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STUDIES ON THE POSSIBILITY OF MANAGING FRUIT SUCKING MOTH, *Eudocima (Othreis) materna* (L.) (LEPIDOPTERA: NOCTUIDAE) USING FEEDING REPELLENTS

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ABSTRACT : Studies were carried out to evaluate eight botanicals for their feeding repellency against fruit sucking moth, *Eudocima* (*Othreis*) *materna* (L.). Results indicated that plant oils *viz.,* jatropa, citronella, poppy, thevetia, neem and pongamia along with neem seed kernel extract were effective in preventing *O. materna* from feeding on the treated guava and pomegranate fruits. Annona oil was found to be a weak repellent. Implications of the results in development of new repellents for controlling *O. materna* populations are discussed.

Keywords: *Eudocima materna*, guava, pomegranate, *Punica granatum*, *Psidium guajava*, repellents.

INTRODUCTION

The fruit piercing moths are serious pests on pomegranate in localized areas of Karnataka, India, where large scale commercial pomegranate cultivation is on the rise due to success in global market. The main fruit sucking moth species active on pomegranate is *Eudocima[Othreis] materna* (L.)., which occurs in the tropics all around the world including Indo-Australian-Pacific region but also in Africa. It attacks a wide variety of commercially important crops including pomegranate, citrus, guava, mango, papaya, litchi, carambola, grapes, eggplant and tomato etc (McDaniel, 1971; Sundarababu and David, 1973; Godfrey and Jah, 1975). Moths feed at night by piercing the skin of the ripe or ripening fruit with their strong proboscis and sucking the juice. Internal injury consists of a bruised dry area beneath the skin. Secondary rots develop at the puncture site (Atachi *et al*., 1989). Fermenting fruits are often visited and fed on by secondary-moth feeders taking advantage of the access hole drilled by the fruit piercing moth, *O. materna*. An individual moth would generally attack a number of fruits on a single night. Damaged fruits are completely unmarketable and should be removed while packing to avoid contamination of healthy fruits. With current world emphasis on quality fruit for local consumption and export, this fruit-piercing moth can cause heavy losses.

The fruit sucking moth is difficult to control, unlike most other moth and butterfly pests, as the immature stages survive only on twining vines of the family Menispermaceae in scrub and forest areas, often remote from orchards (Fay, 1996). Growers are left to combat the adult moths when they arrive to feed. Although the orchards close

to breeding areas are at greater risk of damage, moths have been known to transverse hundreds of kilometers. While moth migrations can be observed from breeding sites to orchards often very distant to one another. Chemical control has not been an option because insufficient contact of the moth with the fruit denies knockdown and in any event, an adequate withholding period is not achievable as ripe fruits are normally attacked. Effective inhibition of fruit piercing moth damage is only possible by bagging fruit or netting trees or orchards. Night watching, hand collection of moths, moth destruction using light traps and bonfires has limited impact. The pomegranate farmers even considered advancing/ delaying the cropping season as much as possible to avoid fruit piercing moth incidence but had limited success. While there is seldom a single method of effective control for *O. materna*, use of feeding repellents against this pest as alternative method was found to be feasible and therefore warranted to improve the effectiveness of present management programmes. Several essential oils have been identified as efficient repellents and have been suggested as part of integrated pest management to reduce the use of insecticides (Woods *et al*., 1970). The repellency qualities of neem oil and some synthetic pyrethroids have also been evaluated against *Othreis fullonia* (Clerck). While neem products showed some repellency to fruit piercing moths (Bosch, 1971), they did not appear to significantly reduce the damage caused by them, at least when applied to near-ripe fruit. Other products and application methods continue to be tested for their repellency against *O. fullonia.* However, such studies are limited in case of *O. materna*.

Therefore, the present study was conducted to assess the relative efficacy of selective feeding repellents in the form of plant oils and extracts against *O. materna*.

MATERIALS AND METHODS

The present study was carried out at the Division of Entomology and Nematology, Indian Institute of Horticultural Research (IIHR), Bangalore ($12^{o}58'$N; $77^{o}35'$E), India. As the study was focused on evaluating different botanicals for their efficacy in repelling the *O. materna* moths, the following tests were conducted to determine the repellency of selected repellents to the fruit sucking moths.

Mass culture: The culture of the *O. materna* was established from field-collected larvae in the Fruit Entomology Laboratory at Division of Entomology and Nematology, Indian Institute of Horticultural Research (IIHR), Bangalore, India. The larvae of *O. materna* were collected from the vines of *Tenospora cordifolia* L. in the fields of IIHR and brought to laboratory. The primary cultures of *O. materna* were maintained as described by Bhumannavar and Viraktamath (2001). From this culture, matured moths of 10-15 days old were selected for the experiments.

Repellency test: The repellency of the different treatments towards *O. materna* was studied under laboratory conditions at 28±1°C. To simulate field conditions, a walk-in indoor-screened enclosure (hereafter called net house) was used for carrying out the experiment. The arena for the *O. materna* moths was a 38" H x 49.5" W x 69" D walk-in net house fitted with iron frames and nylon mesh in all the four sides along with flip door to one side for entry as well as easy handling of moths. The roof portion was also made up of nylon mesh. Moths were transferred from the mass culture to net house just before starting the experiment.

All treatments were tested on two test fruits *viz.*, pomegranate and guava. Eight repellents were evaluated along with an untreated control. The natural plant-derived products tested for their repellency against *O. materna* included *viz.*, i) neem oil, from seeds of Indian neem, *Azadirachta indica* L. ii) pongamia oil, from seeds of karanja, *Pongamia glabra* L. iii) neem seed kernel extract from the seeds of *A. indica*, iv) citronella oil which has a lemony scent, and was extracted from leaf blades of Citronella,

Andropogon nardus L. v) Poppy oil, from seeds of prickly poppy, *Papaver argemone* L. vi) thevetia oil, extracted from seeds of exile tree, *Thevetia nevifolia* L. vii) annona oil extracted from seeds of custard apple, *Annona squamosa* L. and viii) jatropa oil commercially known as curcas oil extracted from the seeds of Barbados nut, *Jatropa curcas* L.. Neem Seed Kernel Extract (NSKE) was prepared by grinding neem seed kernels @ 40 g per liter of water, and leaving over night. The mixture was filtered through muslin cloth the next morning to obtain 4% NSKE. The stock solutions (1 per cent) of all remaining treatments were prepared using distilled water.

The stock solutions of all repellents were mixed with an adjuvant APSA-80 @ 0.3 ml/L to have uniform distribution of the test products on fruits. All treatments were applied by dipping the fruit in the respective treatment solutions, so that the entire surface of each fruit could get uniform coating. Simultaneously, an untreated control was also run. Each treatment was replicated thrice. The fruits were positioned 1 m apart in the net cage using thread and made hung from the roof of the net house. Fruit position was randomized with in the net house during experimentation. The treated fruits were exposed to 50 pairs of *O. materna* adult moths for over night. The next day morning, the fruits were removed from the cage and the number of feeding holes per fruit was counted. The data were transformed in to $\sqrt{x+1}$ values and subjected to a one-way analysis of variance (ANOVA). Least significant differences (LSD) were used for the comparison of means (Little and Hills, 1978). Further, the number of feeding holes per fruit for different repellents was converted to percent repellency respectively over control, was calculated as per Yuwadee *et al.,* (2005).

RESULTS AND DISCUSSION

Two sets of experiments were conducted for each test fruit i.e., guava and pomegranate. No effects of toxicity/phytotoxicity of any of botanical formulations against *O. materna*/test fruit were observed in this study. The data on the number of feeding holes on pomegranate and guava fruits treated with different plant products are shown in Table 1.

Pomegranate as test fruit: In the first experiment, all plant products tried were found ($p<0.05\%$, Table 1) to be significantly superior to untreated control in repelling fruit sucking moth *O. materna*. Of all treatments tried, fruits treated with jatropa oil were found significantly superior in repelling the moths and recorded zero feeding holes followed by thevetia oil (0.33 feeding hole/ fruit) and citronella oil (0.67feeding holes/ fruit). Nevertheless, the remaining treatments *viz.*, neem oil, pongamia oil, NSKE, poppy oil, annona oil were also found to be on par with the above treatments in repelling the *O. materna* moths.

In the second experiment, also all plant products tried were found significantly superior to untreated control in repelling *O. materna*. Similar to first experiment, the number of feeding holes was not significantly different among treatments. Perusal of overall means also exhibited similar trend (Table 1).

Guava as test fruit : Like in the previous tests, all the treatments provided significant repellency against *O. materna* over control. Comparatively, fruits treated with citronella oil recorded 21.33 feeding holes (though statistically not significant). Annona oil did not repel the moths effectively (111.33 feeding holes/fruit) (Table 1).

In the second experiment, all treatments showed similar trend as in first experiment and provided significant repellency compared to untreated control (Table 1). There were no significant differences among the treatments in terms of mean number of feeding holes per fruit.

Overall means calculated also revealed that all treatments (except annona) were significantly superior over untreated control in repelling fruit

Table 1. Relative efficacy of selected attractants against *E. materna* on pomegranate and guava

Attractant	Number of feeding holes/ fruit					
	Pomegranate			Guava		
	Experiment I*	Experiment II*	Mean	Experiment I*	Experiment II*	Mean
Neem oil	2.33[a] (1.82)	1.67[a] (1.63)	2.00[a] (1.73)	74.00[a] (8.66)	22.00[a] (4.80)	48.00[a] (6.73)
Pongamia oil	3.33[a] (2.08)	2.33[a] (1.82)	2.83[a] (1.95)	33.33[a] (5.86)	1.33[a] (1.53)	17.33[a] (3.69)
Neem seed kernel extract	1.33[a] (1.53)	3.33[a] (2.08)	2.33[a] (1.80)	29.00[a] (5.48)	4.67[a] (2.38)	16.84[a] (3.93)
Citronella oil	0.67[a] (1.29)	0.67[a] (1.29)	0.67[a] (1.29)	21.33[a] (4.73)	15.33[a] (4.04)	18.33[a] (4.38)
Poppy oil	1.67[a] (1.63)	3.33[a] (1.08)	2.50[a] (1.86)	43.33[a] (6.66)	50.67[a] (7.19)	47.00[a] (6.92)
Thevetia oil	0.33 (1.15)[a]	2.33[a] (1.82)	1.33[a] (1.49)	28.00[a] (5.39)	7.00[a] (2.83)	17.50[a] (4.11)
Annona oil	2.00[a] (1.73)	3.67[a] (2.16)	2.84[a] (1.95)	111.33[b] (10.60)	137.33[b] (11.76)	124.33[b] (11.18)
Jatropa oil	0.00[a] (1.00)	0.33[a] (1.15)	0.17[a] (1.08)	13.67[a] (3.83)	32.67[a] (5.80)	33.17[a] (5.85)
Control	25.67[b] (5.16)	6.33[b] (2.71)	16.00[b] (3.94)	78.33[c] (8.91)	392.67[c] (18.03)	235.50[c] (14.37)
	1.08	1.15	0.90	5.36	7.62	6.80
CD (p=0.05)	5.36	7.62	6.80	1.08	1.15	0.90

*Mean of three replications
Figures in the parenthesis are √x+1-transformed values

sucking moths. Annona oil treated fruits did not repel the moths satisfactorily from feeding (Table 1).

Repellency of different botanical products

Pomegranate as test fruit: In the first choice test, all treatments tried provided highest level of repellency against fruit sucking moths compared to untreated control. Of all treatments tried, jatropa oil exhibited 100 per cent repellency against *O. materna* and for the other treatments it ranged between 87-98 per cent.

As was the case in the previous test, in the second choice test also all treatments showed greater degree of repellency against *O. materna* compared to untreated control. Jatropa oil was found to be consistently effective in repelling the moths and recorded highest repellency (94.79%). The percent repellency in remaining treatments ranged between 42-89 per cent. A perusal of overall means of all treatments showed that

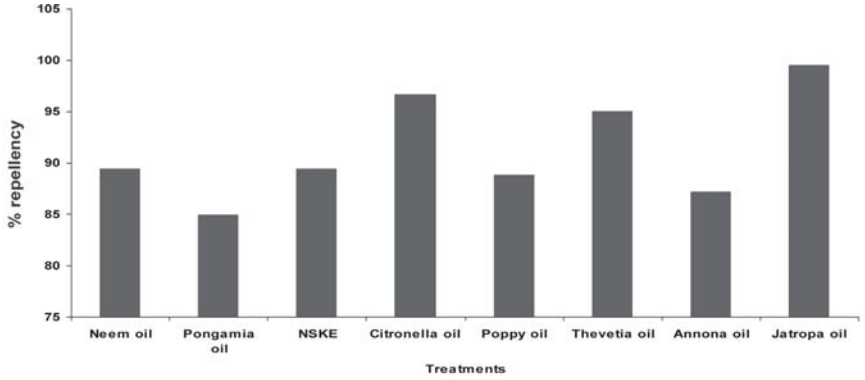

Fig 1. : Overall repellency of different treatments over untreated control using pomegranate as test fruit

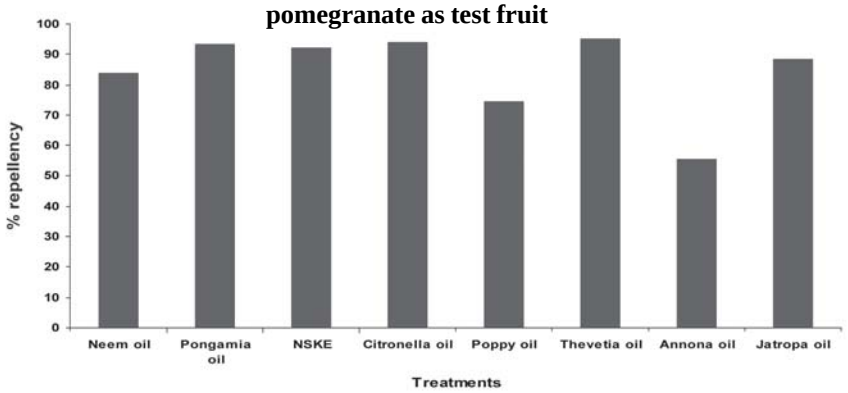

Fig. 2 : Overall repellency of different treatments over untreated control using guava as test fruit

percent repellency ranged between 84-99 per cent, with jatropa oil being superior one (Fig.1).

Guava as test fruit: Here (choice test 1) highest percent repellency against *O. materna* was recorded with citronella oil (72.77%), followed by thevetia oil (64.25%), NSKE (62.98%), pongamia oil (57.45%) and jatropa oil (57.02%). Annona and neem oils did not sufficiently repel the fruit-sucking moths.

In the second choice test, all treatments tried recorded >87% repellency except annona oil, which recorded 65.03 per cent. The mean percent repellency calculated also reflected the similar trend (Fig.2).

Thousands of plants have been tested as potential sources of insect repellents (Jacobson, 1990; King, 1954; Sukumar *et al.*, 1991). Repellents can be either taste repellents or odour repellents. Since odor is initial attractant for getting moths to the host sight, control methods using repellent sprays focus on odour repellents (Bosch, 1971). Although Bosch (1971) reported some success using citronella oil as a repellent, repellent sprays are generally considered ineffective (Baptist, 1944; BŠnziger, 1982). However, unlike synthetic insect repellents, plant-derived repellents have been relatively poorly studied. The oil of citronella is considered the principal mosquito repellent (Anonymous, 1950) and mixing dried leaves of neem (*Azadirachta indica* L.) with stored grains for protection against insects is an age-old practice, still prevalent in some parts of rural India,. There is however, some scanty and unsystematic information on the use of certain

indigenous plant products as insect repellents (Chopra *et al*., 1940; Pradhan *et al.*, 1963; Atwal and Pajni, 1964; Qadri, 1973) against meager number of storage insect pests. None of the natural (plant-derived) repellents tried in the present study were tested for their effectiveness in repelling *O. materna*. Nevertheless, a few showed repellent activity against insect pests other than fruit sucking moth. Plants whose essential oils have been reported to have repellent/ insecticidal activity include citronella, neem oil, jatropa oil, pongamia oil (King, 1954; Quarles, 1996). It was, therefore thought worthwhile to evaluate the relative efficacy of certain commonly available plants products against this obnoxious insect-pest.

In the present study, the natural repellents *viz.*, jatropa oil, neem oil, thevetia oil, citronella oil, annona oil, neem seed kernel extract, poppy oil were tried against fruit sucking moth. Of all treatments tried, citronella oil and thevetia oil provided stronger protection in terms of repellency irrespective of test fruits. Limited data are available from studies that directly compared the efficacy of citronella-based products with that of other plant-based products. Bosch (1971) reported the use of the citronella oil as repellent against fruit piercing and sucking moths (*Calpa emarginata* (F.), *O. materna* (L.), *O. fullonia* (Cl.), *Cyligramma latona* (Cram.), *Sphingomorpha chlorea* (Cram.)) in an apple orchard.

Sprays containing neem extract showed very light (but not significant) repellent action against *O. fullonia* moths in citrus immediately after application (www. austcitrus.org.au/home/files/ Finrpt%2OCT301.pdf). On contrary, in the present study, the neem products tried *viz.*, neem oil and neem seed kernel extract exhibited good repellency against *O. materna* with both test fruits. Earlier studies also reported that neem oil and extracts contain salannin that suppresses some insects' desire to feed and repels in areas that have been sprayed.

Annona oil did not satisfactorily suppress the injury by *O. materna* feeding in guava when compared to other treatments (111.33 and 137.33 feeding holes per fruit). Nevertheless, annona oil repelled moths effectively when pomegranate was used as test fruit.

The indigenous plant products *viz.*, jatropa oil, citronella oil, pongamia oil, neem oil and neem seed kernel extract which were found effective in repelling the moths from feeding as reflected by lower number of feeding holes, may play useful role in management of fruit sucking moth *O. materna*. With the exception of the some repellents (citronella oil, neem oil) evaluated by Bosch (1971), no other repellents have been so far identified for *O. materna*. The latter renders our findings here of practical significance, given that they are not only proved to be effective but also cheap and readily available. Our finding further opens up the possibility of offering readily available and safer inexpensive materials pomegranate and citrus growers. However, there is a need to make a comprehensive study on the consistency of these repellents under field conditions so as to put it into greater use for managing fruit sucking moth.

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REFERENCES

Anonymous, 1950. The wealth of India II. 418-19.

Atachi, P., Desmidts, M. and Durnex, C. 1989. Fruit-piercing moths (Lepidoptera: Noctuidae) as citrus pests in Benin: a description of their damage and morphology. *FAO Plant Protection Bulletin,* **37**(3): 111-120.

Atwal, A.S. and Pajni, H. R. 1964. Preliminary studies on the insecticidal properties of drupes of *Melia azadirach* against caterpillars of *Pieris brassicae* L. (Lepidoptera: Pieridae). *Indian Journal of Entomology*, **26**(2): 221-227.

Baptist, B.A. 1944. The Fruit-Piercing Moth (*Othreis fullonica* L.) with special reference to its economic importance. *Indian Journal of Entomology*, **6**: 1-13.

Bhumannavar, B. S. and Viraktamath, C. A. 2001. Rearing techniques for three species *Othreis* (Lepidoptera:Noctuidae) and their ectoparasitoid, *Euplectrus maternus* Bhatnagar (Hymenoptera: Eulophidae). *Journal of Biological Control*, **15**(2): 189-192.

B·nziger, H. 1982. Fruit-Piercing Moths (Lep., Noctuidae) in Thailand: A General Survey and Some New Perspectives. *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, **55**: 213-240.

Bosch, J. E. 1971. The possibility of controlling fruit piercing moths by means of an odour repellent. *Rhodesia Agricultural Journal*, **68**(6):113.

Chopra, R.N., Badhwar, R.L. and Gosh, S. 1940. Poisonous plants of India. ICAR Scientific monograph No. 17. GOI, Punjab, New Delhi.

Fay, HAC. 1996. Evolutionary and taxonomic relationship between fruit-piercing moths and the Menispermaceae. *Australian Systematic Botany*, **9**(2): 227-223.

Godfrey, S.A.W. and Jah, AMS. 1975. A quick method for determining the cause and nature of citrus 'Windfall' in Sierra Leone. *Acta Horticulturae*, **49**: 295-298.

Jacobson, M. 1990.Glossary of plant-derived insect deterrents. Boca Raton, FL: CRC Press.

King, W.V. 1954. Chemicals evaluated as insecticides and repellents at Orlando, Fla. USDA Agricultural Handbook, **69**: 1-397.

Little, T. M. and Hills, F. J. 1978. Agricultural experimentation design and analysis. Wiley, New York.

McDaniel, J. R. 1971. Pests of deciduous fruit trees. Techinial Bulletin, Rhodesia Ministry of Agriculture, **13**:60-72

Pradhan, S., Jotwani, M. G. and Rai, B.K. 1963. The repellent properties of some neem products. *Bull. Reg. Res. Lab.*, **1** (2):149-151.

Qadri, S. S. H. 1973. Some new indigenous plant repellents of storage pests. *Pesticides*, **7**(2): 18-19.

Quarles, W. 1996. Botanical mosquito repellents. *Common Sense Pest Control*,**12**:12-9.

Sukumar, K., Perich, M.J. and Boobar, L.R. 1991. Botanical derivatives in mosquito control: a review. *Journal of the American Mosquito Control Association*,**7**:210-37.

Sundarababu, P.C. and David, B. V. 1973. A note on unprecedented occurrence of fruit-piercing moths on grapevine. *South Indian Horticulture*, **21**(4): 134-136.

Wood, D.C., Silverstein, R. M. and Nakajima, M. Eds., 1970. Control of insect behaviour by natural products, Academic Press, NewYork and London.

Yoon, J. K. and Kim, K. S. 1977. Control of the fruit-piercing moths. *Korean Journal of Plant Protection*, **16**(2):127-131.

Yuwadee Trongtokit, Christopher f Curtis and Yupha Rongsriyam.2005.Efficacy of repellent products against caged and free flying *Anopheles stephensi* mosquitoes. *Southeast Asian Journal of Tropical Medicine and public health*, **36**(6): 1423-1431.