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Full Length Research Paper

Efficiency of Methyl eugenol as attractant for *Acanthiophilus helianthi* Rossi, 1794 (Diptera: Tephritidae)

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Fruit fly is one of the major pests that attack agronomical commodities, as well as the insect becomes a major pest in safflower plantation all over the world. The objective of this research was to study the response of fruit fly on methyl eugenol (ME) used as attractant. The safflower fly is one of the most important pests of safflower in Iran. Losses caused by larval feeding leads to disrupted plant activities, reduction in flower buds, and ultimately to decreased quality and quantity of crop. Infestation of bolls began 15 days after the formation of flower heads. Laboratory studies show that among the three species of fruit flies tested for attractiveness to methyl eugenol, male of *Acanthiophilus helianthi* Rossi (Diptera: Tephritidae) and *Chaetrollia carthami* (Diptera: Tephritidae) showed no significant difference but both are significantly different (P < 0.05) with *Trellia luteolla* (Diptera: Tephritidae). Virgin adult male's *A. helianthi* more than 18 days old were greatly attracted to methyl eugenol.

Keywords: Efficacy, bait trap, control, safflower fly.

INTRODUCTION

Fruit flies (Diptera, Tephritidae) cause large losses to fruits throughout the world, and are recognized today as major insect pests of the horticultural industries (Permalloo, 1989).Their significance is further increased by a growing international trade (Drew and Allwood, 1997). Fruit fly problems in Iran date back to the beginning of this century (Sabzalian et al., 2010). Fruit flies have been the subject of experimentation and control for many years (Hammes, 1980; Anon, 1983; Anon, 1996; Landell Mills, 1991). Despite an intensive programme of biological control (Hammes, 1980), a long term method of control: the Sterile Insect Release Method (Hammes 1980) and the use of insecticides on backyard gardens (Anon, 1985), the high fly populations and the abundance of fruits throughout the year combined to maintain the status of the fruit flies as the major pests of cultivated fruits. Males of many fruit flies are strongly attracted to methyl eugenol, a compound found naturally in a variety of plant species (Metcalf and Metcalf, 1992). Methyl eugenol plays a major role in male mating behavior by serving as a pheromonal precursor. Working with *Bactrocera opiliae* (Drew and Hardy) and *B. dorsalis* (Hendel), respectively, Fitt (1981) and Nishida et al. (1988) reported that males fed on methyl eugenol produced volatiles which contained metabolites of this compound, whereas unfed males lacked these metabolites. Additionally, Shelly and Dewire (1994) showed that wild males of *B. dorsalis* which ingested methyl eugenol exhibited increased signal effort, signal attractiveness, and mating success compared with males not given access to the lure. Additional tests similarly revealed that irradiated males exposed to methyl eugenol gained a mating advantage over unexposed wild males for up to three weeks after feeding on the lure (Shelly, 1995). Moreover, irradiated males exposed to methyl eugenol were less likely to be captured in lure-baited traps than were unexposed irradiated males (Shelly, 1995). These results suggest that the methyl eugenol-male association could potentially be incorporated in the sterile insect technique (SIT). Specifically, the abundance of wild males could be reduced initially via male annihilation, and then lure-fed irradiated males could be released concurrent with continued male annihilation. If successful, this approach would effectively replace wild

males with irradiated males and thereby generate a high proportion of irradiated male by wild female mattings. Effort to overcome the problem is referred better aimed at integrated pest management. Alternative that have prospect for developed is usage attractant (Epsky and Heath, 1998; Manrakhan and Price, 1999; Bueno and Jones, 2002; Gopaul and Price, 2002; Rouse et al., 2005). Attractant is one of tool to monitor pest population and at the same time applicable to depress population *Bactrocera*spp. (Bueno and Jones, 2002; Michaud, 2003). Enticing Substance that contain single component (males lure) called pharapheromone that only effective to captivate male fruit fly. Methyl eugenol compound have characteristic in common with pharapheromone that can attract male insect (Iwahashi et al., 1996; Manrakhan and Price, 1999). According to Nurdijati and Tan (1996); Kardinan et al. (1999); Miele et al. (2001) and Kothari et al. (2005) basil plant have prospect as methyl eugenol source. The objective of this research was to study the response of fruit fly on methyl eugenol (ME) used as attractant. Safflower (*Carthamus tinctorius* L.) is an important oilseed crop and an essential component of cropping systems in the dry regions and marginal areas of the world (Sabzalian et al., 2008). Like other crops, safflower suffers from various diseases and insects (Weiss 2000). The most serious safflower pest in Asia and Europe is the safflower fly *Acanthiophilus helianthi* Rossi (Tephritidae), and sometimes known as the shoot fly or capsule fly (Talpur et al., 1995; Zandigiacomo and Iob, 1991). In Asia, the safflower fly devastates most production areas in Iraq (Al-Ali et al., 1977), Pakistan (Talpur et al., 1995), and India (Vaishampayan and Kapoor, 1970; Verma et al., 1974). In Iran, seed-yield loss due to the safflower fly is estimated to be 30-70% for different safflower cultivars (Sabzalian et al., 2010). The safflower fly is a polyphagous insect belonging to the Tephritidae family (Ashri, 1971). Adult flies lay eggs on the inner side of involucral bracts of safflower green heads (Narayanan, 1961; Ashri and Knowles, 1960). Heavy infestations of safflower fly occur during the reproductive phase of the plant, and the fly prefers to lay its eggs inside developing heads throughout the flowering stage (Talpur et al., 1995). Larvae hatch from eggs, penetrate the head bracts, and feed on receptacle tissue or the whole seed (Faure et al., 2004; Jkhmola and Yadav, 1980; Narayanan, 1961; Ricci and Ciriciofolo, 1983). Larval feeding on seeds causes significant losses in seed weight, yield, and seed marketability (Ashri, 1971). The increasing impact of *A. helianthi* has elicited concern among entomologists who are looking for pest management options. The biology and behavior of *A. helianthi* has been described by some entomologists in various parts of Iraq (Al-Ali et al., 1977), Pakistan (Rahoo et al., 1997), India (Verma et al., 1974), and Egypt (Hegazi and Moursi, 1983). However, little information is available on the biology of this pest in the dry zone of Iran (Bagheri, 2007), and no information is available for Gachsaran, Iran. The purpose of this study was to examine efficiency of methyl eugenol as attractant for *A. helianthi*.

MATERIALS AND METHODS

Field and laboratory studies were conducted to assess the efficacy of methyl eugenol on fruit flies. A trial was conducted in a safflower field (1.5 ha) at Agricultural Research Station in Gachsaran (12° 39´ N latitude and 76° 41´ longitudes) in southern Iran during November 2008 to July 2009. The experimental site was 1500 m2 situated almost in the center of the field. Laboratory trials were conducted in doors at ambient temperature (27° ± 2°C).

Trial I: Field trapping of *Acanthiophilus helianthi*

This study was initiated on 16th May 2008 for a period of four months. Plastic traps (10 cm × 10 cm) with circular openings measuring 2.4 cm in diameter at both ends were used for trapping the fruit-flies. This round hole trap design was adopted for they were effective in trapping fruit-flies (Ibrahim et al., 1979). A total of nine traps were placed at strategic positions in the field. Each trap was baited with a mixture of 0.5 ml methyl eugenol, 0.5 ml of Malathion EC 56 and 2 ml of Sucrose solution soaked in cotton rolls. The Traps were hung to the branches of plants at a height of 80 cm from the ground. At the chosen height, there was no effect on capture of fruit flies (Hooper and Drew, 1979). Collection of the fruit flies and recharging of the poisoned baits were made every 4th day between 6 - 7 pm. The flies were sexed and identified.

Trial II: Laboratory studies

Three different species of fruit-flies viz: *A. helianthi*, *C. carthami* and *T. luteolla* were reared from infested flower heads of safflower. The third instars larvae were allowed to pupate in nylon-meshed cages (82 cm X 66 cm X 66 cm) filled with infestation flower heads. The newly emerged adults were provided with water, sugar solution (10%) and protein hydrolysate. Thirty male fruit-flies of the same species which had been kept in captivity with females for ten days were tested for their response to methyl eugenol. A total of 90 male flies belonging to three different species were released in a Perspex cage (1 × 1 × 1 m). A small trap (8 cm X 12 cm) of similar shape to the field trap was used in each cage. The trap was baited with three drops of methyl eugenol, one drop of Malathion and 1 ml of sucrose solution. Recordings were made at hourly intervals for four consecutive hours on all the tested species of the fruit flies. In a further trial to eva-

Table 1. Fruit flies, three species attracted to methyl eugenol in safflower fields from 15.4.2008 to 15.8.2008.

Species sex	Total N	Average	catch/ trap/ month
Acanthiophilus helianthi	Male	35959	500.47
	Female	76	
Chaetrollia carthami	Male	26	0.38
	Female	2	
Trellia luteolla	Male	5	0.13
	Female	5	

Table 2. Laboratory study showing cumulative number of fruit flies attracted to methyl eugenol

Fruit flies species	Total no of flies caught within				%
	1hr.	2hr.	3hr.	4hr.	
Acanthiophilus helianthi	29	38	46	52	43.3a
Chaetrolia carthami	38	45	49	57	47.5ab
Trelli aluteola	1	3	4	5	4.2c

Means followed by the same letters are not significantly different at 5 % level as determined by Duncan's Multiple Range Test

luate the stage of adult *A. helianthi* attracted to methyl eugenol, the fruit-flies were reared using artificial diet (Tanaka et al., 1996). Twenty virgin male flies of varying ages of 4, 8, 12, 16 and 20 days were placed in separate cages containing methyl eugenol solution, malathion and sucrose solution. The number of flies caught in the traps was recorded at hourly intervals for four hours. Both laboratory trials were replicated four times using the Completely Randomized Design. The results were analyzed and the means were separated by the Duncan Multiple Range Tests.

RESULTS AND DISCUSSION

During the period of four months (May 2008 to August 2008) the total number of fruit flies caught was 36035. The dominant fruit flies were the males of A. helianthi (Table 1). The number of female flies caught was extremely low. This finding was similar to that of Steiner et al., (1965) that showed that methyl eugenol rarely attract females. Besides *A. helianthi*, the other two species caught were C. carthami and T. luteolla, though the last two species were significantly ($P < 0.05$) few in number.

Analysis showed that there was no significant difference in response to methyl eugenol in the laboratory between ten-day-old males of *A. helianthi* and *C. carthami* but, when compared to *T. luteolla*, their attraction to methyl eugenol was found to be significantly different (Table 2). The percentage of *A. helianthi*, *C. carthami* and *T. luteolla* caught were 43.3%, 47.5% and 4.2% respectively. The higher catch of *A. helianthi* in the field could be due to their abundance in the open, as in for the laboratory, the study showed *A. helianthi* and *C. carthami* were equally attracted to methyl eugenol. Less than 50% of the total number of flies from each species was attracted to methyl eugenol even after four hours. Dissection of the male flies showed them to have well developed testes which suggest that a considerable number of flies are indifferent to methyl eugenol. This suggestion conforms to that of Umeya et al. (1973).

The fruit-flies showed marked seasonal fluctuations with the peak periods in July and early August following boll-set). Bateman (1973) reported an increase of fruit fly population at the onset of flower heads ripening. After all the bolls had been bagged, there was a decline in the population. This could possibly be due to absence of flower heads for oviposition which subsequently resulted in a reduced fly population in the field. Observation of flower heads in the field showed that the fly oviposited as early as 15 days after flower heads set. The flies prefer to oviposit on ripe flower heads but in their absence they oviposit on green flower heads .

The placing of the traps also influences the amount of fruit-flies caught. Traps placed at the periphery of the field had higher counts than those placed in the center. This suggests that peripheral traps had better access to wind movement and methyl eugenol is capable of attracting flies at a distance of 0.6 km. (Steiner, 1952).

The attraction of *A. helianthi* to methyl eugenol is relative to the age of the flies (Table 3). The attraction was greatest when the flies were 20 days old. Since methyl eugenol is a sex attractant, it will attract flies of a

Table 3. Laboratory study showing cumulative number of virgin Acanthiophilus helianthi to methyl eugenol

Age (days)	n	Total No. of flies caught within				
		1hr.	2hr.	3hr.	4hr.	
4	80	4	5	5	5	% 6a
8	80	4	8	0	0	% 10ab
12	80	14	21	25	25	% 31c
16	80	38	44	47	47	% 58d
20	80	67	71	72	72	% 9c

Means followed by the same letters are not significantly different at 5 % level as determined by Duncan's Multiple Range Test

specific physiological age. Umeya et al. (1973) observed that male fruit flies were not attracted to methyl eugenol until the ninth day, suggesting that sexual maturity may play a prominent role. The knowledge of physiological ages of flies which are responsive to the attractant is important in a control programme where sex attractants are used.

CONCLUSION

Acanthiophilus helianthi is the main pest of safflower. The laboratory studies showed varying responses of fruit-flies to methyl eugenol. Male of *A. helianthi* and *C. carthami* were equally attracted to the sex attractant but T. luteolla was less attracted to the chemical. Evidently, with virgin males of *A. helianthi* the response to the attractant increased with the age of the flies.

REFERENCES

Al-Ali AS, Al-Neamy K, Abbas SA, Abdul-Masih AM (1977). On the life history of the safflower fly, *Acanthiophilus helianthi* Rossi (Diptera: Tephritidae) in Iraq. Zeitchrift fur Angewandte Entomologie 83(2): 216-223.

Anon (1983).The Natal fruit fly project. Annual Report, Entomology Division, Ministry of Agriculture, Fisheries and Natural Resources, Reduit, Mauritius. (Unpublished).

Anon (1985). Control of fruit flies. Annual Report of the Ministry of Agriculture, Fisheries and Natural Resources for the year 1982, Reduit, Mauritius, p. 51.

Anon (1996). National fruit fly control programme: Experimentation. Annual Report, Entomology Division, Ministry of Agriculture, Fisheries and Natural Resources, Reduit, Mauritius. (Unpublished).

Ashri A (1971). Evaluation of the world collection of safflower, *Carthamus tinctorius* L. II, Resistance to the safflower fly, *Acanthiophilus helianthi* R. Euphytica 20: 410-415.

Ashri A, Knowles PF (1960). Cytogenetic of safflower (*Carthamus tinctorius* L.) Species and their hybrids. Agronomy. Journal 52: 11-17.

Bagheri MR (2007) .Study on the biology of safflower shoots fly and its damages in spring culture in Esfahan (Iran).Final Report. Esfahan Agricultural and Natural Resources Research Center, 25 pages .

Bateman MA (1973). "Fruit Flies" in Studies of biological control. Delucchi. V.L. (Ed.). p 11-49. London. Cambridge University Press.

Bueno AM, Jones O (2002). Alternative Methods for Controlling the Olive Fly, *Bactrocera oleae*, Involving Semiochemical. 2002. IOBC wprs Bulletin. Vol. 25: 1-11 (2002).

Drew D, Allwood A (1997). Fruit fly control: Arrest of a new pest. Partners (10).

Epsky ND, Heath RR (1998). Exploting the Interactions of Chemical and Visual Cues in Behavioral Control Measures for Pest Tephritid Fruit Flies. Florida Entomologist. 81(3): 273-282 (1998).

Faure AB, Guery JP, Guinefoleau A, Wiesenberger A, Naibo B, Decoin M (2004).Corn crops-2003 Plant health review, drought and insects. Phytoma. 567: 39-41.

Fitt G (1981). The influence of age, nutrition, and time of day on the responsiveness of male Dacusopiliae to the synthetic lure methyl eugenol. Entomol. Exp. Appl. 30: 83-90.

Gopaul S, Price NS (2002). Local Production of Protein Bait for Use in Fruit Fly Monitoring and Control. Indian Ocean Regional Fruit Fly Programme.

Hammes C (1980). Projet de luttecontre la mouche du Natal Pterandrusrosa (Karsch), Diptera, Trypetidae à l'Ile Maurice. France: CIRAD

Hegazi EM, Moursi KS (1983). Studies on the distribution and biology of capsule fly, *Acanthiophilus helianthi* Rossi on wild plants in Egyptian western desert. Zeitchrift fur Angewandte Entomologie 94 (4):333-336.

Hooper, GHS Drew, RAI (1979). Effect of height of Trap on capture of Tephritid Fruit flies with cuelure and methyl eugenol in different environments.Environmental Entornol. 8(5): 786788.

Ibrahim AG, Singh G, King HSK (1979). Trapping of fruit-flies, *Dacus* spp. (Dipt: Tephritidae) with methyl eugenol in Orchards. Pertanika 2(1), 58-61.

Iwahashi O, Sastrodihardjo S, Subahar TS (1996). The Mysteri of Methyl Eugenol: 1. Why Methyl Eugenol is so Effective for Controlling Fruit Flies? Presented in XIX International Congress of Entomology, Firenze-Italy.

Jakhmola SS, Yadav HS (1980). Incidence of and losses caused by capsule fly, *Acanthiophilus helianthi* Rossi in different varieties of safflower. Indian Journal of Entomology. 42(1): 48-53.

Kardinan AM, Iskandar S, Rusli DM (1999). PotensiDaunSelasih (*Ocimum sanctum*) sebagaiAtraktanNabatiuntukPengendali Hama LalatBuah*Bactroceradorsalis*.Makalah Forum KomunikasiIlmiahPemanfaatanPestisidaNabati.BalaiPenelitianTanamanRempahdanObat. Bogor, 9-10 November 1999.

Kothari SK, Bhattacharya AK, Ramesh S, Garg, SN, Khanuja SPS (2005).Volatile Constituents in Oil from Different Plant Parts of Methyl Eugenol-Rich OcimumtenuiflorumL.f. (syn. O. sanctum L.)Grown in South India. J. Essential Oil Res. JEOR, Nov/Dec 2005.

Landell Mills (1991). Fruit fly control in Mauritius. Bath, UK: Landell Mills Ltd. For Government of Mauritius.

Manrakhan A, Price NS (1999). Seasonal Profiles in Production, Fruit Fly Populations and Fly Damage on Mangoes in Mauratius. AMAS, Food and Agriculture Research Council, Reduit, Mauratius. 107-115.

Metcalf RL, Metcalf ER (1992). Plant kairomones in insect ecology and control.Chapman and Hall. New York. 168 p.

Michaud JP (2003). Toxicity of Fruit Fly Baits to Beneficial Insects in Citrus. J. Insect Science. Available online: insectscience.org/3.8.

Miele M, Dondero R, Ciarallo G, Mazzei M (2001). Methyleugenol in

Ocimumbasilicum L. Cv. Genovese Gigante. J. Agric. Food Chem. 49(1): 517-521 (2001).
Narayanan ES (1961).Insect pests of safflower and methods of their control. In: Chavan, V.M. (Ed.), Niger and safflower. Indian Central Oilseeds Committee, Hyderabad, India, 123-127.
Nishida RKH, Tan M, Serit NH, Lajis AM, Sukari ST, Kukami H (1988). Accumulation of phenylpropanoids in the rectal glands of males of the oriental fruit fly, Dacusdorsalis.Experientia (Basel) 44: 107-112.
Nurdijati SKH, Tan YC (1996). Basil Plant (Ocimum spp.) and Their Prospect in the Management of Fruit Flies.Proceedings of the Second Symposium on Tropical Fruit Flies 1995, Kuala Lumpur Malaysia.
Permalloo S (1989). Biological and taxonomic studies on parasitoids associated with some Tephritidae (Diptera). PhD. Thesis. University of Wales, UK.
Rahoo GM, Lohar AG, Kazi AJM (1997). Studies on the biology and behavior of safflower fly, Acanthiophilus helianthi Rossi (Diptera: Tephritidae) on safflower. Pakistan Entomologist, 1(2): 64-69.
Ricci C, Ciriciofolo E (1983). Observations on Acanthiophilus helianthi Rossi (Diptera: Tephritidae) injurious to safflower in central Italy. Redia. 66: 577-592.
Rouse P, Duyck PF, Quilici S, Ryckewaert P (2005). Adjustment of Field Cage Methodology for Testing Food Attractants for Friut Flies (Diptera: Tephritidae). Ann. Entomol. Soc. Am. 98(3): 402-408 (2005).
Sabzalian MR, Saeidi G, Mirlohi A (2008). Oil on tent and fatty acid composition in seeds of three safflower species.Journal American Oil chemistry Society. 85: 717-721 .
Sabzalian MR, Saeidi G, Mirlohi A, Hatami B (2010). Wild safflower species (Carthamusoxyacanthus): A possible source of resistance to the safflower flies (Acanthiophilus helianthi).Crop Protection. 29(6): 550-555.
Shelly TE (1995). Methyl eugenol and the mating competitiveness of irradiated male Bactrocera dorsalis (Diptera: Tephritidae). Ann. Entomol. Soc. America 88: 883-886.
Shelly TE, Dweire A (1994). Chemically mediated mating success in male oriental fruit flies, Bactrocera dorsalis (Diptera: Tephritidae). Ann. Entomol. Soc. America 87: 375-382.
Steiner LF (1952). Methyl eugenol as an attractant for oriental fruit-fly. J. Econ. Entornol. 45(2):241-48.
Steiner LF, Mitchell, WC, Harris EJ, Kozuma TT, Fujimoto, MS (1965): Oriental fruit fly eradication by male annihilation. J. Econ. Entornol. 58(5): 961-4.
Talpur MA, Hussan T, Rustamani MA, Gaad MA (1995). Relative resistance of safflower varieties to safflower shoot fly, *Acanthiophilus helianthi* Rossi (Diptera: Tephritidae). Proc. Pakistan Conger. Zool. 15, 177-181.
Tanaka LF, Ohinata K, Okamato, R (1996 or 1969). Low cost larval rearing medium for mass production of Oriental fruit flies. J. Econ. Entomol. 62(4): 967-68.
Umeya K, Sekiguchi Y, Ushio SZ (1973): The reproductive ability of D. dorsalis Hendel and the response of adults to methyl eugenol. Japanese J. Appl. Entomol. and Zoology. 17(2): 63-70.
Vaishampayan SM, Kapoor KN (1970). Note on assessment of losses to safflower (Carthamus tinctorius) by capsule fly, *Acanthiophilus helianthi* Rossi. Indian Journal of Agricultural Science 40(1): 29-32.
Verma AN, Singh R, Mehratra N (1974). *Acanthiophilus helianthi* Rossi A serious pest of safflower in Haryana. Indian J. Entomol. 34(4): 364-365.
Weiss EA (2000). Oilseed crops, second ed., Blackwell Science Ltd, oxfords.
Zandigiacomo P, Iob M (1991). *Acanthiophilus helianthi*, Rossi (Diptera: Tephritidae) on safflower in Friuli. Bollettino di zoologiaAgraria e di Bachicoltura, 23(1): 31-38.