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Eco-friendly Management of Mango Fruit Fly using *'NAUROJI* Stonehouse Fruit Fly Trap' Under Humid Tropics

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ABSTRACT: Fruit flies, *Bactrocera* spp. (Tephritidae: Diptera), are the most destructive pests of fruits and vegetables not only in India but all over the world. Navsari Agricultural University, Navsari have developed "*NAUROJI* Stonehouse fruit fly trap" an ecofriendly component of IPM which being popularized among farming community. All India Co-ordinating Research Project on Fruits (AICRP-F) is working in all states for developing and strengthening different technologies through multi-location trial in different agro-eco-systems. Paria center from Gujarat demonstrated NAUROJI Stonehouse fruit fly trap in different villages of Valsad District to increase awareness among farmers by various extension activities. Results revealed that the farmers were successful in keeping off the fruit fly incidence in mango with the guidance provided by AICRP scientists. Average 4 to 7 per cent fruit fly damage was observed in demonstrated field as against 14 to 18 per cent in control. Moreover, average 525.31 numbers of fruit flies were trapped per week with 6.78 per cent increase in yield. Finally, fruit flies were managed successfully by adopting IPM practices wherein *NAUROJI* Stonehouse fruit fly trap played a major role with meager investment of Rs. 660.00 per ha and obtained average net profit of Rs. 18900.

Keywords: Fruit fly, male annihilation technique, NAUROJI Stonehouse fruit fly trap, AICRP-F, SCSP.

INTRODUCTION

Fruit flies *Bactrocera* spp. (Tephritidae: Diptera) are the most serious pest of fruits and vegetables not only in India but also all over the world. It also pose a major threat to global trade and invoked quarantine restrictions to minimize the risk of establishment of exotic species, which makes the fruit fly problem more serious. The fruit loss in mango ranges from 5 to 80% was reported due to fruit flies and pests of quarantine importance. It has been reported that in India, the loss in fruit yield ranges from 1 to 31% with a mean of 16% and causes loss up to Rs.29,460 million per annum in mango, guava, sapota and citrus (Mumford, 2001). Patel and Patel (2005) reported 16 to 40 and 4 to 52 per cent damage by fruit flies in mango and sapota, respectively.

Fruit flies are the hidden enemy as maggots feed inside the fruits beyond the reach of insecticides. Secondly, due to good flying capacity management of fruit flies is a great problem. The poison bait technique given by various workers across the country has proved effective to some extent, but due to residue restriction it becomes unusable. Frequent and excessive use of insecticides leads to the control of major insect-pests. However, they do not manage fruit complex as the last application of insecticides do not coincide with initiation of fruit fly damage on one hand and completion of damaging stage of the pest inside the fruit on the other hand. Excessive application of insecticides also leads to many environmental hazards on the harvested fruits and also results in inadequate control. Under these circumstances Area Wide (AW) adoption of management strategy can only be useful against the flies. Compared with the current practices, AW management system suppresses fruit fly populations in a cost-effective and environmentally friendly manner (De Faveri *et al*., 2024). Singly management tactic will not be able to manage fruit flies. Therefore, Integrated Pest Management (IPM) is the only option to get rid of from fruit flies (Pal *et al*., 2021). Pheromones have been successfully used in insect control. Female insect attracted the male insects by releasing odorous chemical. Sex pheromone, released by one sex only activates a series of behaviour patterns in other sex of the same species and thus facilitates mating. This is a behavioral method in which the insects positive anemotactic orientation is exploited in making it approach the trap laid. Population control is achieved by destruction of males within the pheromone baited trap.

Use of methyl eugenol trap is the most eco-friendly and remunerative approach among the various alternate strategies available for the management of fruit flies (Verghese *et al.,* 2006). The mass trapping of mango fruit fly has been very effective by using methyl eugenol based 'Rakshak' fruit fly trap developed by Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli is very effective (Munj *et al.,* 2020). The highest numbers of fruit flies were caught by using methyl eugenol based bottle traps without funnels (Susanto *et al.*, 2020). The

use of chemical attractant along with appropriate trapping technique has also been found effective in monitoring, suppressing fruit flies on large areas by male annihilation technique (MAT) and even complete eradication of various fruit flies (Steiner *et al.*, 1970; Stonehouse *et al.*, 2002a). Naganna *et al.* (2020) validated trap height of 2 and 3 meters from ground level attracted highest number of flies in mango. According to Naganna and Jethva (2021), 25 methyl eugenol traps per hectare is considered optimum to reduce fruit fly population in mango. Patel *et al.* (2022) also tested the population dynamic of different fruit fly species by using methyl eugenol based fruit fly trap. The '*NAUROJI'* Stonehouse fruit fly trap developed by Navsari Agricultural University, Navsari is also based on male annihilation technique (Fig.1-A).Farmers are only demanding pesticides to overcome the fruit fly infestation. Keeping these in minds, to increase awareness among farming community and large scale dissemination of this technology the present work was carried out.

MATERIALS AND METHODS

During present investigation, pheromone-based IPM technology was adopted for the management of mango fruit fly through farmer's participatory approach. With the technological assistance from State Agricultural Universities (SAU's) and ICAR institutes, All India Co-ordinating Research Project on Fruits (AICRP-Fruits) developing and strengthening different technologies through multi-location trial in different agro-eco-systems all over the country. Subsequently, pheromone-based IPM technology was demonstrated and popularized for managing mango fruit fly for two consecutive years, 2021 and 2022 with the financial assistance under the AICRP-Fruits. Before that a preliminary survey were also carried out to know the existing status of management practices for fruit flies by the farmers. Based on this yield gap analysis was assessed. Moreover, technology gap had also been identified. The extension activities *viz.*, training programme (Fig. 1B), farmers-scientist interactions, method demonstration on installation of traps (Fig.1D), filed visit, diagnostic visits were planned accordingly. During training programme 10 fruit fly traps were distributed to selected farmers (Fig. 1C). Details of extension activities performed were given in Table 1.Farmers were trained for preparation of pheromone traps, trap servicing and identification of fruit flies etc. Further other components of IPM practices *viz.*, intercultural operation, phyto-sanitation, collection and destruction affected fruits were also demonstrated. Number of male fruit flies attracted in the pheromone traps was recorded at weekly interval (Fig.1E). For this, 10 mango orchards each of one acre area were observed and number of fruit flies trapped in each trap (5 traps per orchard) were collected and counted. Each trap was cleaned after every observation. Moreover, to record the per cent incidence of fruit fly randomly 50 fruits at full maturity stage were harvested randomly from five treated orchard (trap installed orchard) and five untreated orchard (orchards without trap). These fruits were kept for ripening and observed the incidence of fruit fly (Fig. 1F). Based on this, per cent incidence was worked out. The economics of demonstrated and control plot was also worked out.

Table 1: Details of technology demonstration with extension activities.

Date	Extension activity	Name of village	No. of traps provided	No. of Participants
16.03.2021	Off campus training	Sukhesh, Tahsil-Pardi, Dist. Valsad	10	15
21.03.2021	Off campus training	Motafonda, Tahsil. Pardi, Dist. Valsad	10	61
18.04.2022	Off campus training Method demonstration on preparation and installation of trap	Shegva, Tahsil. Dist. Valsad	10	25
20.04.2022	Off campus training Method demonstration on preparation and installation of trap	Khutej, Tahsil. Pardi, Dist. Valsad,	10	45

RESULTS AND DISCUSSION

Details of performance of technology and economics of demonstrated and control plot was given in Table 2. Results revealed that farmers were successful in management of the fruit fly incidence by using *NAUROJI* fruit fly trap. In demonstrated field average 5 to 8 per cent and 3 to 4 per cent fruit fly damage was observed as against 15 to 20 per cent and 12 to 15 per cent in control/farmers practice during 2021 and 2022, respectively. Average 640.20 and 422.30 numbers of fruit flies were trapped per week during 2021 and 2022, respectively. Besides this, 7.69 and 5.88 per cent yield was found increased over control during both the years, respectively (Table 2). Ultimately, by adopting NAUROJI fruit fly trap technology with meager investment of Rs. 660.00 per ha as technology cost, average of Rs. 19400/- and Rs. 18400/- net profit was obtained during two consecutive years. The mean data of both the years showed that 04 to 07 % fruit fly incidence in demonstrated field as against 14 to 18 per cent in control field. Average 531.25 numbers of fruit flies were trapped per week. Similarly, increase in net profit over control was Rs. 18900.00. The other mango growing farmers from neighboring villages were also attracted. The farmers of surrounding villages are enthusiastic for adopting fruit fly trap technology in mango. The constant follow up and monitoring, made them habitant with eco-friendly installation of *NAUROJI* Stone house fruit fly trap.

Mahmood *et al*. (2000) reported that MAT for the protection of mango was successfully assessed in farmers fields in four areas of Pakistan in comparison with farmers practices of no control or cover spray which results in cent per cent reduction in infestation losses by *B. zonata.* Manrakhan and Price (2000) found that the male *B. zonata* captures in area under MAT were significantly lower than captures in area under BAT (Black River) of Mauritius. Jeuffrault *et al*. (2000) reported that the male annihilation technique and spot spraying prevented establishment of *B. zonata*, on the Island of Reunion. Malavasi (2000) reported that the male annihilation technique complemented with bait stations of fibre blocks impregnated with methyl eugenol and malathion solution, protein bait sprays, fruit stripping, soil treatment and pruning major host trees made the Guyana and Brazil area (South America) free from *B. carambolae*.

Stonehouse *et al*. (2002a) in Pakistan evaluated MAT with wooden block (soaked with lure and insecticide) and lure baited plastic trap against the *Bactrocea* spp. The result indicated that the MAT with wooden block killed four times more flies and lasted over 2 times longer than the lure baited plastic trap. They further stated that the MAT block was less expensive, less venerable to theft and weather; and required no recharging and replacement. In mango, soaked block male annihilation technique was compared with farmers practices of no control that resulted into and average 9 per cent *B. zonata* infestation in unprotected plots and zero per cent in those protected in Pakistan (Stonehouse *et al*., 2002b). Alwood *et al*. (2003) reported that the combination of male annihilation and protein bait application technique was used for eradication of four introduced *Bactrocera* spp. Three out of four species, namely *B. dorsalis*, *B. xanthode*and *B. cucurbitae* were completely eradicated while *B. frauenfeldi* remained persistent in Nauru, Australia.

According to Verghese *et al*. (2006), pre harvest IPM practices (combination of MAT using methyl eugenol as a lure plus sanitation) brought down *B. dorsalis* infestation to 5.00 per cent from an infestation ranging from 17 to 66 per cent in control during 2004 and 2005 in Bangalore, India. Stonehouse *et al*. (2007) evaluated male annihilation technique at the levels of the farm and of the village (taken to be 1 sq km) at a variety of sites in India. Using BAT in cucurbit fields, against a pest population largely of *B. cucurbitae*, with reference to a mean infestation rate in unprotected fields of 27 per cent, farm-level control obtained improvements of 48 per cent, village-level control of 82 per cent and both together of 89 per cent. Similarly, in fruit orchard, mean infestation rate in unprotected orchards of 13 per cent, farm-level control obtained improvements of 71 per cent, village-level control of 96 per cent and both together of 99 per cent by using MAT in fruit orchards. All these findings of earlier workers are more or less similar with the present findings.

Table 2: Details of performance of technology and economics of demonstrated and control plot.

Particulars	2021		2022		Mean	
	***NAUROJI* Stone house fruit fly trap demonstrated plot**	**Control Plot/farmers practice**	***NAUROJI* Stone house fruit fly trap demonstrated plot**	**Control Plot/farmers practice**	***NAUROJI* Stone house fruit fly trap demonstrated plot**	**Control Plot/farmers practice**
Average fruit fly trapped per trap/week	640.20	-	422.30	-	531.25	-
Per cent damage by fruit fly	05-08%	15-20%	03-06%	12-15%	04-07%	14-18%
Cost of technology (Rs/ha)	660.00	-	660.00	-	660.00	-
Gross Cost including Plant Protection (Rs/ha)	63000.00	62400.00	64500.00	65400.00	63750.00	63900.00
Average Yield (t/ha)	6.46 t/ha	6.00 t/ha	7.22 t/ha	6.80 t/ha	6.83 t/ha	6.41 t/ha
Increase yield over control	7.69 %	-	5.88 %	-	6.78	-
Gross income (Rs/ha)	260000.00*	240000.00	324000.00	306000.00*	292000.00	273000.00
Net profit (Rs/ha)	197000.00	177600.00	259000.00	240600.00	228000.00	209100.00
Net profit (Rs/ha) over control	19400.00	-	18400.00	-	18900.00	-
	*Prevailing market price of mango Rs. 40/- per kg		*Prevailing market price of mango Rs. 40/- per kg			

Fig. 1A. *NAUROJI* Stonehouse fruit fly traps; **B-**Off Campus Training programme; **C.** Distribution of fruitfly traps to farmers, **D.** Method demonstration on preparation and installation of trap**; E-** Regular **c**ollection of trapped fruit flies; **F-**Fruits were kept for ripening and observed the incidence of fruit fly

CONCLUSION

Based on results from present studies, it can be concluded that mango fruit fly could be managed effectively and ecofriendly by mass trapping of male fruit fly using methyl eugenol based fruit fly trap with integration of other different practices *viz*., intercultural operation, phyto-sanitation, collection and destruction of affected fallen fruits. *NAUROJI* Stonehouse fruit fly, trap' developed by Navsari Agricultural University, Navsari (Gujarat, India) is an eco-friendly component IPM for fruit fly management in mango under humid tropics.

FUTURE SCOPE

Despite of increase in research on mass trapping of fruit flies, several challenges about the research and application of biological control against fruit fly was remain pending. So, efforts must be focused on mass production of effective natural enemies of different life stages of fruit fly as these issues are constantly in the eye of program managers.

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Conflict of Interest. None.

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