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Evaluation of wooden dispensers block of methyl eugenol formulation for attraction of Tephritid fruit flies (Diptera: Tephritidae) under terai region of West Bengal

Nagendra Kumar and Nripendra Laskar

Abstract
Efficacy of different wooden blocks as dispenser block of methyl eugenol (Male Annihilation Technique) for attraction of *Bactrocera* species has been studies. Self-made transparent rectangular PET plastic jars around 1 litter capacity and having four circular holes of 1 cm in diameter on four sides of the jar just below the shoulder of the bottle (i.e. 1/ 3rd from top) openings for the entry of flies. The pooled data of mean weekly catch was recorded highest in plywood dispenser block (13.40 flies/trap/week) followed by mango (13.37 flies/trap/week) and neem (12.67 flies/trap/week) and lowest in babul dispenser block (10.97 flies/trap/week) followed by sissoo (11.28 flies/trap/week) in 7th DAI. The mean persistence period was highest in plywood dispenser block, while lowest in sissoo dispenser block When overall mean values of trap-catch were considered from DAI, highest efficacy was noted by plywood (7.61 flies/trap/week) followed by mango (7.48 flies/trap/week) and neem dispenser block (7.29 flies/trap/week) whereas lowest catch was observed in sissoo (5.67 flies/trap/week) followed by babul dispenser bock (6.06 flies/trap/week). The results also suggested that more number of flies' species were annihilated in second year of experimentation than first year.

Keywords: *Bactrocera*, wooden dispenser blocks, methyl eugenol, plastic jars, MAT

Introduction
The flies belonging to this family are popularly known as "fruit flies" because of their close association with fruits and vegetables. They are also called "Peacock flies" because of their habit of strutting about and vibrating their spotted wings and showing their elaborate wing and body marking. Their ornate body and wing patterns serve as visual releasers in courtship and agonistic displays. These flies are widespread over the world, except the Arctic and Antarctic regions and richly predominant in tropical, subtropical and temperate areas. They occupy a very important position particularly in the list of enemies of plants, because of their widespread presence and great economic importance due to number of plant species attack, and the enormous direct and indirect damage caused by the major species having grave effects on the agricultural economy of many countries of the world including India.

Bactrocera spp. is an important pest of fruits, especially mango. The present status of researches on fruit fly control is still not satisfactory in developing countries. There is great need for initiating combined effects for pre-harvest control measures and also post-harvest handling. The control methods for fruit flies are largely determined by their biological attributes. Only adults are exposed to control measures while eggs and larvae remain protected in the hosts. The use of systemic insecticides for the control of pupae is not only costly, relatively ineffective but also highly detrimental to ground flora and fauna. The gravid female lays eggs in maturing fruits. The maggots develop in the fruit and cause fruit drop and rotting. The best way to prevent fruit fly infestation is to follow an integrated approach of traps, sanitation and soil raking below the tree. The trap consists of methyl eugenol (ME), (a para-pheromone mixed with a toxicant), which attracts only the males of certain species of *Bactrocera*, and therefore is called male annihilation technique (MAT). In the absence of males, females fail to procreate, and hence fruits will be free of infestation.

The ME traps can be used for both monitoring and management. The latter, however, is more relevant to the farmers. Of the several parapheromones reported (Payne *et al.* 1973) [1], only methyl eugenol is an available lure for *B. dorsalis B. zonata* and *B. correcta* in India. Methyl eugenol is the most powerful of all the male lures attracting Oriental fruit fly, *B. dorsalis* and others (Drew 1974) [2]. It has been successfully used in management programs due to its apparent olfactory, as well as phagostimulatory action to which some species of *Bactrocera* get attracted. Many private companies are selling fruit fly traps at exorbitant rates. So, the objective of this research was to make MAT cost effective, user-friendly, and to enable farmers to fabricate their own traps. Importances of lures and baits trapping have long been employed for monitoring and eradicating insect pests.

Materials and Methods

Preparation of trap and different wooden blocks as dispenser

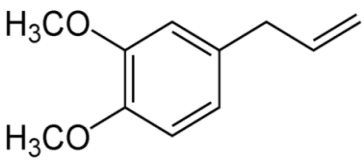
Self-made transparent rectangular PET plastic jars around 1 liter capacity were used and having four circular holes of 2 cm in diameter on four sides of the jar just below the shoulder of the bottle (i.e. 1/ 3rd from top) openings for entry of flies. A warm pen knife or soft drill facilitated the slitting/drilling of a hole. In addition, four random holes of 2-3 mm diameter punched at the bottom with warm needles to allow drainage of water that may get collected in the bottle due to rain. The wooden dispenser blocks *viz; Mangifera indica* (Mango), *Pinus roxburghii* (Chir), *Syzygium cumini* (Jamun), *Acacia nilotica* (Babul), *Azadirachta indica* (Neem), Plywood, *Neolamarckia cadamba* (Kadam), *Artocarpus heterophyllus* (Jackfruit), *Dalbergia sissoo* (Sissoo) and *Tectona grandis (*Teak) of uniform size (5cm×1.5cm×1.5cm) were procured from local carpenter. These blocks were properly planed and sanded to remove loosely adhering fibres on their surface. These wooden blocks were suspended within the traps with the help of thread from the top and the traps were hanged at 1m height in places having no direct sunlight. The study was conducted during 24th to 32nd standard week of 2017 and 2018.

Insecticide

Spinosad (45 SC) was used as insecticide in the traps to annihilate the male flies (Commercial product manufactured by *Nagarjuna Agrichem* Ltd). It is a fermented metabolite containing a mixture of two components and produced by *Saccharopolyspora spinosa*, a soil inhabiting species of Actinomycetes. It is safer to handle and more eco-friendly. Spinosad contains a mix of two spinosoids, spinosyn A ($C_{41}H_{65}NO_{10}$), the major component, and spinosyn D ($C_{42}H_{67}NO_{10}$), the minor component, in a roughly 17:3 ratio.

Attractant

Methyl eugenol (ME) is a phenylpropanoid chemical with many synonyms: 4-allylveratrole; 4-allyl-l,2-dimethoxybenzene; eugenyl methyl ether; 1,2-dimethoxy-4-(2-propenyl) benzene; 3, 4-dimethoxy-allylbenzene; 3-(3,4-dimethoxyphenyl)prop-l-ene; O-methyleugenol; and methyl eugenol ether. It purchased from commercial product manufactured by SISCO Research Laboratories Pvt. Ltd. It is directly derived from eugenol, a product from phenylalanine (an essential amino acid) through caffeic acid and ferulic acid via 'the shikimate pathway' is a common phenylpropanoid found in many plant species, particularly in spices and medicinal plants and has the chemical formula $C_{11}H_{14}O_2$ as under:



Methyl eugenol

The wooden dispenser block were impregnated with 50 ml of the methyl eugenol mixture (6:4:1 of ethanol: methyl eugenol: Spinosad 45% SC by volume) for about 48 hours. Ethanol has been added to act as a dispersant and also increase the ease of absorption of methyl eugenol into the blocks.

Methyl eugenol formulations absorption test

The wooden dispenser block were shed dry for a week and weighed before the treatment and placed under the methyl eugenol formulations at room temperature for 48 hrs. After 48 hrs the specimens are removed from the mixtures and weighed with digital weighing machine. The percent weight change from the original weight represents the methyl eugenol mixture absorption. The absorption of mixtures was calculated by:

$$\text{Methyl eugenol formulations absorption (\%)} = \frac{W2-W1}{W1} \times 100$$

Where

W_1=Initial weight of specimen, g

W_2=Specimen weight after 48 hours of soaking, g

The traps were fixed at a height of 1 m above ground level using a metal string. The traps were placed at the centre of each plot and weekly observations on the total number of fruit flies catch in each treatment, till zero catch in the individual trap was recorded for consecutive two weeks. Care was taken to maintain a distance of 50 m between two traps to avoid trap interference. The experiment was conducted in a randomized block design (RBD) with ten treatments replicated three times. The data on trap catches were statistically analyzed as per standard protocol.

Species diversity determination

The adult flies collected by using sex attractants were critically examined under stereo-binocular microscope for their characteristic morphological features and identified by following the appropriate taxonomic keys of tephritids (R.A.I Drew 1989, V.C. Kapoor 1970) [3, 4].

After proper identification, percentages of each category of species were determined as follows:

$$\text{\% of a species} = \frac{\text{Number of individual of that particular species}}{\text{Total number individual}} \times 100$$

Results and Discussion

Methyl eugenol, a parapheromone is known to attract 69 species of fruit flies (Drew, 1974) [2]; (Drew and Hancock, 1994) [5], which is widely used for male annihilation technique for management of *Bactrocera spp.* Drew *et al.* (1982) [6] recommended use of dichlorvos along with methyl eugenol for successful kill of fruit flies. Data on mean fly catch per ml of methyl eugenol mixture absorbed in different dispensers showed that, the plywood block recorded a

maximum catch efficiency of 0.47 flies/ml followed by acacia block (0.21). The results clearly indicate that traps once charged with acacia, straw board and plywood blocks impregnated with methyl eugenol can be run effectively upto 39th, 40th and 41st week of observation. The present results are in line with the findings of Patel *et al*. (2005a) [7], Satarkar *et al*. (2006) [8] and Rameash *et al*. (2009) [9], who reported that plywood, straw board and acacia blocks impregnated with methyl eugenol and dichlorvos mixtures were best suited for monitoring purpose as they exhibited a constant rate of release of methyl eugenol, longer persistence and comparatively moderate cost of preparation.

The efficacy of different wooden blocks as dispenser block of methyl eugenol formulation (Male Annihilation Technique) for attraction of *Bactrocera* fly from Days after Installation (DAI) has been depicted in (Table-1 and Fig-1) during 2017-18. It appears from the presentation that in 7th DAI, plywood dispenser block recorded the highest catch with a mean number of *Bactrocera* flies trapped/trap/week was 13.68 followed by mango dispenser block (13.20 flies/trap/week) and neem dispenser block (12.44 flies/trap/week). The lowest catch was recorded in sissoo dispenser block (10.29 flies/ trap/week) followed by babul dispenser block (10.65 flies/trap/week) and kadam dispenser block (10.87 flies/trap/week). The catch in plywood dispenser block was significantly superior to other dispensers block throughout the period. The number of annihilated flies was highest in 7th DAI all through the period, and then a decreasing trend was recorded almost similar to all the treatments. The number of trap-catch gradually decreased which may be due to evaporation, drying and other environmental factors. All the wooden dispensers' block of methyl eugenol recorded a zero catch in 49th DAI onward. Sissoo and kadam dispenser blocks recorded low catches as compared to other dispensers block. Kadam and jackfruit dispensers block recorded zero catch in 42nd DAI onwards. The rest of the dispensers block continued to attract the fly catch till 42nd DAI. When overall mean values of trap-catch were considered after DAI, highest efficacy was noted by plywood (6.19 flies/trap/week) followed by mango (5.66 flies/trap/week) and neem dispenser block (5.23 flies/trap/week) whereas lowest catch was noted by sissoo (3.91 flies/trap/week) followed by kadam dispenser block (3.99 flies/trap/week).

More or less a similar trend was noticed during 2018-19 (Table-2 and Fig-2). Plywood dispenser block recorded the highest catch (13.97 flies/trap/week) followed by mango (13.07 flies/trap/week) and neem (12.92 flies/trap/week) and the lowest catch (11.17 flies/trap/week) was observed in sissoo dispenser block followed by kadam dispenser block (11.31 flies/trap/week) during 7th DAI. The catch in plywood dispenser block was significantly superior to other dispensers upto 35th DAI. All the wooden dispensers' block of methyl eugenol recorded a zero catch in 49th DAI onward excluding sissoo dispenser block continued to attract the fly catch till 35th DAI. When overall mean values of trap-catch were considered after DAI, highest efficacy was noted by plywood dispenser block (6.30 flies/trap/week) followed by mango dispenser block (6.04 flies/trap/week) and neem dispenser block (5.75 flies/trap/week) flies/trap/week whereas lowest catch was observed by sissoo dispenser block (4.36 flies/trap/week) followed by kadam dispenser bock (4.78 flies/trap/week).

Comparison of two years data of mean fly catch and persistence periods of the different methyl eugenol dispenser blocks have been presented in (Table-3 and Fig-3). The pooled data on the mean weekly catch was annihilated highest in plywood dispenser block (13.83 flies/ trap/week) followed by mango dispenser block (13.13 flies/ trap/week) and neem (12.68 flies/trap/week) and lowest in sissoo dispenser block (11.05 flies/trap/week) followed by kadam dispenser block (11.09 flies/trap/week) in 7th DAI. The catch in plywood dispenser block was significantly superior to other dispensers block throughout the period. When overall mean values of trap-catch were considered after DAI, highest efficacy was noted by plywood dispenser block (6.26 flies/trap/week) followed by mango dispenser block (5.86 flies/trap/week) and neem dispenser block (5.50 flies/trap/week) whereas lowest catch was recorded in sissoo dispenser block (4.15 flies/trap/week) followed by kadam dispenser bock (4.42 flies/trap/week). The overall mean number of flies trapped from DAI in different wooden dispenser blocks of Methyl Eugenol formulations has been shown in Fig-4.

The quantity of methyl eugenol formulation absorbed by different wooden dispensers' block showed a significant difference among them in per cent gain in their weight (Table-4). The highest per cent gain in weight by Plywood dispenser block of (59.04%) followed by mango (48.76%) and neem (47.34%). The lowest per cent gain in weight by sissoo dispenser block of (20.81%) followed by kadam (27.88%) and babul (30.24%). The data on mean fly catch per week of methyl eugenol mixture absorbed by different dispensers showed that, the plywood block recorded maximum catch efficiency while lowest catch efficiency was recorded by sissoo dispenser block. Mango and neem dispenser bocks were at par with each other to absorbed quantity of methyl eugenol formulation.

The effectiveness of different woods Indian plum; plywood (Delhi-source and local-source); aliyo; Black plum/jamun; mango; neem; tamarind; acacia/babul; dhaman; sevan; malbar kino; teak; sapota; tulip tree; sal; monkey's bread and rose wood as block for impregnating methyl eugenol were evaluated against *Bactrocera* spp. in mango orchards by Patel *et al*. (2005a) [7]. They carried out the experiment in mango orchard deploying 25 cm^2 MAT blocks of different woods soaked in ethanol + methyl eugenol + malathion (6:4:1 v/v) and placed in trap following complete randomized block design with six replications. Based on fly catches, block of plywood was found most effective followed by block of black plum (jamun), neem, Indian plum, aliyo, tamarind, acacia, Dhaman, Sevan, Malbar Kino, teak, Sapota, tulip tree, sal, monkey's bread and rose wood in descending order. Statistically, Indian plum, jamun and neem were at par with each other. Based on half-life of decay, jamun was the best followed by Indian plum or mango, local-source plywood or aliyo and Delhi-source plywood.

Table 1: Mean number of *Bactrocera* species flies trapped/trap/week in different wooden dispenser blocks of Methyl Eugenol formulations at Instructional Farm of mango orchard, UBKV during 2017-18

Wooden Dispenser Blocks	Flies trapped/trap/week (DAI)*								Overall Mean
	7th	14th	21st	28th	35th	42nd	49th	56th	
T_1-Teak	129.33 (11.39)^{cde}	62.33 (7.93)^{de}	35.33 (5.99)^{cd}	22.67 (4.81)^{de}	7.33 (2.80)^{e}	2.00 (1.58)^{c}	0.00 (0.71)	0.00 (0.71)	32.38 (4.49)^{e}
T_2-Sissoo	118.67 (10.29)^{e}	54.67 (7.43)^{e}	26.67 (5.21)^{d}	14.33 (3.85)^{g}	2.00 (1.58)^{g}	0.33 (0.91)^{e}	0.00 (0.71)	0.00 (0.71)	27.08 (3.91)^{f}
T_3-Neem	154.33 (12.44)^{bc}	103.33 (10.19)^{b}	61.67 (7.88)^{ab}	24.33 (4.98)^{c}	12.33 (3.58)^{c}	1.33 (1.35)^{d}	0.00 (0.71)	0.00 (0.71)	44.67 (5.23)^{c}
T_4-Plywood	186.67 (13.68)^{a}	132.33 (11.53)^{a}	71.33 (8.48)^{a}	46.00 (6.82)^{a}	22.67 (4.81)^{a}	7.33 (2.80)^{a}	0.00 (0.71)	0.00 (0.71)	58.29 (6.19)^{a}
T_5-Jackfruit	125.67 (11.23)^{de}	92.33 (9.64)^{bc}	52.33 (7.27)^{b}	23.67 (4.92)^{cd}	4.00 (2.12)^{f}	0.00 (0.71)^{e}	0.00 (0.71)	0.00 (0.71)	37.25 (4.66)^{de}
T_6 -Mango	173.67 (13.20)^{ab}	109.67 (10.50)^{b}	68.33 (8.30)^{a}	32.33 (5.73)^{b}	17.33 (4.22)^{b}	3.33 (1.96)^{b}	0.00 (0.71)	0.00 (0.71)	50.58 (5.66)^{b}
T_7-Jamun	149.33 (12.24)^{bcd}	101.67 (10.11)^{b}	50.67 (7.15)^{b}	21.67 (4.71)^{ef}	9.67 (3.19)^{d}	1.00 (1.22)^{d}	0.00 (0.71)	0.00 (0.71)	41.75 (5.00)^{cd}
T_8-Babul	113.00 (10.65)^{e}	75.33 (8.71)^{cd}	35.33 (5.99)^{cd}	21.00 (4.64)^{f}	11.33 (3.44)^{cd}	2.00 (1.58)^{c}	0.00 (0.71)	0.00 (0.71)	32.25 (4.55)^{e}
T_9-Kadam	117.67 (10.87)^{e}	64.33 (8.05)^{de}	34.33 (5.90)^{d}	12.33 (3.58)^{h}	1.33 (1.35)^{g}	0.00 (0.71)^{e}	0.00 (0.71)	0.00 (0.71)	28.75 (3.99)^{f}
T_{10}-Chir	145.67 (12.09)^{bcd}	90.67 (9.55)^{bc}	48.33 (6.99)^{bc}	21.33 (4.67)^{ef}	9.67 (3.19)^{d}	2.67 (1.78)^{bc}	0.00 (0.71)	0.00 (0.71)	39.79 (4.96)^{cd}
S. Em (±)	0.350	0.340	0.326	0.055	0.094	0.075	-	-	-
CD (0.05)	1.037	1.001	0.966	0.163	0.278	0.222	-	-	-

Mean of three replications
Figures in parentheses are square root transformed values
Figures following by same letters are not significantly different.
* DAI-Days after Installation

Table 2: Mean number of *Bactrocera* species flies trapped/trap/week in different wooden dispenser blocks of Methyl Eugenol formulations at Instructional Farm of mango orchard, UBKV during 2018-19

Wooden Dispenser Blocks	Flies trapped/trap/week (DAI)*								Overall Mean
	7th	14th	21st	28th	35th	42nd	49th	56th	
T_1-Teak	137.00 (11.73)^{cd}	97.67 (9.91)^{cde}	45.67 (6.79)^{d}	20.33 (4.56)^{ef}	10.33 (3.29)^{bc}	2.00 (1.58)^{c}	0.00 (0.71)	0.00 (0.71)	39.13 (4.91)^{fg}
T_2-Sissoo	124.33 (11.17)^{d}	86.33 (9.32)^{e}	39.33 (6.31)^{d}	14.67 (3.89)^{g}	3.67 (2.04)^{d}	0.00 (0.71)^{d}	0.00 (0.71)	0.00 (0.71)	33.54 (4.36)^{h}
T_3-Neem	166.33 (12.92)^{abc}	121.33 (11.04)^{abc}	85.67 (9.28)^{ab}	38.67 (6.26)^{b}	9.67 (3.19)^{c}	3.00 (1.87)^{abc}	0.00 (0.71)	0.00 (0.71)	53.08 (5.75)^{bc}
T_4-Plywood	194.67 (13.97)^{a}	142.33 (11.95)^{a}	97.33 (9.89)^{a}	54.33 (7.40)^{a}	14.00 (3.81)^{a}	3.33 (1.96)^{ab}	0.00 (0.71)	0.00 (0.71)	63.25 (6.30)^{a}
T_5-Jackfruit	144.67 (12.05)^{bcd}	112.67 (1064)^{bcd}	64.67 (8.07)^{c}	28.67 (5.40)^{cd}	8.00 (2.92)^{c}	3.33 (1.96)^{ab}	0.00 (0.71)	0.00 (0.71)	45.25 (5.31)^{def}
T_6 -Mango	170.33 (13.07)^{ab}	137.33 (11.74)^{ab}	89.67 (9.50)^{ab}	47.33 (6.92)^{a}	12.67 (3.63)^{ab}	3.67 (2.04)^{a}	0.00 (0.71)	0.00 (0.71)	57.63 (6.04)^{ab}
T_7-Jamun	153.00 (12.39)^{bcd}	119.33 (10.95)^{a}	74.33 (8.65)^{bc}	31.67 (5.67)^{bc}	8.67 (3.03)^{c}	2.67 (1.78)^{abc}	0.00 (0.71)	0.00 (0.71)	48.71 (5.49)^{cd}
T_8-Babul	140.33 (11.87)^{bcd}	114.33 (10.72)^{bcd}	49.00 (7.04)^{d}	23.00 (4.85)^{de}	8.33 (2.97)^{c}	2.33 (1.68)^{bc}	0.00 (0.71)	0.00 (0.71)	42.17 (5.07)^{efg}
T_9-Kadam	127.33 (11.31)^{d}	94.00 (9.72)^{de}	48.33 (6.99)^{d}	16.33 (4.10)^{fg}	8.67 (303)^{c}	2.33 (1.68)^{bc}	0.00 (0.71)	0.00 (0.71)	37.12 (4.78)^{g}
T_{10}-Chir	148.67 (12.21)^{bcd}	116.33 (10.81)^{bcd}	69.33 (8.36)^{c}	27.33 (5.28)^{cd}	8.33 (2.97)^{c}	2.00 (1.58)^{c}	0.00 (0.71)	0.00 (0.71)	46.50 (5.33)^{de}
S. Em (±)	0.377	0.352	0.289	0.199	0.133	0.084	-	-	-
CD (0.05)	1.117	1.043	0.856	0.589	0.394	0.249	-	-	-

Mean of three replications
Figures in parentheses are square root transformed values
Figures following by same letters are not significantly different.
* DAI-Days after Installation

Table 3: Mean number of *Bactrocera* species flies trapped/trap/week in different wooden dispenser blocks of Methyl Eugenol formulations at Instructional Farm of mango orchard, UBKV (pooled over 2017-18 and 2018-19)

Wooden Dispenser Blocks	Flies trapped/trap/week (DAI)*								Overall Mean
	7th	14th	21st	28th	35th	42nd	49th	56th	
T_1-Teak	133.17 (11.56)^{cd}	80.00 (8.97)^{de}	40.50 (6.40)^{de}	21.50 (4.69)^{e}	8.83 (3.06)^{d}	2.00 (1.58)^{cd}	0.00 (0.71)	0.00 (0.71)	35.75 (4.71)^{fg}
T_2-Sissoo	121.50 (11.05)^{d}	70.50 (8.43)^{e}	33.00 (5.79)^{e}	14.50 (3.87)^{f}	2.83 (1.83)^{f}	0.17 (0.82)^{f}	0.00 (0.71)	0.00 (0.71)	30.31 (4.15)^{h}
T_3-Neem	160.33 (12.68)^{b}	112.33 (10.62)^{bc}	73.67 (8.61)^{ab}	31.50 (5.66)^{c}	11.00 (3.39)^{c}	2.17 (1.63)^{cd}	0.00 (0.71)	0.00 (0.71)	48.88 (5.50)^{c}
T_4-Plywood	190.67 (13.83)^{a}	137.33 (11.74)^{a}	84.33 (9.21)^{a}	50.17 (7.12)^{a}	18.33 (4.34)^{a}	5.33 (2.42)^{a}	0.00 (0.71)	0.00 (0.71)	60.77 (6.26)^{a}
T_5-Jackfruit	135.17 (11.65)^{cd}	102.50 (10.15)^{c}	58.50 (7.68)^{c}	26.17 (4.12)^{d}	6.00 (2.55)^{e}	1.67 (1.47)^{d}	0.00 (0.71)	0.00 (0.71)	41.25 (5.01)^{def}
T_6 -Mango	172.00 (13.13)^{ab}	123.50 (11.14)^{ab}	79.00 (8.92)^{a}	39.83 (6.35)^{b}	15.00 (3.94)^{b}	3.50 (2.00)^{b}	0.00 (0.71)	0.00 (0.71)	54.10 (5.86)^{b}
T_7-Jamun	151.17 (12.32)^{bc}	110.50 (10.54)^{bc}	62.50 (7.94)^{bc}	26.67 (5.21)^{d}	9.17 (3.11)^{cd}	1.83 (1.53)^{cd}	0.00 (0.71)	0.00 (0.71)	45.23 (5.26)^{cd}
T_8-Babul	126.67 (11.28)^{cd}	94.83 (9.76)^{cd}	42.17 (6.53)^{d}	22.00 (4.74)^{e}	9.83 (3.21)^{cd}	2.17 (1.63)^{cd}	0.00 (0.71)	0.00 (0.71)	37.21 (4.82)^{ef}
T_9-Kadam	122.50 (11.09)^{d}	79.17 (8.93)^{de}	41.33 (6.47)^{de}	14.33 (3.85)^{f}	5.00 (2.35)^{e}	1.17 (1.29)^{e}	0.00 (0.71)	0.00 (0.71)	32.94 (4.42)^{gh}
T_{10}-Chir	147.17 (12.15)^{bc}	103.50 (10.20)^{bc}	58.83 (7.70)^{c}	24.33 (4.98)^{de}	9.00 (3.08)^{d}	2.33 (1.68)^{c}	0.00 (0.71)	0.00 (0.71)	43.15 (5.15)^{de}
S. Em (±)	0.318	0.300	0.235	0.113	0.090	0.056	-	-	-
CD (0.05)	0.942	0.887	0.696	0.335	0.267	0166	-	-	-

Mean of three replications
Figures in parentheses are square root transformed values
Figures following by same letters are not significantly different.
* DAI-Days after Installation

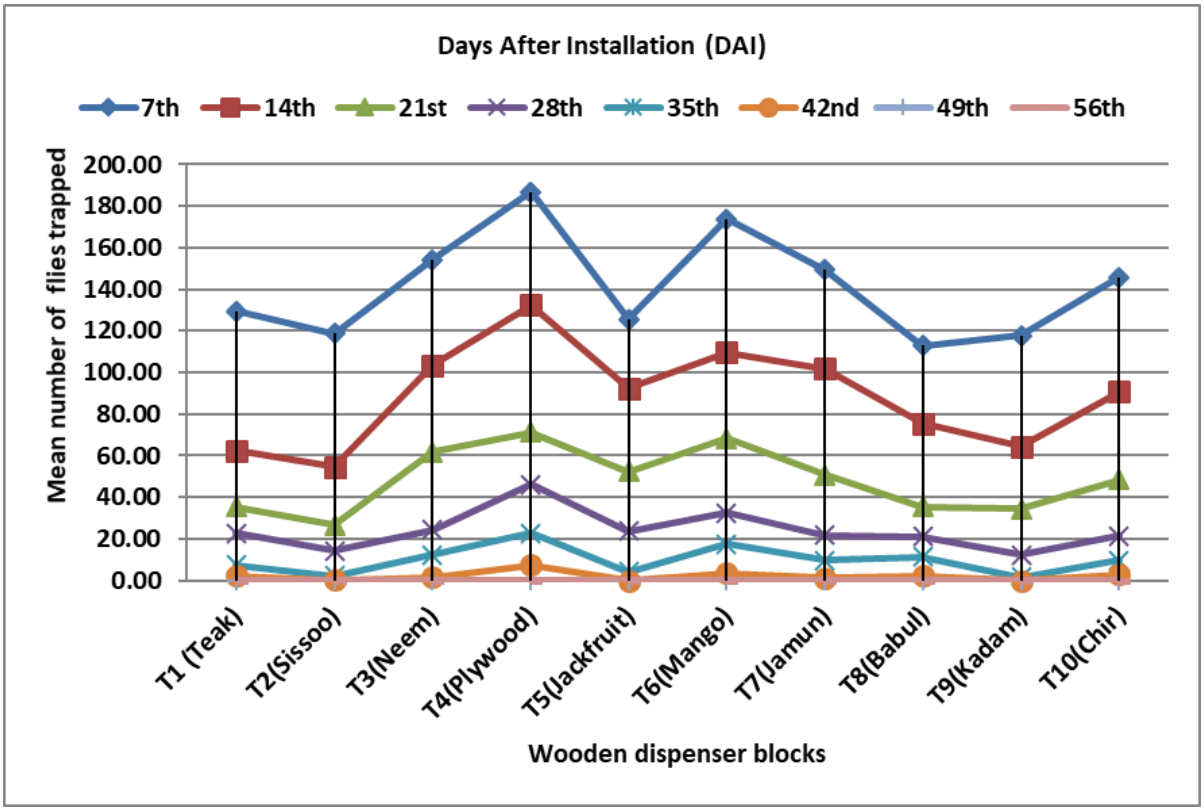


Fig 1: Mean number of flies trapped/trap/week in different wooden dispenser blocks of Methyl Eugenol formulations at Instructional Farm of mango orchard, UBKV during 2017-18

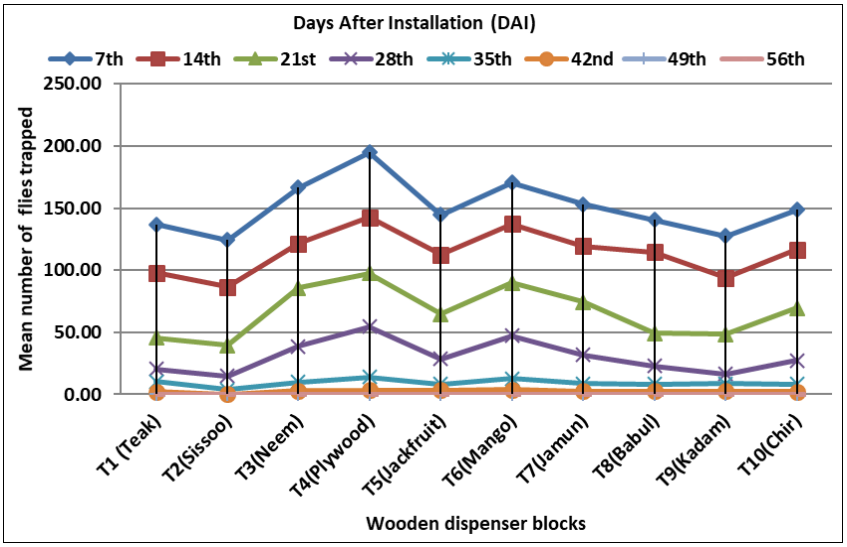


Fig 2: Mean number of flies trapped/trap/week in different wooden dispenser blocks of Methyl Eugenol formulations at Instructional Farm of mango orchard, UBKV during 2018-19

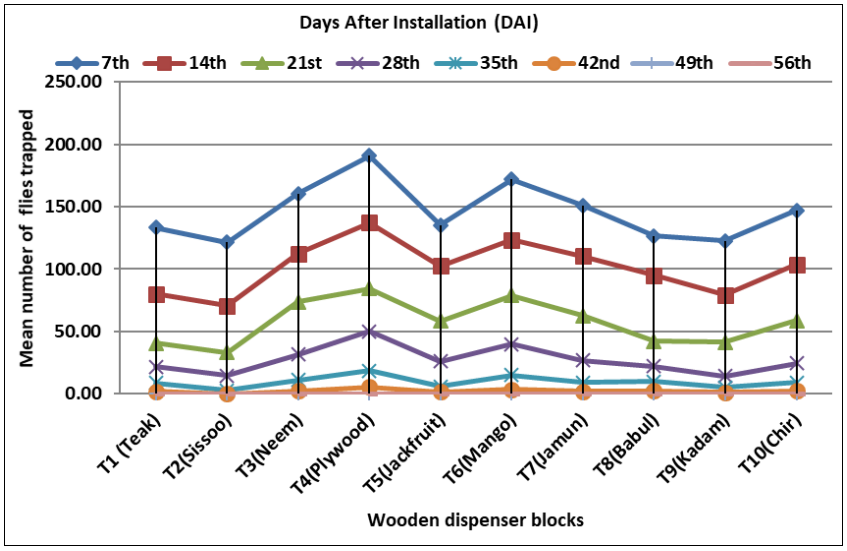
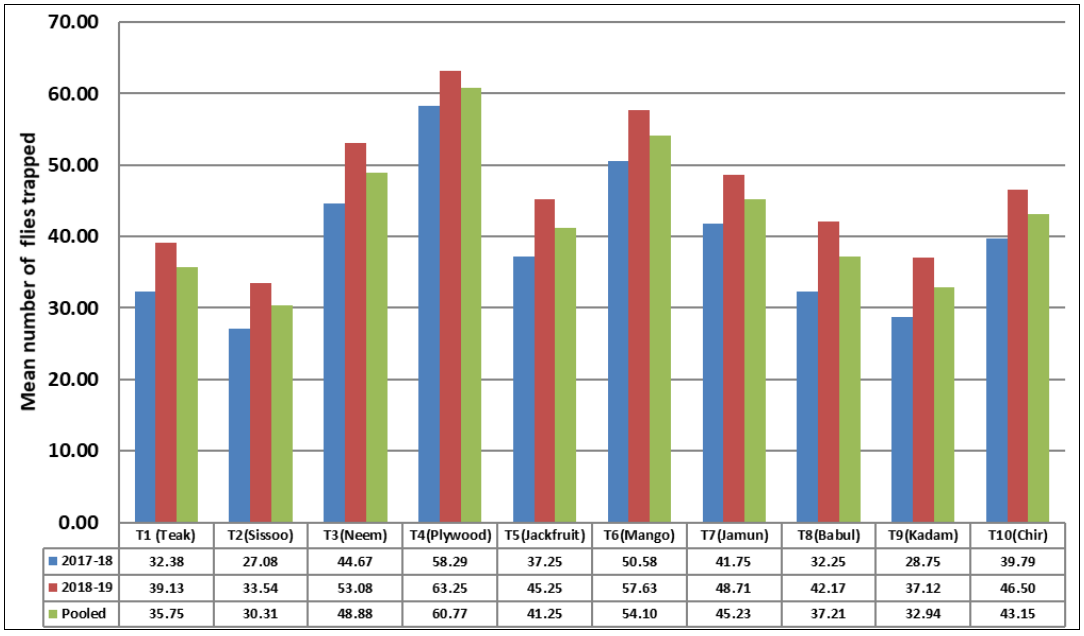


Fig 3: Mean number of flies trapped/trap/week in different wooden dispenser blocks of Methyl Eugenol formulations at Instructional Farm of mango orchard, UBKV (pooled over 2017-18 and 2018-19)



	T1 (Teak)	T2(Sissoo)	T3(Neem)	T4(Plywood)	T5(Jackfruit)	T6(Mango)	T7(Jamun)	T8(Babul)	T9(Kadam)	T10(Chir)
2017-18	32.38	27.08	44.67	58.29	37.25	50.58	41.75	32.25	28.75	39.79
2018-19	39.13	33.54	53.08	63.25	45.25	57.63	48.71	42.17	37.12	46.50
Pooled	35.75	30.31	48.88	60.77	41.25	54.10	45.23	37.21	32.94	43.15

Fig 4: Means of all weeks of flies trapped in different wooden dispenser blocks of Methyl Eugenol formulations from DAI at Instructional Farm of mango orchard, UBKV

Table 4: Methyl Eugenol formulations imbibed in different wooden dispenser blocks

Wooden Dispenser Blocks	Weight of wooden Dispenser Blocks before treated with Methyl Eugenol formulations (g)	Weight of wooden Dispenser Blocks after treated (48 hrs.) with Methyl Eugenol formulations (g)	Weight Gain (g)	Per cent gain in weight
Teak	5.9621	7.9058	1.9437	32.60
Sissoo	5.6185	6.7876	1.1691	20.81
Neem	5.6870	8.3794	2.6924	47.34
Playwood	4.9057	7.8019	2.8962	59.04
Jackfruit	5.5544	7.3694	1.8150	32.68
Mango	5.6874	8.4603	2.7729	48.76
Jamun	5.3436	7.6255	2.2819	42.70
Babul	6.6231	8.6260	2.0029	30.24
Kadam	6.6845	8.5481	1.8636	27.88
Chir	5.0116	7.1276	2.1160	42.22

Species diversity of fruit flies trapped in different wooden dispenser blocks of Methyl Eugenol formulations

Species diversity of Tephritids has been determined after collecting fruit flies trapped in different wooden dispenser blocks of Methyl Eugenol formulations from Instructional farm of UBKV, Pundibari, Coochbehar. The agro-ecological region has very good floral as well as faunal diversity. Several hosts of fruit flies are available here. Collected specimens of fruit flies were identified by using the keys of tephritids R.A.I Drew (1989) [3] and V.C. Kapoor (1970) [4].

Four fruit fly species were recovered *viz*. *Bactrocera dorsalis* (Hendel), *Bactrocera zonata* (Saunders), *Bactrocera versicolor* (Bezzi) and *Bactrocera correcta* (Bezii) (Table-5 and Fig-5). In Instructional farm of UBKV, Pundibari, Coochbehar highest catch was noted in case of *B. dorsalis* (72.52%) followed by *B. zonata* (14.23%) and *B. versicolor* (10.43%). Minimum catch was observed in *B. correcta* (2.82%). Hence it appeared that a good number of tephritid flies have been found to exist in Instructional farm of UBKV, Pundibari, Coochbehar. *B. dorsalis* were dominated among all species trapped whereas very scanty presence was noted in case of *B. correcta* in different wooden blocks as dispenser blocks of Methyl Eugenol formulations. The observations are in corroboration with Afzal *et al*. (2001) [10], Chiu and Chu (1988) [11], Seewooruthun *et al*. (2000) [12], Kawashita *et al*., (2004) [13] and Qureshi *et al*. (1976) [14].

Table 5: Species diversity of fruit flies trapped in different wooden dispenser blocks of Methyl Eugenol formulations

Location	Trap	Total Number of fruit flies trapped	Species	Total nos. of individuals per species	Relative Abundance (%)
Instructional farm of UBKV, Pundibari, Coochbehar (W. Bengal)	Wooden dispenser blocks of Methyl Eugenol formulations	21644	*B. dorsalis*	15696.23	72.52
			B. zonata	3079.94	14.23
			B. versicolor	2257.47	10.43
			B. correcta	610.36	2.82

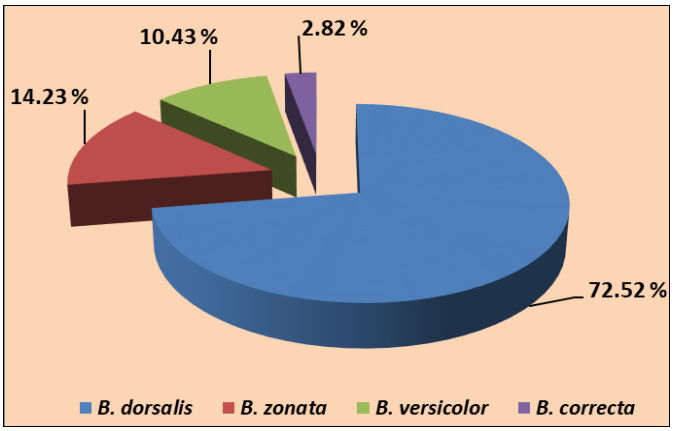


Fig 5: Species composition of fruit flies attracted in different wooden dispenser blocks of Methyl Eugenol formulations (pooled over 2017-18 and 2018-19)

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