



ROLE OF PROTEIN AND FOOD BAITS IN ATTRACTION OF MELON FRUIT FLY *ZEUGODACUS CUCURBITAE* IN BITTER GOURD

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ABSTRACT

A field experiment was conducted to evaluate the attractiveness of various protein and food baits against cucurbit fruit fly (*Zeugodacus cucurbitae*) (Coquillett) in bitter gourd fields. Protein baits evaluated were soybean, yeast, casein and Proteinex baits. Food baits evaluated were banana, guava, tomato, pineapple and bitter gourd juice baits. The incidence of *Z. cucurbitae* was also observed. Among the evaluated protein baits, Proteinex bait trapped more i.e., 8.05/ trap/ week (female-4.94 and male-3.11), and showing 44.45% reduction incidence. Of the food baits assessed, tomato juice bait was the best, trapping 3.35 fruit flies/ trap/ week (female-2.09 and male-1.26) with 37.16% damage reduction. From the present investigation it can be concluded that among protein and food baits evaluated, Proteinex and tomato respectively with attractant materials @ 12 nos/ ha with weekly replenishment may effectively attract both sexes of adult fruit flies and thereby act as reliable management strategy against fruit flies in horticultural crops.

Key words: *Zeugodacus cucurbitae*, bitter gourd, protein bait, Proteinex, food bait, fruit juice, banana, guava, tomato, pineapple, attraction, efficiency, attraction enhancers

In India, vegetable crops are cultivated in 1,03,16,000 ha with productivity of 18,94,64,000 mt (Anonymous, 2020-21). Of these, cucurbits are the most important summer vegetables, and these are affected by the fruit flies. Because of the polyphagous, frugivorous and florivorous nature, fruit flies are serious in many horticultural crops causing economic loss (Dhillon et al., 2005). In India, bitter gourd is cultivated in 1,07,000 ha with a production of 12,92,000 mt (Anonymous, 2020-21). The fruit fly family, Tephritidae with about 4500 species, is one of the largest families of Diptera (David, 2011), of which 250 species are economically important. Fruit flies are widely distributed in tropical, subtropical and temperate regions. Several measures are deployed to reduce these pests including insecticides (Sen et al., 2019). Application of insecticides not only poses harmful effects on beneficial arthropods but also contaminates the environment, increases the cost of production as well as raises MRL issues (Gogi et al., 2010). There is need to develop alternatives for insecticides for management of fruit flies. At present, pheromone traps using cue lure as the active ingredient are commercially available which can attract only male fruit flies. However, this male lure has limited effectiveness because they are sex-specific. Attracting female fruit flies is very important because they are

the dominant factor for the multiplication of the pest (Epsky et al., 1999). The present study compares the efficiency of several protein and food baits to attract the *Zeugodacus cucurbitae* (Coquillett) relying on two facts about the females i.e. protein source is important for the sexual maturation (Biasazin et al., 2018) and egg development (Manrakhan and Lux, 2006) and their preference for host fruit odour when searching for oviposition.

MATERIALS AND METHODS

A field experiment was conducted in bitter gourd fields (Abhishek variety) during February, 2021 to April, 2021 in Ayyur village, Alanganallur block, Madurai district (10°4'N, 78°5'E). There was minimum 50 m distance between the treatments, and among protein baits, four protein baits with negative control and untreated control were evaluated. Thus, there were seven treatments including control, replicated four times in randomized block design. The protein baits evaluated were soybean powder (10%), yeast powder (10%), casein powder (10%) and Proteinex (10%). All the treatments were mixed with attraction enhancers and insecticide viz., jaggery (10%), ammonium acetate (5%), malathion (0.001%) and borax (2%). In the

negative control, attraction enhancers and insecticide alone were used. Seven food baits treatments were evaluated which included elaichi banana, guava, pineapple, tomato and bitter gourd pulps @10% with the jaggery (10%), citric acid (5 g), malathion (0.001%), yeast 10 g and borax (2%) a negative control and an untreated control. The negative control contained only the attraction enhancers and insecticide.

Bait traps were prepared with the plastic containers of 10 cm dia, 20 cm height and 1 l capacity in which four holes of 20 mm size were made in the middle part. Prepared baits were poured in these traps @ 200 ml/ trap and were hung to the iron wires of pandal in bitter gourd ecosystem at a height of 1.5 to 2 m under shade. Traps were installed @ 1 trap/ 1000 m² and baits were kept in the field at the time of initiation of flowering @ 15/ha. Baits were maintained in semi liquid state by adding approximately 10-15 ml water in alternate days. In all the treatments, borax was added to avoid the decomposition of trapped flies (Lasa and Williams, 2021) and to raise the alkalinity of the bait (Heath et al., 1994). Jaggery was used to increase the attractiveness of bait (Thomas and Mangan, 2005). Yeast was used as a fermentation stimulator and ammonium acetate was a female fruit fly attractant enhancer (Pinero et al., 2020). Baits were changed once in a week and maintained up to the harvest of the crop. In each treatment, observations on total number of fruit flies, number of female and male fruit flies trapped was recorded at weekly intervals. After the weekly observation, site of the trap was changed to maintain uniform distribution in field. Observations were also taken on incidence and level of fruit infestation. For this, ten bitter gourd fruits were collected randomly, cut opened, and observed for infestation and number of larvae counted under the microscope. The data were subjected to appropriate transformations before analysis. Means were separated by Tukey's HSD test. Statistical analyses were performed using the software IBM SPSS Statistics version 22.0 (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results revealed significant variation in the fruit flies trapped with protein and natural food baits. Protein as a critical source of component of food baits for *Z. cucurbitae* is well known (Fabre et al., 2003). Wood (2001) stated that when mixed with killer compounds, protein-bait sprays paved a way to blast the flies. In bitter gourd, among the protein baited traps, Proteinex was found to be superior (72.50 fruit flies/ trap/ 9

weeks), and female fruit flies were more i.e., 51.75/ trap/ week (Table 1). Proteinex had been observed to trap Oriental fruit flies in guava in Punjab by Mann (1996), with soybean powder found to be the next best, and both equally effective in attracting the male flies. Cornelius et al. (2000), and Ravikumar and Viraktamath, (2007) also observed that the combination of Proteinex in bait significantly attracted more flies. Sunandita and Gupta (2001) found that protein hydrolysate and boric acid bait mixtures were effective with *B. tau*. Pinero et al. (2015) stated that the attraction of females towards the protein baits was enhanced by ammonium acetate. Iqbal et al. (2020) revealed that in field as well as in laboratory studies protein hydrolysate, yeast and ammonium acetate-based lures captured comparatively more adults of *Z. cucurbitae*. Guava pulp when added with Proteinex yeast, cane sugar and alcohol attracted more flies in snake gourd and ridge gourd (Abinaya et al., 2020). Trapped male and female ratio in the protein baits ranged from 0.35:1 to 0.51:1 clearly indicating that the traps attracted more females than the males. In guava and mango orchards, Rajitha and Viraktamath (2005) observed that protein baits attracted female fruit flies effectively. Malathion as effective killer agent in protein baits against fruit flies was observed by Khosravi et al. (2018).

Among the food baited traps, tomato juice bait was the more preferred (30.25/ trap/ 9 weeks), with majority being females (19.51); banana juice bait was the next best. Pandey et al. (2010) concluded that banana bait - banana (1 kg) + carbofuron (10 g) + yeast (10 g) + citric acid (5 g) showed a consistent superiority in fruit fly catches. Food baits containing banana pulp as base attracted significantly more (Bharathi et al., 2004; Rajitha and Viraktamath, 2005). Satpathy and Samarjit Rai (2002) reported that melon fruit flies are lured to bait with over ripped banana, citric acid and furadan during peak activity periods. Pandey et al. (2008) observed that melon fruit fly is effectively controlled by bait of 1 kg rotten banana + 10 g carbofuran + 5 g yeast + 5 g citric acid. Pujar et al. (2020) observed that banana pulp with food grade alcohol and vinegar attracted more fruit flies. Male and female ratio in the catches with the food baits ranged from 0.36:1 to 0.57:1 indicating that the traps attracted more females. Level of incidence was the lowest in the tomato bait treatments (3.53 larvae/ fruit) and this was on par with the banana and bitter gourd baited treatments; incidence was minimum in the tomato baited treatment (20.56), and % reduction was more (37.16) in tomato baited treatment followed by banana baited treatment (30.37) (Table 2). Thus, it

Table 1. Attraction of fruit flies to the protein baits and their incidence

Treat- ments	Week after trap placement*										Total No. of fruit flies attracted/ trap/ 9 weeks		Mean no. of fruit flies/ trap/ week		Male female ratio	Mean Level of inci- dence	Mean % inci- dence	Mean % reduc- tion over control	
	No. of fruit flies/ trap/ week										Male	Female	Total						
	1 st week	2 nd week	3 rd week	4 th week	5 th week	6 th week	7 th week	8 th week	9 th week	Male				Female					Total
Soybean bait	6.00 (2.55) ^b	8.00 (2.92) ^a	7.00 (2.74) ^b	13.00 (3.67) ^a	4.75 (2.29) ^b	5.50 (2.45) ^{ab}	4.50 (2.24) ^{bc}	7.25 (2.78) ^b	3.00 (1.87) ^b	17.15 (4.27) ^a	41.25 (6.46) ^b	59.00 (7.71) ^b	1.97 (1.57) ^a	4.58 (2.25) ^b	6.56 (2.66) ^b	0.43:1	3.40 (1.97) ^{ab}	19.44 (26.17) ^a	44.45
Caesin bait	3.75 (2.06) ^c	4.00 (2.12) ^b	7.25 (2.78) ^{ab}	5.25 (2.40) ^b	3.75 (2.06) ^b	2.00 (1.58) ^c	3.50 (2.00) ^c	4.50 (2.24) ^c	1.50 (1.41) ^c	14.00 (3.74) ^b	25.50 (5.04) ^d	39.44 (6.00) ^d	1.33 (1.35) ^b	2.61 (1.76) ^d	3.95 (2.11) ^d	0.51:1	4.47 (2.22) ^c	27.22 (31.45) ^{ab}	22.23
Proteinex bait	8.25 (2.96) ^a	6.25 (2.60) ^{ab}	9.50 (3.16) ^a	5.50 (2.45) ^b	8.75 (3.04) ^a	6.75 (2.69) ^a	11.50 (3.46) ^a	11.00 (3.39) ^a	5.00 (2.35) ^b	21.50 (4.61) ^a	51.75 (7.22) ^a	72.50 (8.54) ^a	2.31 (1.67) ^a	5.75 (2.50) ^a	8.06 (2.92) ^a	0.41:1	2.87 (1.82) ^a	18.33 (25.35) ^a	47.63
Yeast bait	4.25 (2.18) ^{bc}	4.50 (2.24) ^b	4.00 (2.12) ^b	4.00 (2.12) ^b	7.00 (2.74) ^a	5.00 (2.35) ^b	5.75 (2.50) ^b	4.50 (2.24) ^c	3.25 (1.94) ^b	11.00 (3.38) ^b	31.25 (5.62) ^c	42.25 (6.53) ^c	1.22 (1.31) ^b	3.47 (1.99) ^c	4.69 (2.28) ^c	0.35:1	4.13 (2.14) ^{bc}	28.33 (32.16) ^{ab}	19.06
Negative control	0.25 (0.87) ^d	0.50 (1.00) ^c	0.50 (1.00) ^d	0.50 (1.00) ^d	0.75 (1.12) ^c	0.75 (1.12) ^c	0.50 (1.00) ^d	1.25 (1.32) ^d	0.75 (1.12) ^c	1.75 (1.48) ^c	4.00 (2.11) ^c	5.75 (2.50) ^c	0.19 (0.83) ^c	0.44 (0.97) ^e	0.64 (1.07) ^e	0.43:1	5.91 (2.53) ^d	34.44 (35.94) ^{bc}	1.60
Untreated control	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0.0 (0.71) ^d	0:0	6.96 (2.73) ^e	35.00 (36.27) ^c	-
CD (p=0.05)	0.26	0.30	0.32	0.28	0.33	0.24	0.25	0.30	0.29	0.08	0.14	0.26	0.06	0.11	0.28	-	0.42	0.84	-
SE (d)	0.61	0.71	0.75	0.61	0.70	0.50	0.54	0.79	0.46	1.00	2.37	2.02	0.04	0.06	0.04	-	0.56	1.41	-

*Mean of three replications; Values in parentheses $\sqrt{x \pm 0.5}$ transformed values; % data arsinh transformed; Mean followed by same letter in a column not significantly different by Tukey's HSD test (p=0.05)

Table 2. Attraction of fruit flies to the food baits

Treat- ments	Week after trap placement*										Total no. of fruit flies attracted/ 9weeks				Mean no. of fruit flies/ trap/ week		Male female ratio	Mean Level of inci- dence	Mean % inci- dence	Mean % reduc- tion over control
	No. of fruit flies/ trap/ week										Male		Female							
	1 st week	2 nd week	3 rd week	4 th week	5 th week	6 th week	7 th week	8 th week	9 th week	Male					Female	Total				
Tomato bait	2 (1.58) ^a	2.25 (1.66) ^a	2.5 (1.73) ^a	2 (1.58) ^a	3.5 (2.00) ^a	4.5 (2.24) ^b	6.25 (2.60) ^a	4.25 (2.18) ^a	3 (1.87) ^a	10.75 (3.35) ^a	19.51 (4.47) ^a	30.25 (5.54) ^a	1.19 (1.30) ^a	2.17 (1.63) ^a	3.36 (1.96) ^a	0.55:1	3.53 (1.99) ^a	20.56 (26.96) ^a	37.16	
Banana bait	0.5 (1.00) ^b	1 (1.22) ^b	1 (1.12) ^b	0.75 (1.12) ^b	0.75 (1.12) ^b	7.25 (2.78) ^a	3 (1.87) ^a	4 (2.12) ^b	1.25 (1.32) ^b	5.25 (2.36) ^b	14 (3.80) ^b	19.25 (4.44) ^b	0.58 (1.04) ^b	1.56 (1.43) ^b	2.14 (1.62) ^b	0.37:1	4.35 (2.17) ^{ab}	22.22 (28.13) ^{ab}	30.37	
Bitter gourd bait	0.25 (0.87) ^b	0.5 (1.00) ^b	0.75 (1.12) ^b	1.5 (1.41) ^{ab}	1.25 (1.32) ^b	2.75 (1.80) ^c	0.75 (1.12) ^b	0.75 (1.12) ^b	0.25 (0.87) ^b	2.50 (1.70) ^{bc}	6.25 (2.60) ^c	8.75 (3.04) ^c	0.19 (0.85) ^b	0.67 (1.05) ^c	0.84 (1.15) ^{cd}	0.4:1	4.43 (2.21) ^{ab}	28.33 (32.16) ^{cd}	13.42	
Guava bait	1 (1.22) ^{ab}	0.5 (1.00) ^b	1 (1.22) ^b	0.75 (1.12) ^b	1.5 (1.41) ^b	1 (1.22) ^b	0.75 (1.12) ^b	0.75 (1.12) ^b	0.25 (0.87) ^b	2 (1.54) ^{bc}	5.5 (2.44) ^c	7.50 (2.83) ^{cd}	0.22 (0.85) ^b	0.44 (0.97) ^c	0.67 (1.08) ^d	0.36:1	4.83 (2.31) ^b	26.11 (30.73) ^{bc}	20.20	
Pine apple bait	0.75 (1.12) ^{ab}	1 (1.22) ^b	1 (1.12) ^b	0.75 (1.12) ^b	0.75 (1.12) ^b	0.5 (1.00) ^d	0.75 (1.12) ^b	0.75 (1.12) ^b	0 (0.71) ^b	2.5 (1.73) ^{bc}	3.5 (2.09) ^c	6 (2.55) ^{cd}	0.28 (0.88) ^b	0.69 (1.09) ^c	0.97 (1.21) ^c	0.57:1	5.88 (2.53) ^c	27.78 (31.81) ^{cd}	16.96	
Negative control	0.50 (1.00) ^{ab}	0.50 (1.00) ^b	0.50 (1.00) ^b	0.50 (1.00) ^b	0.75 (1.12) ^b	0.50 (1.00) ^d	0.50 (1.00) ^b	0.50 (1.00) ^b	0.50 (1.00) ^b	1.75 (1.41) ^c	3 (2.10) ^c	4.75 (2.50) ^d	0.19 (0.83) ^b	0.33 (0.91) ^c	0.53 (1.01) ^d	0.58:1	6.48 (2.63) ^c	32.22 (34.59) ^{de}	10.19	
Untreated control	0 (0.71) ^c	0 (0.71) ^c	0 (0.71) ^c	0 (0.71) ^c	0 (0.71) ^c	0 (0.71) ^c	0 (0.71) ^c	0 (0.71) ^c	0 (0.71) ^c	0 (0.71) ^c	0 (0.71) ^d	0 (0.71) ^d	0 (0.71) ^d	0 (0.71) ^d	0 (0.71) ^e	-	6.00 (2.56) ^e	35.56 (36.60) ^e	-	
CD(p=0.05)	0.33	0.28	0.27	0.26	0.31	0.22	0.29	0.26	0.27	0.43	0.32	0.45	0.41	0.30	0.51	-	0.43	0.63	-	
SE(d)	0.45	0.38	0.37	0.37	0.45	0.41	0.43	0.41	0.39	1.05	1.16	0.83	0.06	0.05	0.03	-	0.32	0.32	-	

*Mean of three replications; Values in parentheses $\sqrt{x \pm 0.5}$ transformed values; % data arsinh transformed; Mean followed by the same letter in a column not significantly different by Tukey's HSD test (p=0.05)

is concluded that, Proteinex bait replenished at a week interval gave efficient control of fruit flies when placed @ 12 traps/ ha. Among the food baits, tomato bait @ 12 traps/ ha led to effective management.

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(Manuscript Received: October, 2021; Revised: March, 2022;

Accepted: March, 2022; Online Published: April, 2022)

Online First in www.entosocindia.org and indianentomology.org Ref. No. e21224