Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(6): 895-899

Received: 22-09-2020
Accepted: 25-10-2020

S Abinaya
Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Elaiyabharathi T
Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Srinivasan T
Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Paramasivam M
Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Corresponding Author:
S Abinaya
Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Field evaluation of food baits against female melon fruit fly, *Zeugodacus cucurbitae* (Coquillett) (Diptera: Tephritidae)

S Abinaya, Elaiyabharathi T, Srinivasan T and Paramasivam M

DOI: https://doi.org/10.22271/j.ento.2020.v8.i6l.7957

Abstract
The attraction of the female melon fly, *Zeugodacus cucurbitae* (Coq.) (Diptera: Tephritidae) to three food baits were evaluated in snake gourd (*Trichosanthes anguina* L.) and ridge gourd (*Luffa acutangula* (L.)) ecosystems at both Coimbatore and Tiruppur districts during January to march 2020. Food bait admixtures were prepared by combining base baits (guava-B1, muskmelon-B2 and guava+ muskmelon-B3) and bait additives (yeast, food grade alcohol, cane sugar and ProtineX®). The result indicated that both ridge gourd and snake gourd at Coimbatore (23 fruit flies/trap/day) attracted more adult flies than at Tiruppur. Greater number of *Z. cucurbitae* were attracted to food bait traps in snake gourd field (24 fruit flies/trap/day) at both Coimabtore and Tiruppur. In common, the performance of guava bait admixture (21 fruit flies/trap/day) was relatively greater than other two baits by trapping more adult flies. At individual sites, the three food baits attracted equivalently higher number of females than males (about 70% females). The number of adult flies trapped at first week (42 fruit flies/trap/day) was high and gradually decreased in successive weeks and found low at 11th (2 fruit fly/trap/day) and 12th (1 fruit fly/trap/day) weeks. This management practice for *Z. cucurbitae* effectively reduced the pest population by attracting most females.

Keywords: Melon fruit fly, *Zeugodacus* cucurbitae, food baits, female attractant, bait traps, field evaluation

Introduction
The melon fruit fly, *Zeugodacus cucurbitae* (Coquillett) is an important quarantine pest, damages all vegetable crops throughout the world [1]. Based on the season and the host, it causes 30 – 100% loss [2]. The management of this pest with surface insecticides is difficult, as *Z. cucurbitae* larvae prevails inside the fruit and pupates in the soil [3]. This provoked the development of integrated pest management for melon fruit fly [4]. Present IPM strategies comprise traps, field sanitation, host plant resistance, fruit bagging, sterile insect technique (SIT), parasitoids (*Fopius arisanus*), predator (*Philonthus* spp.), pathogens (*Bacillus thuringensis* (Bt), protozoa and fungi) and nematodes (*Neoaplectana* spp and *Heterorhabditis* spp.), insecticides and biopesticides [5]. Traps with attractants are found effective for monitoring and mass trapping of this pest [6]. Relatively, male lures like cuelure and melolure have received huge attention than female attractants. The lures that attracts females have the potential to control the pest population by trapping females and preventing their future progeny [7]. Current female targeted lures include fermenting sugars, yeast, ammonium salts and hydrolyzed proteins as food attractants [8, 9]. Various food-based attractants have been available either as liquid protein hydrolysates (e.g., Nulure, Mazoferm), yeast products (e.g., Torula yeast and hydrolyzed waste yeast from breweries) and GF-120 (formulated with spinosad as toxicant), or dry bait (BioLure consisting of Putrescine, Trimethylamine, and Ammonium Acetate) [10, 11]. ProtineX® with guava pulp attracts more female fruit flies [12].
Generally, *Z. cucurbitae* shows a strong response to food based baits [13]. Food baited traps were developed for the management of *Z. cucurbitae* [14]. Both traps and baits prepared from locally available materials found eco-friendly and effective for the management of fruit flies [15]. Fruits like guava and musk melon pulps after fermentation attracts melon fruit fly. This attraction is further enhanced with several additives like yeast, cane sugar, protein and food grade alcohol. However, the effective food baits are identified, its performance in managing the pest is essential. The novel technique after undergoing several field experiments should

reach the end user. Continuous attraction of melon fruit flies in long term under filed condition by food baits is recorded. The reduction of fruit fly population through mass trapping provides an effective method for the management of this pest. The objective of the present study was to further evaluate the attractiveness of food baits (guava, musk melon + yeast, food grade alcohol, cane sugar and protineX®). The study was conducted in two districts, Coimbatore and Tiruppur in both snake gourd and ridge gourd ecosystems. Results focussing on capture of female *Z. cucurbitae* are presented for a period of 12 weeks at 4 sites.

Materials and methods

Experimental sites

As the melon fly was a major pest found infesting snake gourd (*Trichosanthes anguina* L.) and ridge gourd (*Luffa acutangula* (L.) gardens in Tamil Nadu. The present field screening experiments were conducted in four sites in two locations, during January to March 2020. The Location I - Coimbatore district, Tamil Nadu with snake gourd ecosystem at TNAU orchard (11.01°N & 76.93°E)- Site 1 and ridge gourd ecosystem at farmer's field, Sundrapuri, Pollachi (10.59°N & 76.92°E)- Site 2 and Location II –Tirupur district, Tamil Nadu with snake gourd ecosystem at farmer's field, Kethanor, Palladam (10.92°N & 77.26°E)- Site 3 and ridge gourd ecosystem at farmer's field, Goundampalayam (11.02 °N & 77.31 °E)- Site 4. The area of the selected fields at sites 1,3 and 4 was 2 acres and at site 2 was 2.5 acres. The selected fields consisted of crops at effective fruiting stage.

Traps

The trap designed by Pujar *et al*. 2018 was used with slight modifications. The bottom portion was provided with 12-18 entry holes in two rows instead one row in previously designed bottle traps [14].

Preparation of food baits

From the previous research work () the three most effective food baits, Guava (30 g) + Yeast (0.3 g) + FGA (10 ml) + CS (3 g) + ProtineX® (3 g), Muskmelon (40 g) + Yeast (0.4 g) + FGA (10 ml) + CS (4 g) + ProtineX® (4 g) and Guava + Muskmelon (20+20 g) + Yeast (0.4 g) + FGA (10 ml) + CS (4 g) + ProtineX® (4 g) were selected for attracting higher number of female melon fruit flies.

Base baits: Guava and Musk melon and Bait additives: dry yeast, food grade alcohol, cane sugar and ProtineX®, available in the market were purchased. The fully ripen fruits were washed, cut into pieces and pureed with hands. About one kg of each fruit pulps were needed for preparing baits for 2 acres. For one kg fruit pulp, 10g of yeast, 250ml of food grade alcohol, 100g of cane sugar and 100g of protineX® were added and mixed. From this 450 g of guava and musk melon pulps were taken and mixed together in separate container. The three food bait admixtures, guava (B1), musk melon (B2) and guava + musk melon (B3). In airtight plastic containers of one kg capacity, B1(900g), B2 (900 g) and B3 (900 g) baits were taken and allowed to ferment for 36 hours.

Sampling

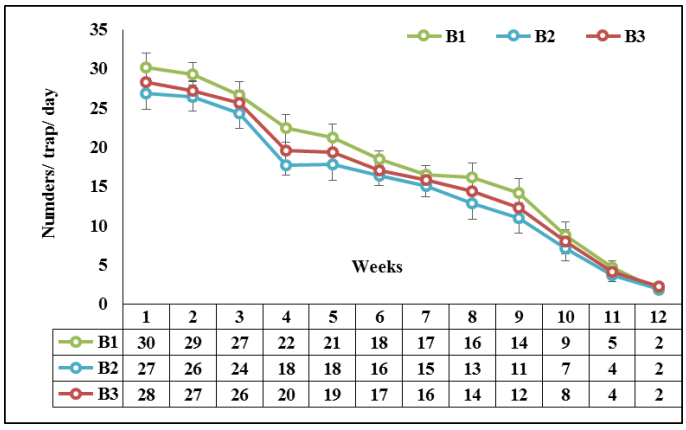
For all the four sites, the experimental design used randomized block. The same sampling procedure was followed at all the sites. each bait type was replicated 15 times at sites 1,3 and 4 and 20 times at site 2, since the area is larger at site 2. Each block had one representative of each bait. The fermented bait materials were weighed, B1(50 g), B2 (60 g) and B3 (60g), and placed in each bottle traps using a spoon in the field. The traps were tied to the grid at 2m above the ground with13 m apart inside and between blocks. The fruit flies trapped in the top portion were collected weekly over the sampling period. The collected fruits flies were sexed and counted. After collecting the trapped melon fruit flies, the traps were rotated sequentially in the same block in a clockwise direction, whereas the baits were replaced with fresh one, on a weekly basis over a 12weeks period. The food bait trap positions were sequentially changed between each sampling intervals to reduce the influence of the position of the trap on fruit fly captures. The reduction in the trapped population over the period shows the effectiveness of food baits in managing the melon fruit flies.

Data analysis

The data collected on total adult fruit flies, females and males from field experiments at four sites were used for statistical analysis. The data collected from randomized block design and were transformed to $\sqrt{x+0.5}$ to stabilize the variance. The analysis of variance (ANOVA) was performed for individual sites and combining all the sites. The means were separated by Tukey's HSD test. Paired *t*-test was performed for sex comparisons. These statistical analyses were performed using the software IBM SPSS Statistics version 22.0.

Results

The experiment conducted in snake gourd field at Coimbatore over 12weeks period showed the efficiency of three different food bait traps in attracting the female melon fruit flies (Fig. 1). For this experiment, food baits (F = 7.67, df = 2,490, P= 0.001) and weeks (F = 114.02, df = 11,490, P< 0.001) had significant impact on trapping of female *Z. cucurbitae*. Their interaction, food baits × weeks was not significant (P> 0.05). All the three food bait traps showed a decrease in the number of melon fruit fly attraction down the weeks. The highest number of females were attracted during the first (28 females/trap/day), second (28 females/trap/day) and third weeks (26 females/trap/day). By 11th (4 females/trap/day) and 12th (2 females/trap/day) weeks, the number of females attracted was the lowest. The food bait based on Guava (18 females/trap/day) attracted consistently higher number of females than other two food baits, over the period.



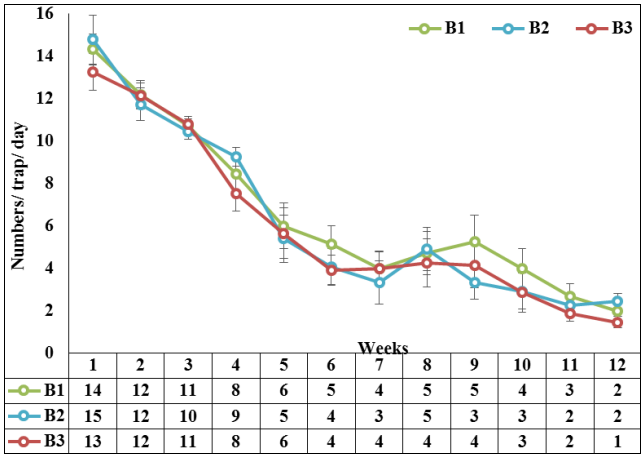
	1	2	3	4	5	6	7	8	9	10	11	12
B1	30	29	27	22	21	18	17	16	14	9	5	2
B2	27	26	24	18	18	16	15	13	11	7	4	2
B3	28	27	26	20	19	17	16	14	12	8	4	2

Fig 1: Field evaluation of food baits for female *Z. cucurbitae* in site 1. Points represent means (± SE) of 15 traps per food bait.

In this, the potential of the selected food baits was evaluated in snake gourd field at Tiruppur for a period of 12 weeks. Weeks (F = 73.93, df = 11,490, P< 0.001) significantly influenced the attraction of females for the food baits. Neither the food bait nor the interaction were significant (P> 0.05).

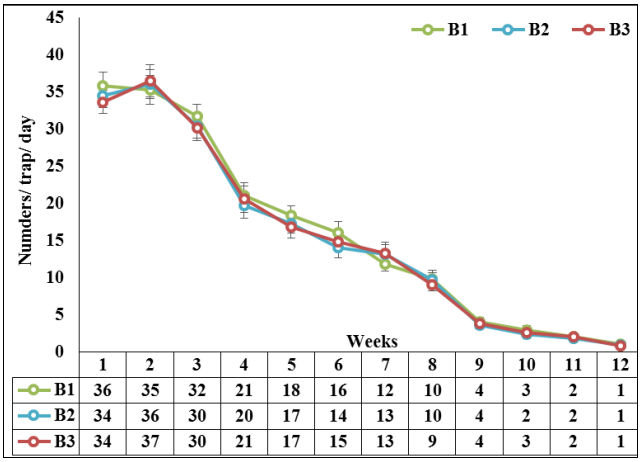
Examination of the data (Fig. 2) reflected the fact that the number of females attracted to the food bait traps decreased with time. The female numbers were significantly high during the first (14 females/trap/day) and second (12 females/trap/day) weeks. The population reached lowest during 10th (3 females/trap/day), 11th (2 females/trap/day) and 12th (2 females/trap/day) weeks. Almost, all the three food baits attracted similar number of *Z. cucurbitae* females.

In Ridge gourd field at Coimbatore, for the trapping of female *Z. cucurbitae*, week (F = 381.68, df = 11,665, P< 0.001) alone had significant effect. Neither the food bait nor the interaction were significant (P> 0.05). The results (Fig. 3) showed decreasing trend in attracting the females over the period. The numbers were high at the weeks one (35 females/trap/day) and two (36 females/trap/day). The lowest number of females was found at the weeks 11 (2 females/trap/day) and 12 (1 female/trap/day). There was no significant difference found among the three food bait traps in attracting the female *Z. cucurbitae*.



	1	2	3	4	5	6	7	8	9	10	11	12
B1	14	12	11	8	6	5	4	5	5	4	3	2
B2	15	12	10	9	5	4	3	5	3	3	2	2
B3	13	12	11	8	6	4	4	4	4	3	2	1

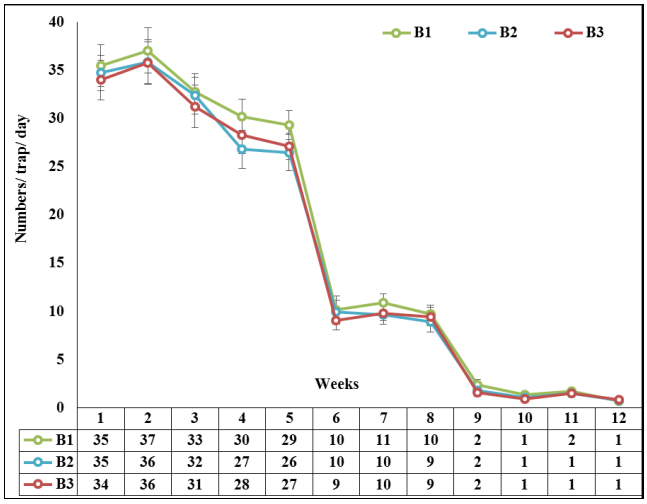
Fig 2: Field evaluation of food baits for feamle *Z. cucurbitae* in site 2. Points represent means (± SE) of 20 traps per food bait



	1	2	3	4	5	6	7	8	9	10	11	12
B1	36	35	32	21	18	16	12	10	4	3	2	1
B2	34	36	30	20	17	14	13	10	4	2	2	1
B3	34	37	30	21	17	15	13	9	4	3	2	1

Fig 3: Field evaluation of food baits for *Z. cucurbitae* in site 3. Points represent means (± SE) of 15 traps per food bait

For evaluating the food baits, Ridge gourd field at Tiruppur was selected. In this, the significant impact on attracting the females was found only for the weeks (F =392.84, df = 11,490, P< 0.001). From the data obtained (Fig. 4), the number of females were highest during first three weeks, 1st (35 females/trap/day), 2nd (36 females/trap/day) and 3rd (32 females/trap/day). The female melon fruit fly reduced to a greater extent during 9th week and remained low, till 12th week. All three food bait types attracted statistically equivalent number of female melon fruit flies.



	1	2	3	4	5	6	7	8	9	10	11	12
B1	35	37	33	30	29	10	11	10	2	1	2	1
B2	35	36	32	27	26	10	10	9	2	1	1	1
B3	34	36	31	28	27	9	10	9	2	1	1	1

Fig 4: Field evaluation of food baits for *Z. cucurbitae* in site 4. Points represent means (± SE) of 15 traps per food bait

On pooling the data obtained from the above experiments, locations (F= 515.51, df= 1,1974 P< 0.001), crops (F= 344.09, df= 1,1974 P< 0.001), food baits (F= 11.44, df= 2,1974 P< 0.001) and weeks (F= 775.14, df= 11,1974 P< 0.001) and their interactions like, locations × crops (F= 386.94, df = 1,1974 P< 0.001), crops × weeks (F= 96.79, df = 11,1974 P< 0.001), location × weeks (F= 13.80, df = 11,1974 P< 0.001) and locations × crops × food baits × weeks (F= 3.27, df = 55,1974 P< 0.001) had significant effect on attracting the melon fruit flies. Whereas, the interactions, crops × food baits, locations × food baits, food baits × weeks, locations × crops × food baits and locations × food baits × weeks were not significant (P> 0.05 in all the cases). On focussing the data, Coimbatore (23 fruit flies/trap/day) had higher melon fruit fly in both snake gourd and ridge gourd field. In both the locations, the more number of melon fruit flies were found in snake gourd field (24 fruit flies/trap/day).

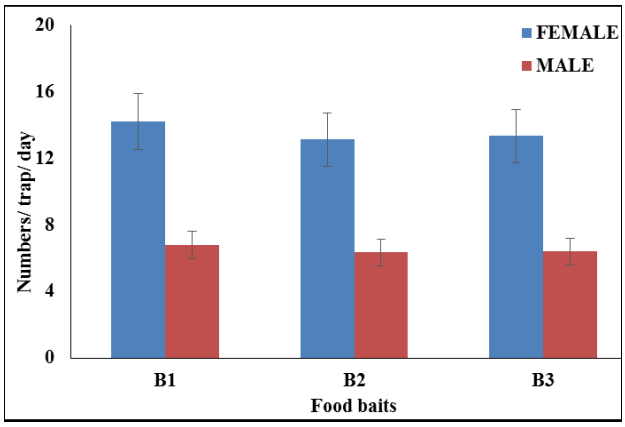


Fig 5: Field evaluation of food baits for *Z. cucurbitae*. Bars represent means (± SE) of 780 values {(15 traps × 3 sites) + 20 traps × 1 site)] × 12 weeks.

Guava based food bait (21 fruit flies/trap/day) was found to attract significantly higher number of *Z. cucurbitae*. All the three food baits reflected a sex biased attraction by attracting more females than the males (t= 47.61, df= 2159). Guava, Muskmelon and Guava + Muskmelon attracted about 70.00%, 68.42% and 67.18% of females (Fig. 5). Initially during week

one (42 fruit flies/trap/day) and week two (fruit flies/trap/day), the melon fruit flies were present in greater numbers. In 12th week (1 fruit fly/trap/day), the population of fruit flies was very below the damaging level. This showed that the melon fruit flies were managed over 12weeks period using food bait traps.

Discussion

The higher population of melon fruit flies in snake gourd ecosystem represent the preference of host. On comparing, food bait traps in snake gourd field at both Coimbatore and Tiruppur districts attracted relatively more number of adult flies than ridge gourd fields. This reflected the report of higher order of preference of *Z. cucurbitae* for snake gourd due to its low tissue firmness [16]. Similarly, both snake gourd and ridge gourd fields at Coimbatore, food baits attracted higher fruit flies than at Tiruppur. This reflected the fact that multiple hosts of *Z. cucurbitae* are present throughout the year in Coimbatore, which led to continuous presence of this pest in higher numbers. Survey conducted in Coimbatore and Dharmapuri districts, consistently, revealed the presence of more fruit flies at Coimbatore [17].

All the food baits attracted both females and males of *Z. cucurbitae*, which is advantageous over parapheromone lures. Relatively higher number of females were attracted, which is in line with the reports of attraction by food based lures [18]. For females, the protein source is essential for the development of gonads after emergence and for egg maturation after mating [19]. By providing protein in the bait admixture, large number of females are attracted [20]. Protein deprived females preferentially oriented towards this food bait admixture. By attracting females, the total pest population is targeted by preventing offsprings, which led to a potential control program [7].

The selected three food baits performed equivalently in the sites 2,3and 4 except in site 1. In site 1, food bait based on guava attracted more number of *Z. cucurbitae*. by neglecting this exception, all the three baits can be used for the management of this pest. Among the three, farmers can accordingly select the bait whichever is feasible to manage the melon fruit fly. The present results showed a decreasing trend of fly catches from first week to twelfth week, which is similar to the reports on combination of different traps and lures for *Z. cucurbitae* [21]. The incidence was recorded throughout the year, but the population was low during winter. The population reached the peak while the fruiting reach the peak. By the use of food bait traps, this trend is altered. At early fruiting stage, during first week the population is maximum and at peak fruiting, the population gets reduced. The present results confirmed the effective management of the pest by attracting with food bait traps.

Conclusion

In the present study we evaluated the attractiveness of three food baits at four sites over a 12 weeks period for the management of *Z. cucurbitae*. Other factors such as percent fruit damage, percent yield increase and cost benefit ratio need to be investigated. Through further studies, this may be considered to enhance the attribute of food bait traps in the management of melon fruit flies.

Acknowledgement

This study was funded by Science and Engineering Research Board, Department of Science and Technology, Government of India, New Delhi. We are much grateful to the farmers and the Department of vegetable science, Orchard, Tamil Nadu Agricultural University for allowing us to use their farms and for their field assistance.

References

1. Mohamed AS. Biology, host and Host Plant Relationship of two Psyttalia species (Hymenoptera: Braconidae): Parasitoids for Fruit Flies (Diptera: Tephritidae) in Kenya. Ph.D. Thesis, University of Gezira, 2003.
2. Dhillon MK, Singh R, Naresh JS, Sharma HC. Evaluation of bitter gourd (*Momordica charantia* L.) genotypes to melon fruit fly, *Bactrocera cucurbitae* (Coquillett). Indian Journal Plant Protection 2005;33:55-59.
3. Heve WK, El-Borai FE, Carrillo D, Duncan LW. Biological control potential of entomopathogenic nematodes for management of Caribbean fruit fly, *Anastrepha suspensa* Loew (Tephritidae). Pest Management Science 2016;73(6):1220–1228.
4. Mau R, Jang E, Vargas R. The Hawaii area-wide fruit fly pest management programme: Influence of partnerships and a good education programme. In: Vreysen MJB, Robinson AS, Hendrichs J (ed) Area-wide control of insect pests. Springer, Netherlands 2007,73-90.
5. Badii KB, Billah MK, Afreh-Nuamah K, Obeng-Ofori D, Nyarko G.Review of the pest status, economic impact and management of fruit-infesting flies (Diptera: Tephritidae) in Africa. African Journal of Agricultural Research 2015;10(12):1488-1498.
6. Jang EB, Light DM. Olfactory semiochemicals of tephritids. In: McPheron BA, Steck GJ (ed) Fruit Fly Pest: A World Assessment of their Biology and Management. St. Lucie Press, Florida 199673-90.
7. Siderhurst, MS, Jang EB. Cucumber volatile blend attractive to female melon fly, Bactrocera cucurbitae (Coquillett). Journal of Chemical Ecology 2010;36:699-708.
8. Fabre F, Ryckewaert P, Duyck PF, Chiroleu F, Quilici S. Comparison of the efficacy of different food attractants and their concentration for melon fly (Diptera: Tephritidae). Journal of Economic Entomology 2003;96:231-238.
9. Moustafa SA. Response of the Mediterranean fruit fly, *Ceratitis capitata* (Wied.) and peach fruit fly, *Bactrocera zonata* (Saund.) to some food attractants. Egyptian Academic Journal of Biological Sciences 2009;2(2):111-118.
10. Ekesi S, Mohamed S, Tanga CM. Comparison of food-based attractants for *Bactrocera invadens* (Diptera: Tephritidae) and evaluation of mazoferm-spinosad bait spray for field suppression in mango. Journal of Economic Entomology 2014;107:299-309.
11. Manrakhan A, Daneel JH, Beck R, Virgilio M, Meganck K, Meyer M. Efficacy of trapping systems for monitoring of Afrotropical fruit flies. Journal of Applied Entomology 2017;141:825-840.
12. Ravikumar P, Viraktamath S. Attraction of female fruit flies to different protein food baits in guava and mango orchards. Karnataka Journal of Agricultural Sciences 2007;20(4):745-748.
13. Piñero JC, Souder SK, Smith TR, Vargas RI. Attraction of *Bactrocera cucurbitae* and *Bactrocera dorsalis* (Diptera: Tephritidae) to beer waste and other protein

sources laced with ammonium acetate. Florida Entomologist 2017;100(1):70-76.
14. Pujar K, Elaiyabharathi T, Kempraj T, Kavitha C. A low cost bisexual food baited trap for *Bactrocera cucurbitae* (Coquillet) (Tephritidae: Diptera) in gourds. Entomon 2018;43(4):287-290.
15. Candia IF, Bautista V, Walter A, Castro NO, Tasin M, Dekker T. Locally sustainable lures and traps against the Mediterranean Fruit Fly (Diptera: Tephritidae). Pest Management Sciences 2019;75(6):1671-1680.
16. Manoj AM, Sridharan S, Mohan C, Aswathi NS. Varying infestation of fruit fly, *Bactrocera cucurbitae* (Coquillett) in different cucurbit crops. Journal of Entomology and Zoology Studies 2017;5(3):1419-1421.
17. Pujar K, Elaiyabharathi T, Kempraj T, Kavitha C. Species diversity and relative abundance of fruit flies (Tephritidae: Diptera) in cucurbitaceous vegetables. Madras Agricultural Journal 2018;105(4-6):196-200.
18. Shelly T, Kurashima R, Nishimoto J, Andress E. Capture of *Zeugodacus cucurbitae* (Diptera: Tephritidae) in traps baited with torula yeast solution versus cucumber volatile plugs. Florida Entomologist 2017;100(1):15-20.
19. Meats A, Leighton SM. Protein consumption by mated, unmated, sterile and fertile adults of the Queensland fruit fly, *Bactrocera tryoni*, and its relation to egg production. Physiological Entomology 2004;29:176-182.
20. Mazor M, Peysakhis A, Reuven G. Release rate of ammonia – a key component in the attraction of female Mediterranean fruit fly to protein-based food lures. International Organization for Biological and Integrated Control of Noxious Animals and Plants Bulletin 2002;25:1-6.
21. Divya S, Kalyanasundaram M, Sidhanandham S. Studies on combination of different traps and lures in cucurbit fruit flies attraction. Journal of Entomology and Zoology Studies 2019;7(3):996-998.