M., and Uppar, V. 2012. Evaluation of different trap designs for capture of fruit flies in mango orchard. In: Proceedings of International Conference of Entomology, Punjab University, Patiala, 28.

Das, U., Okram, S., and Jha, S.K. 2017. Species diversity and monitoring of population dynamics of two species of *Bactrocera* (*B. dorsalis*, *B. zonata*) through methyl eugenol traps at lower gangetic alluvium of West Bengal. Journal of Entomology and Zoology Studies, 5(4): 372-376.

Deepa devi, N. 2017. Medicinal values of *Trichosanthes cucumerina* L. (Snake gourd) – A Review. British Journal of Pharmaceutical Research, 16(5): 1-10.

Dhillon, M.K., Ram singh, Naresh, J.S., and Sharma, H.C. 2005. The melon fruit fly, *Bactrocera cucurbitae*: A review of its biology and management. Journal of Insect Science, 1536-2442.

Divya, S., Kalyanasundaram, M., and

Sidhanandham, S. 2019. Studies on combination of different traps and lures in cucurbit fruit flies attraction. Journal of Entomology and Zoology Studies, 7(3): 996-998.

Ghule, T.M., and Jha, S. 2014. The incidence studies of melon fruit fly (*Bactrocera cucurbitae* coq.) in relation to weather parameters on pointed gourd (*Trichosanthes dioica* roxb.). Ecology, Environment and Conservation, 20: 1-4.

Ghule, T.M., Uikey, B.L., Barma, P.R., and Jha, S. 2014. Incidence studies on some important insect-pests of Cucumber (*Cucumis Sativus* L.). The Ecoscan, 8(1&2): 177-180.

Hardy, D.E. 1979. Review of economic fruit flies of the South Pacific region. Pacific Insects, 20: 429-432.

Kapoor, V.C. 2002. Fruit fly pests and their present status in India. In: Proceedings of 6th International Fruit fly Symposium.

Kapoor, V.C. 2005. Taxonomy and biology of economically important fruit flies of India. Israel Journal of Entomology, 35(36): 459-475.

Kate, A.O., Bharodia, R.K., Joshi, M.D., Pardeshi, A.M,, and Makadia, R.R. 2009. Seasonal incidence of fruit fly, *Bactrocera cucurbitae* (Coquillet) on cucumber. Asian sciences, 4: 83-84.

Katsoyannos, B.I. 1989. Field responses of Mediterranean fruit flies to spheres of different color. Fruit Flies of Economic Importance, 11083: 393-400.

Laskar, N., and Chatterjee, H.I. 2010. The effect of meteorological factors on the population dynamics of melon fly, *Bactrocera cucurbitae* (Coq.) (Diptera: Tephritidae) in the foot hills of Himalaya. Journal of Applied Sciences and Environmental Management, 14(3): 53-58.

Manoj, A.M., Sridharan, S., Elango, K., Muthukumar, M. 2020. Use of traps and baits in the management of cucurbit fruit fly, *Bactrocera cucurbitae* (Coquillett). International Journal of Advanced Biological Research, 10 (1): 2250-3579.

Narayanan, E.S. 1953. Seasonal pests of crops. Indian Farming, 3(4): 29-31.

Nasiruddin, M., Alam, S.N., Khorsheduzzaman, A.K.M., Rahman, A.K.M.Z., Karim, A.N.M.R., Jasmine, H.S., and Rajotte, E.G. 2004. Integrated management of cucurbit fruit fly, *Bactrocera cucurbitae* Coquillett in Bangladesh. IPM CRSP Bangladesh Site Tech, Bull. No.1. P. 16.

Pedigo, L.P., and Rice, M. 2008. Entomology and Pest Management. Edition 6, Prentice Hall: Upper Saddle River, NJ, USA, 784.

Rajitha, A.R., and Viraktamath, S. 2005. Efficacy of different types of traps in attracting fruit flies in guava orchard at Dharwad, Karnataka. Pest Management and Economic Zoology, 131: 111-120.

Sureshbabu, K.S., and Viraktamath, S. 2003. Species diversity and population dynamics of fruit flies (Diptera: Tephritidae) on mango in Northern Karnataka. Pest Management and Economic Zoology, 11(2): 1-10.

Vargas, Roger, I., John, D., Stark, and Toshiyuki Nishida. 1989. Abundance, distribution and dispersion indices of the oriental fruit fly and melon fly (Diptera: Tephritidae) on Kauai, Hawaiian Islands. Journal of Economic Entomology, 82(6): 1609-1615.

Venkatachalam, A., Sithanantham, S., Kumar, S.S., Mathivanan, N., Ramkumar, D., Janarthanan, S., and Marimuthu, T. 2014. Seasonal catches of fruit flies in traps with two lure sources in noni. Indian Journal of Entomology, 76(4): 317-320.

How to cite this article:

Sowmiya, L., M. Chandrasekaran and Soundararajan, R. P. 2021. Evaluation of Modified Cost Effective Trap Designs to enhance the Trapping Efficiency of Fruit Flies in Snake Gourd Ecosystem. *Int.J.Curr.Microbiol.App.Sci.* 10(03): 990-1005.
doi: https://doi.org/10.20546/ijcmas.2021.1003.126