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Full Length Research Paper

Evaluation of pheromone dispenser units in methyl eugenol trap against *Bactrocera invadens* Drew, Tsuruta and White (Diptera: Tephritidae) in Sudan

Omar A. A. Sidahmed[1*], Awad K. Taha[2], Gasim A. Hassan[1] and Ishtiag F. Abdalla[3]

[1]Department of Crop Protection, Faculty of Agriculture, Omdurman Islamic University.
[2]Department of Plant Protection, College of Agricultural Studies (Shambat), Sudan University of Science and Technology.
[3]Agricultural Economics and Policy Research Center, Agricultural Research Corporation.

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A field experiment was carried out in Khartoum and Gezira States during the period 2010 – 2012, to evaluate the effectiveness and longevity of plywood, white wood block and sponge wick in comparison with the recommended method (cotton wick). Oblong plywood blocks applied with the mixture of methyl eugenol (ME) and malathion (MA) showed more effectiveness and longevity than the white wood blocks, sponge and cotton wicks. They remained effective in the field for more than four months (135 days). In addition to its effectiveness and longevity, use of the oblong plywood blocks with (ME+MA) was easy and cheap, in comparison to the recommended method (cotton wicks). In conclusion, the application of plywood blocks with (ME+MA) is suitable to be applied in male annihilation technique (MAT) against *B. invadens* in Sudan. Also, the application of plywood blocks decreases the cost of ME+MA up to half in comparison with recommended method. Moreover, this application could be used for controlling *B. invadens* in and/or out of fruiting season.

Key words: *Bactrocera invadens*, MAT, ME, dispenser units, Sudan.

INTRODUCTION

The invasive fruit fly *Bactrocera invadens* Drew, Tsuruta and White, was recorded in Sudan during May 2004 (Drew et al., 2005). In 2007, the damage due to fruit flies became so severe to the extent that they were added to the list of the notorious national pests of the Sudan (Ali et al., 2008). Rwomushana et al. (2008); Goergen et al. (2011), mentioned that *B*. *invadens* attacks over 43 plant species related to 28 families in more than 28 African countries. In Sudan, the main host plants found was guava (*Psidium guajava*) fruits, mango (*Mangifera indica*) and banana (*Musa* sp.) fruits, with an infestation level ranged between 73 – 100% (Elaraky et al., 2012). In control trails in Sudan, homemade traps with methyl eugenol lure were used to attract the adult males of *B*. *invadens* (Mohamed and Ali, 2008). Gubara et al. (2009) adopted that, the methyl eugenol with 3 ml mixture of 80 % methyl eugenol and 20 % of malathion 57% by volume in a cotton wick (4 cm long × 1 cm diameter) to be applied for controlling adult males of *B. invadens*.

Methyl Eugenol (ME) occurs naturally in more than 450 plant species from 80 families that grow mainly in the tropics and is a fundamental nutrient of some *Bactrocera* spp. (Aluja and Norrbom, 1999; Vayssieres et al., 2007; Tan and Nishida, 2012). The first use of specific bait attractant for males of fruit flies was (ME) for *B. zonata* in 1912 (IAEA, 2003). Vayssieres et al. (2007) mentioned that, the male annihilation technique (MAT) has been used successfully in eradicating several *Bactrocera* spp. such as the oriental fruit fly, *Bactrocera dorsalis* from Rota and Japan and the papaya fruit fly, *Bactrocera papaya*, from Australia. The MAT baits stations that were used in French Guiana (Vayssieres et al., 2007), were

*Corresponding author. E-mail: a.omerahmed@yahoo.com or aomerahmed5@gmail.com.

made of absorbent fiberboard blocks. These blocks were soaked in a mixture of ME and ultra-low volume malathion (96%) (3:1 vol/vol), and then hung by a wire in host trees throughout the area in which the population had been detected. The males, attracted by the ME, consume a small portion of the mixture (although contact is sufficient) and are killed by the malathion (MA). Also Stonehouse et al. (2002b), applied MAT for the control fruit flies in Pakistan. They used wooden blocks soaked in lure and insecticide compared to a lure-baited plastic traps. Their results showed that, blocks killed four times more flies than traps, and was cheaper, less vulnerable to theft and weather, and require no recharging and replacement. In their conclusion, Vayssieres et al. (2007), mentioned that, in MAT program for fruit fly control, high levels or male mortality (up to 100%) are needed for an effective reduction in fruit fly infestation and a high distribution of the bait station through the area.

This study was made to evaluate the effectiveness and longevity of some materials; plywood, white wood and sponge in comparison to the recommended method (cotton wick) soaked in methyl eugenol and malathion to attract and kill the adult males of *B. invadens*.

METHODOLOGY

A field experiment to evaluate varying designs application of ME traps to attract *B. invadens* was conducted during the major guava season in two villages Al-Kadaro (15˚ 45´ N, 32˚ 33´ E) and Kordogeili (14˚ 35´ N, 33˚ 55´ E) at the States of Khartoum and Gezira, respectively. The experiment was repeated three times in Alkadro area, in December 2010, April 2011and November 2012 and in Kordogili village during February 2011. In these orchards, no pesticide treatments were given during the period study.

The mixture of 80% Methyl Eugenol (ME) and 20% malathion 57 (MA) was provided by the Plant Protection Directorate (PPD), Khartoum North, Sudan. Homemade traps designed with different pheromone dispensing units were used to test the efficiency and field persistence. The dispensing units were as follows:

i.) Plywood block (1cm width × 5cm length × 1cm diameter), soaked in 20 ml of ME + MA for 72 h, allowed to dry for 48 h (repeated 3 times) then calculated the rest of mixture.
ii.) White Wood, measuring (1cm width × 5cm length × 1 cm diameter), soaked in 20 ml of ME + MA for 72 h, allowed to dry for 48 h (repeated 3 times) then calculated the rest of mixture.
iii.) Sponge wick, measuring (1cm width × 4cm length × 1cm diameter), supplied with 3 ml of ME + MA.
iv.) Cotton wick, measuring (1cm width × 4cm length × 1cm diameter), supplied with 3 ml of (ME+MA), recommended method for comparison.

Each treated material was repeated three times and hung in the center of a transparent homemade trap by using a wire, with four holes in the upper third of the trap. Ready traps were transferred to orchards and hung on trees. The traps were hung approximately 2 m above the ground in shaded areas, and separated from each other by more than 50 m. Traps were distributed in orchards according to randomized complete block design (RCBD).

Adult males of *B. invadens* captured per trap (a replicate) were collected every two weeks in labeled nylon bags with capacity of ½ kg, and brought to the laboratory for counting and identification. Data were transformed with square root of ($\sqrt{\times}$ + 0.5). One way ANOVA was computed and means separated by using Duncan Multiple Range Test (DMRT).

RESULTS

Results in Table 1 shows that, tested materials of plywood, white wood, sponge and cotton soaked in (ME+MA) attracted large numbers of adult males during all the seasons. Highly significant differences between these materials were recorded at all sites of Al-Kadaro (1^{st}, $2^{nd}$and 3^{rd}seasons) and Kordogeili (4^{th}season). Plywood with (ME+MA) captured large number of adult males during the last two seasons.

Table 2 shows that, after impregnated period the plywood and white wood blocks absorbed about 7 ml of (ME+MA) at one time remained effective for more than four months (135 days). In comparison, the cotton wick and sponge, each, needed 3 ml or more of ME+MA every month to stay effective (i.e., more than 13.5 ml ME+MA per 4.5 months). The cost of each trap was calculated and the difference between alternatives was examined. The treatments of the plywood and white wood, showed high difference in the cost, reached up to -50%, from the cotton and sponge wicks.

Discussion

Application of plywood as dispenser of ME in the field indicated that the longevity and efficiency for capturing the males of *B. invadens* are more better than the white wood, sponge and cotton. Also, these applications kept the population low during the last 10 weeks (less than 100 males/trap/2weeks) in comparison with the first week. These results are in agreement with those of Vayssieres *et al*. (2007) who demonstrated that the use of fiberboard blocks impregnated with ME+MA can be used in an area-wide program without risk to non-target insect populations. They also, mentioned that, the absorbed fiber board blocks with ME+MA were used successfully in eradicating several *Bactrocera* species in many countries. The results of the present study also showed that, the application of plywood impregnated in 7

Table 1. Efffect of various dispensers on the efficiency in trapping *B. invadens*.

Treatment (dispenser unit)	Mean of adult males captured / trap / site / season			
	1st Al-Kadaro (2010)	2nd Al-Kadaro (2011)	3rd Al-Kadaro (2012)	4thKordogeili (2011)
Plywood	455.5 (18.74) a	47.7 (6.33) a	104.5 (9.07) a	79.0 (6.57) a
White wood	652.5 (20.76) a	36.4 (5.42) ab	22.73 (4.34) c	48.3 (4.91) ab
Sponge	430.1 (15.95) b	11.1 (2.85) c	39.24 (5.16) bc	44.7 (4.56) ab
Cotton	275.6 (13.72) b	29.9 (4.49) b	34.18 (5.70) b	16.9 (3.13) b
S.E.±	0.9	0.5	0.4	1.1

Means followed by the same letter(s) are not significantly different at P 5%
Means between brackets are transformed by (√ × + 0.5).

Table 2. Economics of different dispenser units / trap based on amount, number and cost factor involved.

Dispenser unit	Amount of ME (ml / trap)	Cost incurred by ME /trap/month*	Cost incurred by ME/ trap / 4.5 months*	% Difference in the cost from standard
Plywood**	7	7.6	7.6	- 48.1
White wood***	7	7.6	7.6	- 48.1
Sponge	3	3.3	14.7	0
Cotton(standard)	3	3.3	14.7	-

*****The cost was calculated according to the value of ME and MA during March 2012 per SDG.
** Cost of one piece plywood estimated as about 0.046 SDG including labor (2013).
*** Cost of one piece whitewood estimated as about 0.054 SDG including labor (2013).

ml of ME at one time, remained effective for more than four months. In comparison, the cotton wick and sponge, each, needed 3 ml or more of ME every month to stay effective (i.e., more than 12ml ME/4months). These finding indicated that the cotton wick (recommended method by PPD) is more expensive than the plywood block. In similar study, Stonehouse et al. (2002a) mentioned that, the use of plastic traps containing cotton wicks soaked in lure, which can be expensive, needed regular reloading and emptying, and are vulnerable to sunlight, wind and theft; these shortcomings can be remedied if traps are replaced by wooden blocks soaked in lure and insecticide which can be nailed or hung in trees - male flies are attracted to the blocks, feed from their surfaces and are killed. In Mauritius, a block programme has successfully maintained low levels of flies over large areas. According to Stonehouse et al. (2002b), MAT by wooden blocks soaked in lure and insecticide was compared with the plastic lure-baited traps currently used in Pakistan; blocks killed four times more flies than traps, are cheaper and less vulnerable to theft and weather, and require no recharging and replacement. Plywood blocks killed more flies than those of mulberry and poplar wood, though not than acacia. Square and oblong blocks were more effective than round and hexagonal ones.

Conclusion

Mixture of ME+MA impregnated plywood blocks are suitable to be applied for male annihilation technique (MAT) programs against adult males of *B. invadens* in Sudan. Due to cheapness of plywood blocks the cost of application decreased up to half when compared to the recommended method. The reduced cost included (quantity of ME+MA used and number of application times). Moreover, the above suggested method could protect the fruit produce against *B. invadens* in/out of fruiting season.

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