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EVALUATION OF INSECTICIDES AND SUITABLE TRAP CONTAINERS FOR EFFECTIVE FRUIT FLY CATCHES

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ABSTRACT

Fruit flies are quarantine pests and major impediments in horticultural production, domestic market, and export of fresh fruits and vegetables. Trapping with a lure is the best known method to monitor/ manage the fruit fly *Bactrocera dorsalis* populations. The fruit fly attraction and its mortality depend on the lure, type of killing agent, and design of the trap container. To make the trapping technology more robust, a study was conducted to find out the suitable killing agent amongst ten insecticides and the best trap design among the available six trap designs. The results revealed that emamectin benzoate 1.9EC was superior as killing agent with the maximum trap catches (648.75 to 1304.75 fruit flies/ trap) up to 12 weeks, followed by abamectin 1.9EC and profenophos 50EC. Among the trap designs, the CISH trap container was found to be superior (306.25 to 940.00 fruit flies/ trap/ week).

Key words: Fruit flies, mango, *Bactrocera dorsalis*, insecticides, trap designs, methyl eugenol, emamectin benzoate, abamectin, profenophos, CISH trap

Post-harvest losses in fresh fruits and vegetables are caused by tephritid fruit flies. Furthermore, they are significant impediments to the trade of fresh fruits and vegetables. Mango and guava are two of the most important fruit crops that are being affected by fruit fly all over the world. Despite decades of research, fruit flies continue to be a significant threat to India's fruit and vegetable production. Fruit flies (*Bactrocera* spp.) cause significant damage and economic impact to all stakeholders. Smallholder farmers may suffer greater losses as a result of fruit fly infestation. These quarantine pests may also endanger the export potential of fresh fruits and vegetables. In general, fruit flies monitoring is being done in India using parapheromones like methyl eugenol (in the case of fruit crops like; mango, guava, banana, peach, orange, fig, sweet lime, etc) and cue lure (in the case of cucurbits). Male tephritid fruit flies show strong behavioural responses to these parapheromones. Methyl eugenol is widely recognized as the most powerful male lure currently in use for detection, control, and eradication of any tephritid species (Verghese et al., 2012; Singh et al., 2008). These lures, when used together with an insecticide-impregnated into a suitable wood substrate, forms the basis of the male annihilation technique (MAT) and result in the reduction of the male population of fruit flies to such a level that eradication and suppression are achieved (Stonehouse et al., 2005). This technique has been successfully used for the eradication and control of several *Bactrocera* species (Cunningham, 1989). A concerted effort has been made on fruit fly trapping technology in India and abroad however there has always been a scope of improvement in this technology, hence the present study was designed to evaluate the different pesticides as killing agents in methyl eugenol-based traps and the different trap designs for their trap catch efficiency.

MATERIALS AND METHODS

The present study comprised of two sets of experiments first was for the evaluation of insecticides for their efficacy in killing blocks and the second was on the evaluation of trap containers. These experiments were conducted in mango orchards of ICAR-CISH, Rehmankhera experimental farm Lucknow (Uttar Pradesh) during the mango season. Ply woodblocks of 4.5x4.5x1.2 cm were soaked in ethyl alcohol 99.9%AR, methyl eugenol, and different insecticides (T_1: bifenthrin 10EC, T2: carbosulfan 25EC, T3: profenophos 50 EC; T4:imidacloprid 17.8 SL; T5:indoxacarb 14.5 EC, T6:spiromecifin, T7:emamectin benzoate 1.9 E, T8:abamectin 1.9 EC, T9:lamda cyhalothrin, T10:malathion 50 EC in the ratio of 5:4:1. These impregnated ply woodblocks were suspended in a uniform type of trap container in mango orchards and catches were counted at weekly intervals. Different designs of fruit flies trap containers are commercially available in the market. They are

available as a package of trap containers and killing blocks of different sizes. Based on their container design and killing block size, their attraction potential and persistence may vary. Individually they are being promoted by their promoters but their relative efficacy in catching fruit flies has not been tested so far. Many of them are rain sick and killing block get wetted in rains.

The CISH new trap container was designed by using a specific dye that gave rainproof provision and a mechanism of easy handling for installation and flies count. This trap container was compared with the other five different types of traps to work out its relative efficiency. T1 comprised trap of private company had a volume of 550 ml with two round holes of 1.6 cm in opposite directions. It used a plywood block of 4x1.5x1.2 cm having a volume of 7.2 cm^3 which soaked 2.64 ml of soakate mixture but lacked a water drainage system in its base. T2 is ICAR - CISH old model trap had almost similar specifications as T1 trap excepting its volume of 500 ml. T3 popular company trap with 600 ml volume had 3 rectangular holes of 1.6x2.5 cm in opposite directions but without water drainage system in its base. Its plywood block of 5x3.5x1.2 cm having a volume of 21 cm^3 soaked the soakate mixture to the tune of 9.31 ml. T4 and T5 traps of IIHR -CHES, and IMFFI -Water bottle trap, respectively had common features such as volume of 950-1000 ml with 4 round holes of 2 cm diameter in opposite directions with a water drainage system in their bases. The plywood blocks of these two traps had woodblock dimension of 5x5x1.2 cm with a volume of 30 cm^3 and soaked around 13.31 ml soakate mixture. T6 is ICAR- CISH new model trap with a volume of 1150 ml had 4 round holes of 2.5 cm diameter in opposite directions with the rainwater drainage system in its bottom. Its plywood block of 4.5x4.5x1.2 cm with a volume of 24.30 cm^3 absorbed 10.48 ml of soakate mixture. Trap container-specific plywood blocks were soaked in ethyl alcohol 99.9% AR, methyl eugenol, and Malathion 50 EC (6:4:1). These soaked killing blocks were loaded in respective traps and installed in the mango orchard and catches were counted at weekly intervals. In the mango orchards, ten traps/ ha were placed at a uniform distance to cover the entire orchard. The traps were replicated four times. The traps with lures were placed at 1.5 to 2 m in height. Observations were taken every week during the fruiting period from May to August. During each observation, the flies were counted after the opening of the trap container lid, and traps were emptied to get the exact number of attracted flies in the next week. Fruit fly trap catch data were subject to ANOVA and means were compared by Tukey's honesty test of significance (p=0.05, 0.01).

RESULTS AND DISCUSSION

The data on fruit flies in mango trapped with the methyl eugenol mixed with insecticides as killing agents presented in Table 1 reveal that trap catches differed significantly ($F_{9, 360}$=204.34; p<0.00), over the different weeks ($F_{11, 360}$=37.62; p<0.00) and in their interactions ($F_{99, 360}$= 1.80;p<0.001). Malathion 50EC, emamectin benzoate 1.9EC, abamectin 1.9EC, and prophenophos 50EC resulted in maximum catches over all the weeks. Emamectin benzoate 1.9EC was found superior with the highest catches ranging from 648.75 to 1304.75 fruit flies/ trap/ week over all the weeks of monitoring. The killing efficiency varied over the period as observed by Stonehouse et al. *(*2005) that insecticides' persistence and their killing efficiency differ in killing blocks. In the present study, malathion was very effective up to 12 weeks; however, its equally effective alternatives were found as emamectin benzoate 1.9EC, abamectin 1.9EC, and prophenophos 50EC. Study on the trap container and respective wooden blocks indicates the persistence of soakate mixture and thereby catch was highly dependent on the size of killing blocks and the amount of mixture soaked into it. The smaller blocks were less effective with low persistence capacity. The number of the fly catch was higher in the CISH trap container, which might be due to the bigger size killing block and design of the container. It was found that methyl eugenol traps were capable of effectively attracting fruit flies up to 12 weeks, though varying greatly in persistence and attraction. The duration of lure effectiveness was found to be in accordance with earlier results of others. Stonehouse et al. (2005) reported long-term eradication/ suppression campaigns were made by using a combination of cue lure and insecticides against *B. cucurbitae*. The higher number of fruit fly catch/ trap with plywood killing block had also been reported by Patel et al. (2005). Singh et al. (2005) observed that plywood blocks attracted and killed more flies than those of mango wood, hardwood, or soft board.

Trap catches were found to significantly vary in different type of traps ($F_{5, 213}$=301.17; p<0.00), among the different weeks ($F_{11, 213}$=70.15; p<0.00) and their interaction ($F_{55, 213}$= 1.89;p<0.001). Among traps, CISH trap container was found more efficient (catches of 306.25 to 940.00 fruit flies/ trap/ week (Table 1). This might be due to four holes of bigger size located in opposite direction facilitated lure dispensing effectively as compared to other trap containers. The size and

Table 1. Fruit fly catches in different insecticide treatments and in different traps over different weeks

	No. of fruit flies/ trap/ week											
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
Efficacy of insecticides												
Bifenthrin 10EC	80.5^{c}	109.5^{b}	103.25^{b}	85^{c}	64.75^{d}	52^{d}	44^{d}	23.5^{b}	18^{f}	15.25^{d}	12^{d}	4^{d}
Carbosulfan 25EC	352.5^{abc}	805.5^{a}	922.5^{a}	888.75^{b}	796.5^{c}	670^{ab}	610^{b}	700^{a}	392.5^{cde}	292.5^{cd}	285^{bcd}	216.25^{bcd}
Profenophos 50 EC	308.5^{abc}	898^{a}	1131.25^{a}	1136.25^{ab}	971.75^{abc}	545^{bc}	651.5^{ab}	625^{a}	521.25^{abc}	446.25^{abc}	427.5^{abc}	363.75^{abcd}
Imidacloprid 17.8 SL	217.75^{bc}	375^{b}	392.75^{b}	395^{c}	324.75^{d}	231.25^{cd}	185.75^{cd}	190^{b}	133.5^{def}	107.5^{cd}	83.75^{cd}	68.75^{cd}
Indoxacarb 14.5 EC	177.25^{bc}	331.25^{b}	346.25^{b}	450^{c}	399^{d}	206.25^{cd}	165^{d}	106.25^{b}	81.25^{def}	73.75^{cd}	66.25^{cd}	58.75^{cd}
Spiromeciphan	65.5^{c}	101.75^{b}	181.25^{b}	168.75^{c}	163.75^{d}	98.25^{d}	67^{d}	63^{b}	46^{ef}	34^{d}	30^{d}	32.5^{cd}
Emamectin benzoate 1.9 EC	648.75^{a}	1037.5^{a}	1215.75^{a}	1266.25^{a}	1304.75^{a}	1033.25^{a}	989.75^{a}	928.25^{a}	851.5^{a}	775^{a}	725.25^{a}	682.5^{a}
Abamectin 1.9 EC	332.5^{abc}	760^{a}	952.5^{a}	906^{ab}	930^{bc}	812.5^{ab}	555^{bc}	566.25^{a}	455^{bcd}	336.25^{bcd}	358.75^{abcd}	391.25^{abc}
Lamda cyhalothrin	93.75^{c}	138.75^{b}	141.25^{b}	156.5^{c}	149.75^{d}	86.25^{d}	74.25^{d}	67.25^{b}	58.25^{ef}	43.25^{d}	19.25^{d}	12^{d}
Malathion 50 EC	504^{ab}	953.78^{a}	1191.25^{a}	1190^{ab}	1260^{ab}	977.5^{a}	922.5^{ab}	845^{a}	792.5^{ab}	706.25^{ab}	626.25^{ab}	525^{ab}
Efficacy of traps												
Private company trap	311.25^{de}	249.25^{d}	222.00^{c}	204.00^{d}	155.75^{c}	85.00^{c}	55.50c	42.25^{c}	32.25^{c}	25.75^{c}	13.25^{b}	5.25^{b}
ICAR - CISH old model trap	266.25^{e}	227.50^{d}	220.25^{c}	152.25^{d}	144.75^{c}	79.25^{c}	50.50c	33.75^{c}	27.25^{c}	17.50^{c}	4.75^{b}	3.50^{b}
Popular private company trap	331.25^{cd}	290.50^{c}	435.75^{b}	181.25^{c}	158.50^{b}	78.00^{c}	256.25^{b}	230.75^{b}	225.75^{b}	208.75^{b}	66.25^{b}	4.00^{b}
IIHR -CHES trap	656.25^{ab}	668.25^{ab}	830.50^{a}	703.25^{ab}	670.75^{a}	570.50^{ab}	415.00^{ab}	445.25^{a}	393.25^{a}	310.50^{ab}	282.50^{a}	267.75^{a}
IMFFI -Water bottle trap	532.50^{bc}	512.50^{bc}	600.25^{b}	599.75^{bc}	589.00^{a}	480.00^{b}	393.00^{ab}	380.75^{ab}	358.75^{ab}	289.00^{ab}	258.50^{a}	268.00^{a}
ICAR- CISH new model trap	792.50^{a}	768.75^{a}	940.00^{a}	857.50^{a}	750.00^{a}	657.50^{a}	535.25^{a}	515.00^{a}	457.50^{a}	395.00^{a}	338.00^{a}	306.25^{a}

Means with same letter not significantly different in Tukey's honesty test (p=0.01)

direction of the hole on the trap body influence the fly catch- Ravikumar and Viraktamath, (2006) found bottle traps with 4 holes of 20 mm dia were significantly superior in attracting *B. dorsalis, B. correcta, and B. zonata* than those with l, 2, 3, 5, or 6 holes/ trap. In the present study also traps with 4 holes opposite to each other (CISH trap) were found superior. Shanker et al. (2010) also observed that traps with 4 holes had the highest fruit fly catch. Thus, it is evident that insecticide type and trap container design affect the catch potential of the fruit fly traps. The present results are more relevant in the light of the ensuing ban on the most used insecticide in the MAT technique is malathion and, in that case, emamectin benzoate, abamectin, or profenophos may be used as an efficient killing agent in fruit flies traps. Although, a lot of work has been done on the development of various types of trap containers, however, so far, no universal, effective trap has been developed, nevertheless the CISH trap container with the rainproof provision and has been found superior among the existing commercial traps.

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