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Effect of Turmeric Extracts on Settling Response and Fecundity of Peach Fruit Fly (Diptera: Tephritidae)

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Abstract. Extracts of turmeric, *Curcuma longa* in petroleum ether, acetone and ethanol were separately prepared using Soxhlet's extractor . Settling response of peach fruit fly *Bactrocera zonata* to the extracts in a cage having treated or untreated guava indicated that the acetone extract had the maximum effect on settling response and fecundity. In 48 hours at 2% concentration of this extract average number of flies settled on treated guava were 0.13 as compared with 0.83 in control showing 84.64% non-preference. The progeny was inhibited in the exposed treated fruits. Acetone extract at 2% caused the maximum inhibition of 85.84% in pupation and 94.71 % in adult emergence.

Key words: Turmeric, peach fruit fly, *Bactrocera zonata* , solvent extracts, settling response, fecundity.

INTRODUCTION

Fruits are grown on 0.64 million hectares in Pakistan with an annual production of about 6.3 million tonnes. Fruits are used not only for local consumption but are also exported. The value of total fruit exports during the fiscal year 2002-2003 was 11.35 billion rupees (Agricultural Statistics of Pakistan 2002-2003).

Peach fruit fly, *Bactrocera zonata* (Saunders), causes heavy damage to guava, mango, peach, apricot, loquat, etc. The damage is caused by the larvae only and the attack is characterized by the dark punctures, oozing of fluid, and the rotting or dropping of fruits. The fruits attacked by this pest are malformed, misshaped, undersized and are found rotting inside.

B. zonata is the most common and wide spread species not only in Pakistan but also in all the fruit growing areas of the world (Ghouri, 1960; Syed, 1967; Hashmi, 1994). Therefore, it has attracted the attention of economic entomologists. It is abundant in Punjab, Sindh and Balochistan and rare in northern foothills and Peshawar valley (Mohyuddin, 1989). *B. zonata* alone has 80.6% population, thus the most abundant species in Bannu (Marwat and Baloch, 1986).

Fruit flies have been important pests of fruits in the past in Pakistan but now these are being considered as quarantine pests in the international trade. They have attained more importance with respect to WTO. Fruit fly infestations and its resultant consequences in the shape of pesticide residues and quality deterioration of fruits are putting adverse effects on the economy of farmers and traders. Some of the fruits which could fetch foreign exchange are not being exported due to infestation of fruit flies.

Although the use of plant species to control insect pests has been in practice for centuries to a limited extent, but recently the interest has been renewed in the pest management potential of natural products. Plants are nature's "chemical factories", providing the richest source of organic chemicals on Earth. Plant products have several uses in insect control (Hashmi, 2001).

Turmeric, *Curcuma longa*, has been traditionally used for insect control in Indo-Pak Sub-Continent (Chattergee, 1980; Jilani, 1985). Turmeric extracts have also shown repellent and growth inhibiting effects against *Tribolium castaneum* (Jilani and Su, 1983; Mostafa, 1993). Turmerone and ar-turmerone isolated from turmeric oil are repellents against *T. castaneum* (Su *et al.,* 1982). Some plants have shown various types of effects on fruit flies. Neem seed kernel extracts are oviposition deterrent to *Bactrocera cucurbitae* and *B. dorsalis* (Shivendra and Singh, 1998), extracts of *Acorus calamus* affected longevity and showed chemosterilant effects on adults of *B. cucurbitae* (Shankutala and Thomas, 2001a) and reduced field population (Tewari, 2001; Shankutala and Thomas, 2001b).

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Akhtar *et al.* (2004) have demonstrated repellent and growth inhibiting effects of various solvent extracts of neem, turmeric and sweetflag. Turmeric extracts probably suppressed egg laying, egg hatching or larval survival as minimum number of pupae were recovered from the treated guava. The present studies are continuation of these studies and aimed at determination of effects of turmeric extracts on settling response and fecundity of peach fruit fly, *B. zonata.*

MATERIALS AND METHODS

Rearing of fruit fly

Peach fruit fly, *B. zonata,* was reared under controlled conditions of 28±1°C and 55±5% R.H. Fresh and clean guava fruit were exposed for 48 hours to the graved *B. zonata* females for egg laying. The infested fruits were transferred to glass jars (1-lb capacity) containing sand. The pupae were collected by sieving and kept in a cage for obtaining fruit fly adults of uniform age. For mass culture, the adults were provided artificial diet consisting of two bananas, six egg yolks, four table spoons of honey, two table spoons of Leaderplex vit B. complex syrup, one table spoon of yeast and eight table spoons of sugar.

Preparation of test materials

Turmeric, *Curcuma longa* L.*,* rhizomes purchased from a local ayervadec shop were ground to a fine powder in an electric grinder. A weighed amount of 100 grams turmeric powder was extracted separately with 500ml acetone, petroleum ether and ethanol on Soxhlet's extraction apparatus for 8 hours. The extracts were concentrated on rotary evaporator and finally made solvent free in a vacuum desiccator.

Preparation of solutions

One gram of each extract was separately dissolved in 50 ml water to get stock solutions of 2% concentration from which lower concentrations of 1.0 and o.5% were obtained by dilution. The guava fruits were treated by dipping in 2, 1 and 0.5% solution, air dried for 24 hours and evaluated for settling response of *B. zonata* adults.

Bioassays

Settling response

The treated and untreated fruits were offered to 15 pairs of 20 days old gravid *B. zonata* adults in a cage of $18^{//}$ x $16^{//}$ x $16^{//}$ providing free choice. The experiment was replicated three times. The number of fruit fly adults settled on treated or untreated fruits were counted after every 2 hours from 8 a.m. to 4 p.m. for 2 days. Percent non-preference was worked out by comparing the mean number of the adults settled on treated or untreated fruits as given by the following formula:

$$\text{Percentage non preference} = 100 - \frac{\text{Mean number of flies settled on treated fruit} \times 100}{\text{Mean number of flies settled on untreated fruit}}$$

Effect on fecundity

After 48 hours, both treated and untreated fruits were individually kept in separate plastic jars containing sand for pupation at 28±1°C and 55±5% R.H. The jars were covered with muslin cloth. After 15 days, pupae were collected by sieving and kept in separate glass vials for adult emergence. The number of pupae and adults emerged from different treatments were compared to evaluate the effect of plant extracts on fecundity.

RESULTS

Settling response and non-preference

Table I shows that the number of flies settled on guava fruit separately treated with petroleum ether, acetone and ethanol extracts of turmeric were significantly lower than those on untreated fruits. The lowest number of flies settled was 0.13 on guava fruit treated with 2.0% acetone extract of turmeric followed by 0.23 and 0.33 on the fruits treated with 1.0% and 0.5% concentration of the same plant extract, respectively, as compared with 0.83 in control.

Number of adults settled on guava fruits treated with 2.0% concentration of petroleum ether extract were significantly lower than those settled on fruits treated with 1.0% and 0.5% concentrations. The highest level of non-preference shown by the flies was 84.64% to the fruits treated with 2.0%

acetone extract of turmeric followed by 71.82% and 59.73% to the guava fruits treated with 1.0% and 0.5% concentration of the same extract with reference to control, respectively. Non -preference of flies to the fruits treated with petroleum ether or ethanol extracts was lower than those treated with acetone extract.

Table I.- Mean number of *B. zonata* settled on untreated guava fruit or those treated with different concentrations of turmeric extracts in various solvents exposed for 48 hours in a free choice test

Solvent	% Conc.	Settling response	
		No. settled	% Non-preference
Acetone	2.00	0.13^{e}	84.64
	1.00	0.23^{ef}	71.82
	0.50	0.33^{de}	59.73
Petroleum ether	2.00	0.35^{e}	58.05
	1.00	0.59^{bc}	28.29
	0.50	0.65^{d}	21.76
Ethanol	2.00	0.43^{cd}	47.64
	1.00	0.49^{bcd}	40.38
	0.50	0.53^{bc}	35.55
Control		0.83^{a}	

Values followed by the same letters are not significantly different from each other ($P \leq 0.05$), [Duncan's 1951] Multiple Range Test LSD=0.153 Average of 3 replications.

Settling of comparatively lower number of adults on a treated than on untreated fruit is considered as a marker of non-preference of that particular material applied to the fruit. The material having non-preference is considered as repellent. Such materials affect insect behaviour. This indicated that fruit fly adults preferred untreated guava fruits

Fecundity

Effect of plant extracts on pupation

The number of pupae obtained from guava fruits treated with various extracts of turmeric in different concentrations and exposed to *B. zonata* for 48 hours are presented in Table II. It revealed that the number of pupae obtained from fruits treated with acetone extract was significantly lower than those treated with petroleum ether and ethanol extracts and from untreated fruits. The minimum number of 14.00 pupae recovered from guava treated with 2.0% acetone extract were followed by 21.00 at 1.0% which were not significantly higher. However 26.00 pupae recovered at 0.5% concentration were significantly higher than those at 2.0% concentration.

The number of pupae recovered from guava treated with petroleum ether extract at 2.0, 1.0 and 0.5% concentration was 46.67,47.67 and 56.33, respectively, which were non-significant from each other but significantly lower than 98.67 obtained from untreated fruits and 67.00, 87.67 and 88.67 from those treated with ethanol extract at 2.0, 1.0 and 0.5% concentration, respectively.

Inhibition of pupae recovered from fruits treated with acetone extract of turmeric at 2.0, 1.0, and 0.5% concentrations was 85.84, 78.72, and 73.65%, respectively with reference to control. Pupal inhibition in petroleum ether extract and ethanol extract was lower than that in acetone extract

Effect of plant extracts on adult emergence

Minimum number of 4.67 adults were recovered from guava fruits treated with 2.0% acetone extract of turmeric followed by 11.00 and 15.33 from those treated with 1.0 and 0.5% concentrations, respectively, as compared with 88.33 in control

The number of adults emerged at different concentrations of the acetone extract were non-significant from each other but significantly lower than those treated with petroleum ether and ethanol extract and from untreated fruits. The number of adults were 41.00, 42.67, and 51.33 at 2.0, 1.0 and 0.5% from petroleum ether extract treated fruits, respectively. These were significantly lower than 72.00 adults recovered each from 1.0% and 0.5% ethanol extract treated fruits. There were 54.33 adults emerged at 2.0% ethanol extract and 72.00 each at 1.0 and 0.5% concentration which were non-significant from each other and from 88.33 in control. Inhibition of adult emergence was highest

Table II.- Mean number of *B.. zonata* pupae recovered from untreated guava fruits and those treated with various concentrations of turmeric extracts in various solvents exposed for three days in a free choice test.

Solvent	% Concentration	Progeny			
		Pupae		Adults	
		Number	% inhibition	Number	%inhibition
Acetone	2.00	14.00^{e}	85.84	4.67^{d}	94.71
	1.00	21.00^{de}	78.72	11.00^{d}	87.54
	0.50	26.00^{d}	73.65	15.33^{d}	82.64
Petroleum ether	2.00	46.67^{c}	52.70	41.00^{c}	53.58
	1.00	47.67^{c}	51.68	42.67^{c}	51.69
	0.50	56.33^{bc}	42.91	51.33^{c}	41.89
Ethanol	2.00	67.00^{a}	32.09	54.33^{c}	38.49
	1.00	87.67^{a}	11.15	72.00^{b}	18.48
	0.50	88.67^{a}	10.13	72.00^{b}	18.48
Control		98.67^{a}		88.33^{a}	

Values followed by the same letters are not significantly different from each other (P≤0.05), [Duncan's 1951] Multiple Range Test LSD=10.83(Pupae), 13.27(Adults) Average of 3 replications.

in acetone extract of turmeric. It was 94.71, 87.54 and 82.64% at 2.0, 1.0 and 0.5% respectively. Petroleum ether and ethanol extracts had comparatively lower inhibition of adults.

Acetone extract of turmeric being the most promising was further studied for its effect by feeding through admixture with artificial diet used for rearing. Feeding on treated diet increased mortality and inhibited progeny by affecting reproduction process.

DISCUSSION

Presently, farmers rely mainly on the use of insecticides for controlling fruit flies. In some of the fruits like guava, the cover sprays of insecticides are being applied about 5-7 times at every 10-15 days interval in summer crop, 2-3 times in mango, two times in plums, peaches, persimmon, pear apricot and at weekly interval in melons for protection against fruit flies. In an estimate about 10% of insecticides used in the country are applied for the control of fruit flies (Stonehuose *et al.,* 1998). This state of affairs is most concerning from ecological point of view as well as the issue of insecticide residues in exportable fruits and vegetables. Pakistan's export of fruits and vegetables faces serious threat to the use of insecticides. Sri Lanka refused to accept onion from Pakistan in 2002 because of insecticide residues and required certification that the imported citrus fruit should come from fruit fly free area. Similarly, Mauritius needs certification for the import of persimmon. Korea, Japan and Jordan have already banned the import of fruits from Pakistan. Under such circumstances massive thrust to increase export of fruits by Pakistan to new and existing markets may suffer a serious set back unless solutions to pest attack are found other than pesticides. Under WTO regulations, the international standards of exportable fruits and vegetables have to be followed especially under sanitary and phytosanitary measures under which these must be free of pest and pesticide residues.

Plant derivatives appear to be a good source of safe and environment friendly chemicals which can be used as alternatives to insecticides .

Studies by Shivedra and Singh (1998), Shakuntala and Thomas (2001), Tewari (2001) and present research indicated great potential of some indigenous plants for controlling fruit flies. Being medicinal and having traditional uses, these plants are not expected to leave any harmful residues in the treated commodities.

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