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PEG a Humectant for Increasing Bait Longevity in Food Baited Female Melon Fruit Fly Trap

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ABSTRACT: The bait longevity study of food baited trap in field condition for the attraction of female melon fruit fly, *Zeugodacus cucurbitae* (Coq.) (Diptera: Tephritidae) was evaluated in snake gourd ecosystem (*Trichosanthes anguina* L.) at Coimbatore district, Tamil Nadu during the year 2021-2022. Two different humectants, poly-ethylene glycol and glycerol (PEG) at different concentrations was added to the base bait mixture and tested to improve the shelf life of the bait in field condition. The results indicated that the attractiveness of base baits with 1% poly-ethylene glycol lasted longer (up to 1 week) than that of bait without any humectants (2–3 days). The number of adult female flies trapped at first three days was also high and gradually decreased in successive days and found low at seventh day (6.8 female flies/trap/day). Thus, base bait + 1% poly-ethylene glycol serves to extend the life of bait material for a week in field condition.

Keywords: Poly-ethylene glycol, glycerol, humectant, longevity, melon fruit fly.

INTRODUCTION

Fruit flies (Tephritidae: Diptera) are one among the most fascinating species of creepy crawlies, also known as "peacock flies" due to their propensity to flail and swagger, and they are among the most serious pests in green harvests worldwide (Gopaul *et al.*, 2001; Kapoor, 1993). The subgenus melon fruit fly, *Zeugodacus cucurbitae* is considered as an economically important species within the genus *Bactrocera* (Verghese *et al.*, 2006; Biswas *et al.*, 2007) and it is also regarded as a federal quarantine pest in India and many other Nations, where the majority of them inflict extensive damage to various fruits and vegetables, particularly cucurbitaceous crops. They have been reported as a major stumbling block to high yields and good quality of cucurbits (Mir *et al.*, 2014). Extent of losses ranges from 30 to 100 percent, depending on the season of attack and the host species. Fruit flies prefer to lay their eggs on green fruits, penetrating the tissue with their ovipositor and depositing the eggs inside. Inside the fruit, the eggs hatch into maggots, which begin to feed on the flesh and form tunnels. Young fruits rot and wither as a result of this, while older fruits may become distorted, lowering the economic value (Dhillon *et al.*, 2005). Due to their concealed egg laying and feeding behaviour makes them difficult to control using insecticidal sprays. The requirement for good management in the gourd's ecosystem is necessitated by these various deleterious effects. The majority of fruit fly management attempts have concentrated on capturing adults using cue-lure baited traps. Though these traps were used for mass trapping in the field, they are employed for male annihilation (Sohrab and Prasad 2018) and females are not attracted in common. These Para-pheromones are also synthetic, which impede biodegradation, (Sankaram, 1999) and are not accessible to farmers due to their high cost or unavailability (Sookar *et al*., 2002). Nevertheless, low-cost, eco-friendly and effective food bait combination for the management of fruit flies, using locally available food-based materials was developed by Abinaya *et al*. (2020). It consists of guava, muskmelon and some additives including yeast, cane sugar and food graded alcohol. The tested food bait has low shelf life in field condition and dries within 2-3 days due to high temperature. Therefore, the present study aims at addition of some humectants *viz*., poly-ethylene glycol and glycerol to base bait. Hence, the current research intends to improve the bait longevity by addition of two different humectants and studying the bait efficacy in attracting the female melon fruit fly under field condition in gourds eco-system.

MATERIALS AND METHODS

Experimental sites. The present field screening experiments to extend the shelf life of food baited traps was conducted at Thennampalayam, Annur (11.22°N & 77.10°E) Coimbatore district, Tamil Nadu with snake gourd ecosystem (*Trichosanthes anguina* L.) during 2021-2022.

Trap. For the field study, trap designed by Pujar *et al*. (2018) with further modification made by Abinaya *et al*. (2020) was utilized.

Preparation of food baits

Base bait. The food bait combinations with a focus on trapping female fruit flies developed by Abinaya *et al*. (2020) was used in longevity study. The food bait combination includes guava (20 g) + muskmelon (20 g) + cane Sugar (4 g) + yeast (0.4 g) + food grade alcohol (10 ml). Fully ripened fruits and bait additives were purchased from the local market. The fruits were washed, peeled, and finely grinded to pulp. Bait additives such as cane sugar, yeast and food grade alcohol were added in correct proportions to the pureed pulp, and fermentation was allowed for 48 hours.

Addition of humectants. The bait material placed in the traps dries out within 2–3 days due to changes in weather conditions. To extend the bait's shelf life, comparison experiments were conducted by addition of two different humectants, polyethylene glycol and glycerol, at different concentrations. Poly-ethylene glycol and glycerol were procured from Sigma Aldrich, India and added at different proportions to the base bait mixture. The treatment combination is presented in Table 1.

Table 1: Bait longevity (Base bait + Humectant in different combinations).

Treatment	Food bait + Humectant combinations
T_1	Base bait + Poly-ethylene glycol @ 0.5%
T_2	Base bait + Poly-ethylene glycol @ 1%
T_3	Base bait + Poly-ethylene glycol @ 1.5%
T_4	Base bait + Poly-ethylene glycol @ 2%
T_5	Base bait + Glycerol @ 0.5 ml
T_6	Base bait + Glycerol @ 1 ml
T_7	Base bait + Glycerol @ 1.5 ml
T_8	Base bait + Glycerol @ 2 ml

Trap count. The experimental design was randomised block with 10 replications per humectant. The fermented bait materials, along with the two different humectants, were placed inside the bottle trap with a spoon through the foldable window in the trap. The traps were hung 1.2m above ground from the grid support for the snakegourd vines. The baits were placed in the bait chamber of the trap at 0600h. The trapped flies were killed with ethyl acetate dipped in a cotton and inserted into the trap. The dead flies were then counted and sexed. The trap-wise counts were made daily after 1800h.

Statistical analysis. Field data on fruit fly catches was analysed using Analysis of Variance (ANOVA). The data collected from randomized block design were subjected to appropriate transformations before analysis and the Sample means were separated using Tukey's HSD test. The analyses were performed in the statistical package, IBMSPSS Statistics 22.

RESULT AND DISCUSSION

The experiment conducted in snake gourd field at Coimbatore showed the comparison between the efficiency of two different humectants used in the food baited traps in extending the shelf life and also attraction of female melon fruit flies (Fig. 1). The bait in traps typically dries in 2-3 days because of the weather factors (Taneja *et al*., 1986). The fermentation process reduces gradually as the moisture content drops and the production of volatile chemicals from the baits is minimal. Consequently, the baits show less attraction even on the third day when the temperature is high (Bharathi *et al*., 2004). The attractiveness of baits decreased significantly each day and the humectants helped in sustaining the shelf life and the attractiveness of the base bait material by 7 days (Table 2).

Polyethylene glycol showed to reduce evaporation of bait material when added to aqueous bait (Mangan and Thomas 2014; Epsky *et al*., 2014b) in addition they also function as a dispersant (Moreno *et al*., 2001). Addition of glycerol also reduces the loss of moisture and act as a potential humectant (Mckibben *et al.*, 1971). Hardee *et al.* (1972) increased the bait's longevity by 7 days by adding poly-ethylene glycol and glycerol in their formulation. It was proved that T_2 -base bait + polyethylene glycol at 1% was able to sustain the attractiveness of the baits with highest catch of fruit flies (25.8 female flies/trap) which is in accordance with Moreno and Mangan 2002. This is followed by T_1-base bait + poly-ethylene glycol at 0.5% with fly catch of 17.2 female flies/trap and T_6 – base bait + glycerol at 1% with a fly catch of 15.2 female flies/trap. The effect of glycerol was comparatively lower than that of poly-ethylene glycol. On the first day, the attractiveness of the control bait mixture, *i.e*., base bait alone (23.2 female flies/ trap / day) was as high as that of base bait + poly-ethylene glycol at 1% (27.4 female flies/trap/day) and Base bait + glycerol at 1% (19.4 female flies/trap/day), while the attraction of base bait mixture with other humectant combination was less attractive (9.4 – 18 female flies/trap/day). On the second day and third day, the base bait containing 1% poly-ethylene glycol attracted greater number of flies 40.8 female flies/trap/day, 51.4 female flies/trap/day respectively when compared to other combinations. The control bait lost its capability of attraction rapidly and by day four there was no attraction, whereas in the base bait containing 1% poly-ethylene glycol the attractiveness lasted up to seven days with gradual decrease in the fly catch from 26 female flies/trap/day to 6.8 female flies/trap/day.

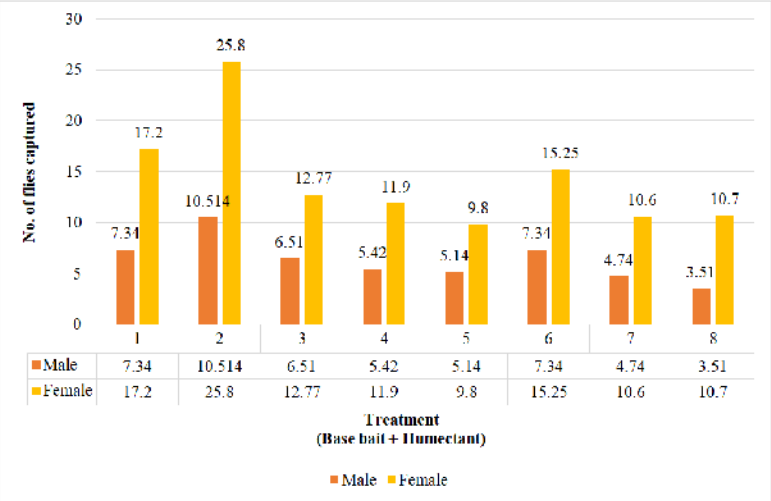

Fig. 1. Attractiveness of adult *Zeugodacus cucurbitae* to the base bait + Humectants.

Table 2: Relative attractiveness of the humectants to adult *Zeugodacus cucurbitae.*

DAYS	1		2		3		4		5		6		7	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
T1 – PEG @0.5%	6.8 (2.58) ^{c}	18 (4.22) ^{b}	10.6 (3.25) ^{b}	24.6 (4.94) ^{b}	11.2 (3.33) ^{c}	33 (5.73) ^{b}	10.4 (3.21) ^{a}	20.6 (4.52) ^{b}	6.4 (2.51) ^{b}	11.8 (3.43) ^{b}	4.8 (2.17) ^{a}	8.4 (2.89) ^{b}	1.20 (1.26) ^{a}	4.2 (2.04) ^{b}
T2 – PEG @1%	10.8 (3.28) ^{a}	27.4 (5.23) ^{a}	16.4 (4.04) ^{a}	40.8 (6.38) ^{a}	21.8 (4.65) ^{a}	51.4 (7.16) ^{a}	11.4 (3.37) ^{a}	26.0 (5.07) ^{a}	8.8 (2.96) ^{a}	17.8 (4.21) ^{a}	4.4 (2.06) ^{a}	10.4 (3.22) ^{a}	0 (0.707) ^{c}	6.8 (2.58) ^{a}
T3 – PEG @1.5 %	8.4 (2.89) ^{b}	16.8 (4.09) ^{b}	11.8 (3.41) ^{b}	17.2 (4.14) ^{c}	11.2 (3.34) ^{c}	25.4 (5.03) ^{c}	6.2 (2.46) ^{b}	9.8 (3.11) ^{d}	5.8 (2.40) ^{bc}	8.4 (2.88) ^{cd}	1.4 (1.16) ^{d}	7.6 (2.75) ^{b}	0.8 (1.12) ^{ab}	4.2 (2.03) ^{b}
T4– PEG @2%	4.8 (2.18) ^{d}	17.8 (4.20) ^{b}	10.6 (3.24) ^{b}	17.0 (4.13) ^{c}	10.2 (3.19) ^{cd}	19.8 (4.34) ^{d}	5.4 (2.28) ^{b}	8.8 (2.95) ^{d}	4.6 (2.13) ^{cd}	8.2 (2.85) ^{cd}	1.4 (1.18) ^{d}	8.2 (2.86) ^{b}	1.00 (1.14) ^{ab}	3.8 (1.94) ^{bcd}
T5– Glycerol@ 0.5ml	4.8 (2.18) ^{d}	11 (3.31) ^{c}	7.8 (2.78) ^{c}	16.4 (4.03) ^{c}	11.2 (3.36) ^{c}	16.2 (4.01) ^{d}	5.6 (2.35) ^{b}	9.4 (3.04) ^{d}	3.2 (1.77) ^{e}	7.8 (2.79) ^{d}	2.8 (1.65) ^{bc}	4.6 (2.14) ^{c}	0.60 (1.01) ^{abc}	3.6 (1.89) ^{bcd}
T6– Glycerol@ 1ml	6.8 (2.60) ^{bc}	19.4 (4.38) ^{b}	12.8 (3.57) ^{b}	22 (4.68) ^{b}	13.6 (3.68) ^{b}	27.2 (5.19) ^{c}	9.0 (2.97) ^{b}	14 (3.73) ^{c}	4.8 (2.18) ^{cd}	12.4 (3.51) ^{b}	3.6 (1.89) ^{ab}	7.6 (2.74) ^{b}	0.8 (1.08) ^{abc}	4.2 (2.02) ^{bc}
T7 – Glycerol@ 1.5ml	5.4 (2.31) ^{cd}	10.8 (3.27) ^{c}	7.6 (2.75) ^{c}	17.6 (4.19) ^{c}	8.8 (2.95) ^{de}	18.2 (4.24) ^{d}	5.0 (2.23) ^{b}	10.6 (3.24) ^{d}	4.2 (2.04) ^{de}	9.6 (3.08) ^{c}	2.0 (1.39) ^{cd}	4.4 (2.07) ^{c}	0.20 (0.81) ^{bc}	3.00 (1.72) ^{cd}
T8– Glycerol@ 2 ml	2.8 (1.65) ^{e}	9.4 (3.06) ^{c}	6.8 (2.58) ^{c}	18.2 (4.26) ^{c}	7.6 (2.73) ^{e}	19.2 (4.37) ^{d}	4.2 (2.04) ^{b}	11 (3.30) ^{d}	1.6 (1.24) ^{f}	9.7 (3.09) ^{c}	1.6 (1.24) ^{d}	4.8 (2.18) ^{c}	0 (0.70) ^{c}	2.8 (1.66) ^{d}
CD (0.05)	0.273	0.371	0.345	0.384	0.330	0.460	0.401	0.383	0.267	0.277	0.284	0.271	0.402	0.313
SEd	0.132	0.180	0.168	0.187	0.160	0.224	0.195	0.186	0.130	0.128	0.138	0.132	0.163	0.137

The values represent means of 10 replications; Figures in parenthesis are square root transformed values.

CONCLUSION

From the result of the above study, it is concluded that poly-ethylene glycol at 1% added to the food bait can be used for IPM concepts under field conditions to trap female melon fruit fly in the gourds ecosystem.

FUTURE SCOPE

The developed food bait with increased longevity could be an efficient method for trapping female melon fruit flies when compared to para-pheromone traps and existing chemical pesticides. Since the bait is made from locally available materials, it is also economical and cost-effective in contrast to other available approaches.

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Conflict of interest. None.

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