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Evaluation of protein food baits against *Bactrocera cucurbitae* (Coquillett) infesting cucumber

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Abstract
The field experiment was conducted on evaluation of seven protein food baits along with untreated check with eight applications at eight days interval against *B. cucurbitae* on cucumber crop at Experimental Farm of Dept. of Agril. Entomology, Mahatma Phule Krishi Vidyapeeth, Rahuri during *Kharif*, 2019 and *Kharif*, 2021. Data on field evaluation of seven protein food baits indicated as Molasses plus Cue-lure plus Malathion > Cue-lure plus Malathion > Protein Hydrolysate plus Cue-lure plus Malathion > Jaggery plus Cue-lure plus Malathion > Yeast Autolysate plus Cue-lure plus Malathion > Soya Powder plus Cue-lure plus Malathion > Deltamethrin plus Malathion.

Keywords: Protein, food baits, *B. cucurbitae*, cucumber

Introduction
India is a major producer of fruits and vegetables in the world due to diverse climate ensure availability of all varieties of fresh fruits and vegetables. The Cucurbitaceae, also called cucurbits or the gourd family and are a plant family consisting of about 965 species in around 95 genera, of which are the most important to humans (Christenhusz and Byng, 2016) [4]. Cucumber, *Cucumis sativus* (Linnaeus) is one of the oldest vegetable and grown during *Kharif*, *Rabi* and *Summer* seasons belonging to the family cucurbitaceae. It is originated in India from where it spreaded to Asia, Africa and Europe and has been in cultivation since 3000 to 4000 years (Patel, 1989) [9]. Cucurbits are attacked by numerous pests *viz*., red pumpkin beetle, leaf miner, flea beetle, fruit fly, etc at different crop stages which affect the quality and quantity of produce unfavorably (Dubale *et al*., 2018) [6]. Fruit flies are one of the world's most destructive horticultural pests and pose risks to most commercial vegetable crops. Particularly Melon fruit fly (*Bactrcoera cucurbitae* C.) has been considered as serious pest. Quarantine laws aimed at preventing the entry and establishment of melon flies and hence reduce the export potential of crop produce (Ronald and Jayma, 2011) [10]. The melon fruit fly, *Bactrocera cucurbitae* has more than 81 host species, in which fruit losses can range from 30 to 100% and consequently, it is considered as quarantine pest (Dhillon *et al*., 2005) [5]. 9 species out of 207 species of fruit flies found to be the major and economically important in India. The management of melon fruit fly is challenging as three of its life stages are hidden and the only adult stage is the usually targeted for its management mostly chemically-based insecticides are used for their control without knowing the ill effects of these chemicals on environment. Pheromone traps provide an easy and efficient method to monitor the activities of fruit fly populations (Alyokhin *et al*., 2000) [1] and can also be used for mass trapping and they have been successfully used worldwide. Now-a-days, due to the ever increasing global awareness about the undesirable side effects of deadly chemicals on human health, the plant protection strategies have been shifting from the use of chemicals to integrated pest management (IPM) because of increasing failure of chemical pesticides in controlling major pests and diseases. Field sanitation, diversion from the main crops, use of cue-lure traps, food baits and hydrolyzed protein bait are some of the appropriate IPM tools (Satpathy and Rai, 2002) [11]. One such approach is population dynamics (by using lures or traps, food baits or attractants), application of poison food baits (containing an attractant plus insecticide mixture) and use of plant extracts that possesses insecticidal properties. As the female fruit flies are the dominant factor for multiplication therefore it is needed that to apply different attractive baits for females for monitoring fluctuations in population of pest and as direct control. These bait traps have high specificity, low cost, environment friendly and ecologically more sound (White and Elson-Harris, 1992; Sureshbabu and Viraktamath, 2003) [15, 12].

Hence, it is desirable to explore the alternative methods of control and development of an effective management strategies against this pest.

Material and Methods

The field experiment was conducted at Experimental Farm of Department of Agricultural Entomology, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri during the *Kharif*, 2019 and 2021at fruiting phase of crop. The bio-efficacy of different combinations of baits, attractant and insecticide was determined. Comparative efficacy and attractability of these bait combinations were evaluated in terms of male annihilation technique (MAT) of adult male flies from the location. Bait treatments consists of female food-lures, mixed with 1 ml of attractant (Cue-lure) and 1 ml of toxicant (Malathion 50 EC). Cotton wicks were soaked in bait combinations and were suspended in the traps. The baited traps were installed in each of the plot of cucumber field at height of 1.5 metre above the ground level. Each treatment was replicated thrice. The impregnated cotton wicks were changed at weekly intervals and the number of flies trapped or annihilated was checked at weekly intervals. The data pertaining to the efficacy of different treatments were analysed statistically. The bait combinations were used during entire course of investigations are given below.

Table 1: Protein food baits used against *B. cucurbitae*

No.	Treatment
T_1	Soya Powder (10 g) + Cue-lure (1 ml) + Malathion 50 EC (1 ml)
T_2	Yeast Autolysate (10 ml) + Cue-lure (1 ml) + Malathion 50 EC (1 ml)
T_3	Jaggery (10 g) + Cue-lure (1 ml) + Malathion 50 EC (1 ml)
T_4	Protein Hydrolysate (10 ml) + Cue-lure (1 ml) + Malathion 50 EC (1 ml)
T_5	Molasses (10 ml) + Cue-lure (1 ml) + Malathion 50 EC (1 ml)
T_6	Cue-lure (1 ml) + Malathion 50 EC (1 ml)
T_7	Deltamethrin 2.8% EC (1 ml) + Jaggery Bait (15 g)
T_8	Untreated check

Result and Discussion

Evaluation of protein food baits in attracting *B. cucurbitae* flies during *Kharif*-2019 and 2021

Field experiments were undertaken in cucumber during *Kharif*-2019 and 2021 to evaluate seven combinations of protein food baits along with the untreated check. Observations on weekly catches of number of flies trapped were recorded initiating from 34th to 41st SMW and the data were statistically analyzed and data are presented in Table 2.

Total number of flies trapped in between 34th to 41st SMW during both the years were considered to judge the efficacy of test treatments. Data reveals that lowest number of flies were caught in the trap with in the untreated check (24.00) and rest of the test treatments were found significantly superior over it. Efficacy was indicated as Molasses plus Cue-lure plus Malathion (460.00) followed by Cue-lure plus Malathion (391.00) followed by Protein Hydrolysate plus Cue-lure plus Malathion (322.67) followed by Jaggery plus Cue-lure plus Malathion (234.00) followed by Yeast Autolysate plus Cue-lure plus Malathion (195.33) followed by Soya Powder plus Cue-lure plus Malathion (152.00) followed by Deltamethrin plus Malathion (78.67).

Table 2: Cumulative mean of trapped adults of *B. cucurbitae* by protein food baits during *Kharif*-2019 and 2021

Treatments	*Kharif*-2019	*Kharif*-2021	Cumulative Mean
T_1	74.33 (8.65)*	77.67 (8.84)	152.00 (12.35)
T_2	99.33 (9.99)	96.00 (9.82)	195.33 (13.99)
T_3	115.67 (10.78)	118.33 (10.90)	234.00 (15.31)
T_4	153.00 (12.39)	169.67 (13.04)	322.67 (17.98)
T_5	212.33 (14.59)	247.67 (15.75)	460.00 (21.46)
T_6	183.33 (13.56)	207.67 (14.43)	391.00 (19.79)
T_7	41.00 (6.44)	37.67 (6.18)	78.67 (8.90)
T_8	12.33 (3.58)	11.67 (3.49)	24.00 (4.95)
SE (M) ±	2.28	3.50	5.27
CD at 5%	6.92	10.64	15.99
F Test	SIG	SIG	SIG
CV	3.55	5.03	3.93
*Figures in parenthesis are square root transformed values			

Data presented in Table 3 on mean percentage flies trapped during both the years from 34th to 41st SMW in distinct combination of protein food baits numerically indicates that higher percentage of flies were trapped in Molasses plus Cue-lure plus Malathion (24.85%), Cue-lure plus Malathion (20.94%) and Protein Hydrolysate plus Cue-lure plus Malathion (17.18%). Moderately lower percent was observed in descending order as Jaggery plus Cue-lure plus Malathion (12.63%), Yeast Autolysate plus Cue-lure plus Malathion (10.60%), Soya Powder plus Cue-lure plus Malathion (8.19%), Deltamethrin plus Jaggery bait (4.33%) and the untreated check (1.22%). The perusal of literature reveals that protein diet with carbohydrates and moisture are essential for female flies to attain sexual maturity (Christenson and Foote, 1960) [3] and especially during the pre-oviposition (Verma and Nath, 2006) [14]. In present studies, treatment with Molasses plus Cue-lure plus Malathion and Cue-lure plus Malathion were found to be effective, the results however could not be compared due to paucity of literature. Next best treatment was found with Protein Hydrolysate plus Cue-lure plus Malathion and the findings are in confirmation with that of reported by Bateman and Arretz (1973) [2], Thakur and Gupta (2013) [13], Nasiruddin *et al*. (2003) [8] and Kotikal and Math (2017) [7].

Table 3: Cumulative mean percentage of trapped adults of *B. cucurbitae* by protein food baits during *Kharif*-2019 and 2021

Treatments	*Kharif*-2019	*Kharif*-2021	Cumulative Mean Percentage
T_1	8.39 (16.84)*	7.98 (16.41)	8.19 (16.63)
T_2	11.15 (19.51)	10.04 (18.47)	10.60 (19)
T_3	13.02 (21.15)	12.23 (20.47)	12.63 (20.82)
T_4	16.87 (24.25)	17.49 (24.72)	17.18 (24.49)
T_5	23.88 (29.25)	25.81 (30.53)	24.85 (29.9)
T_6	20.55 (26.96)	21.32 (27.5)	20.94 (27.23)
T_7	4.73 (12.56)	3.93 (11.43)	4.33 (12.01)
T_8	1.31 (6.57)	1.13 (6.1)	1.22 (6.34)
*Figures in parenthesis are arcsine transformed values			

Conclusion

In conclusion that, Molasses plus Cue-lure plus Malathion, Cue-lure plus Malathion and Protein Hydrolysate plus Cue-lure plus Malathion were found comparatively effective and shows an overall strong response to protein baits in attracting flies of *B. cucurbitae*.

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