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INSECTICIDAL EFFECT OF PLANT EXTRACTS ON THE ACTIVITY OF FRUIT FLY

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Abstract

The aqueous extracts of leaves of neem (*Azadirachta indica*), eucalyptus (*Eucalyptus globules*), telakucha (*Coccinia indica*), mahagony (*Swietenia macrophylla*), and joba **(***Hibiscus rosa-sinensis*) were used to evaluate their repellence, abundance and infestation on fruit fly (*Bactrocera cucurbitae)* (Diptera: Tephritidae). The repellent effect on the insect was observed in laboratory, and the abundance and infestation activities were studied in ash gourd (*Benincasa hispida)* in the field. The investigations were done with 1, 2, and 4% extracts of all the selected plants and with an untreated control. The repellent effect of the extracts varied with plant species, concentrations, and exposure time. The results indicated that the repellent effect of the extracts on fruit fly varied from 4.0 ± 2.4 to 60.0 ± 3.2%, where the maximum effect was obtained with 4% neem leaf extract at 1 hour after treatment. The minimum effect was achieved with 1% joba leaf extract at 5- hour after treatment. The plant extract also affected the abundance and infestation of the insect, where 4% neem leaf extract caused the lowest abundance (3.7/30 sweeps) and fruit infestation (8.7%). Among the tested extracts, 4% neem leaf gave better result against *B. Cucurbitae,* which might be incorporated as an IPM component to manage fruit fly infesting ash gourd in the field.

Keywords: Ash gourd**,** abundance, botanicals, repellent**,** *Bactrocera cucurbitae.*

Introduction

Fruit fly (*Bactrocera cucurbitae)* Coquillett (Diptera: Tephritidae) is the most destructive insect pest of cucurbitaceous vegetables in Bangladesh and other south-east Asian countries. It is a frugivorous, multivoltine, and ubiquitous insect which cause 50.0 to 100.0% damage in different species of cucurbitaceous vegetables (York, 1992; Atwal and Dhaliwal, 2005).

The fruit fly causes different levels of fruit infestation in different climatic regions and in different fruits and vegetables. Mannan (2004) reported a minimum of 19.2% infestation and as much as 69.9% in sweet gourd. Ramadan and Messing (2003) observed, on an average, 94.4% fruit infestation by *B. cucurbitae* on three cucurbit species in Thailand and Sapkota *et al.,* (2010) found 40.0% on squash in Nepal.

For extensive crop damage and management cost, the fruit fly (*B. cucurbitae)* is considered the most economically important fruit pest in Bangladesh. To guarantee a minimum management of cucurbit crops and to prevent fruit fly damage, various chemicals and environmental friendly practices have been suggested. Kapoor (1993) suggested for chemical, biological, and legal approaches. The bagging of fruits in scaffold is an environmentally sustainable method and showed the lowest level of infestation, but the method is very expensive and laborious (Mukherjee *et al*., 2007; Amin *et al.,* 2008).

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Over recent decades, the management of fruit fly is mainly depending on the use of pesticides applied either as a bait or covered sprays (Kakani and Mathiopoulos, 2008). This practice, when used extensively, has adverse consequences on human health, environment, and cause resistance to insects (Kim *et al.,* 2003). The synthetic insecticides also directly kill the insect pollinators and natural enemies of the pests (Azad *et al.,* 2011). In this context, development of a pest control strategy based on minimum use of chemicals is needed to improve productivity, while maintaining positive ecological balance.

The environmentally safe method, such as the use of plant extracts, oils, and dusts are growing interest to replace synthetic pesticides (Yuya *et al.,* 2009). Therefore, the present study was conducted with the leaf extracts of neem (*Azadirachta indica),* eucalyptus (*Eucalyptus globules),* joba (*Hibiscus rosa-sinensis),* telakucha (*Coccinia indica),* and mahagony (*Swietenia macrophylla)* to evaluate their repellent effects on the larvae of fruit fly and the impacts of the extracts on the abundance and infestation rate of this pest infesting ash gourd (*Benincasa hispida)* grown in the field.

Materials and Methods

Collection and preparation of plant samples

The study was carried out in the experimental field and laboratory of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur during November 2015 to June 2016. The leaves of neem, eucalyptus, telakucha, mahagony, and joba were collected from BSMRAU campus and brought in the Entomology Laboratory. The collected leaves were washed with tap water and air dried for 7 days in the shade. Later, the leaves were dried in an oven at 50-60°C for 24 hours to obtain constant weight. The leaves were powdered by using an electric blender passed through 40 mesh screen and stored at 28°C in air tight dark glass bottles.

Preparation of extracts from the leaves

Dried powder of each plant species were separately extracted in water. For each preparation, 10g powder was macerated in a 2.5 L glass bottle using 1 L water for 7 days. For complete extraction, the sample was shaken for 72 hours using an electric shaker. The extract was filtered and the filtrate was maintained at 1% concentration (1 g/100 ml). Similarly, 2 and 4% extracts were prepared and stored in a refrigerator at 4°C until bioassay.

Observation of repellency effect

Maggots of the fruit fly were collected from the field of the Department of Entomology, BSMRAU, Gazipur, Bangladesh. Ash gourd fruit pieces were mixed with different extracts separately and then the pieces were air-dried. Treated and untreated fruit pieces were placed separately in surrounding of the Petri dish and ten maggots were released at the center of the Petri dish. The insects present on each half of the Petri dish were counted at hourly intervals up to 5 hours. Observation for each extract concentration was repeated three times and data were expressed as percentage repulsion (PR%) by the formula: PR (%) = (Nc - 50) × 2, where N is the percentage of insects present in the untreated half.

Cultivation of ash gourd

Ash gourd was cultivated in a Randomized Complete Design (RCD) with 3 replications. The whole experimental land was divided into

18 equal plots (2.0 × 1.5 m) with an inter plot distance of 0.5 m. Manures and fertilizers were applied to the experimental plots according to the prescribed doses of Soil Resources Development Institute (SRDI), Bangladesh. Seeds were collected from the Bangladesh Agricultural Research Institute (BARI), Gazipur. Each plot had one pit (40×40×40 cm) at its north-east corner and five seeds were sown in a pit. Two healthy plants were kept in each pit representing a replication. Bamboo scaffold was provided for proper development of the creepers. Sevin 85 WP 1.5 kg/ha was applied to the soil for management of cutworm, whereas red pumpkin beetle and epilachna beetle were controlled mechanically. Weeding and irrigation were done properly.

Observation of insect abundance and fruit infestation in ash gourd field

During flowering and fruiting stages, field inspection was done daily to observe the incidence of the fruit flies. Four percent extract of each plant was applied as soon as the flies were found in the field. Each extract was applied in three plots and repeated 6 times at 7 days interval. Three plots were kept free from treatment and left as untreated control. To avoid dipping from one plot to the other, temporary barrier of polythene sheet was built surrounding the treated plot just before the treatment application and was removed after the application. Free living adults were collected using a 30 cm diameter sweep net having1.5 mm mesh and attached with a 2 m long rod. Every week, sweeping was done in between 10.00 and 11.30 am and each sample was consisted of 30 sweeps swept on the bamboo scaffold. The collected insects were brought from the experimental field to the Entomology Laboratory for sorted out the fruit flies and counted for their abundance. At every inspection, infested fruits were tagged with possible date of infestation. Both infested and non-infested fruits were harvested at their maturity and percent infestation was calculated.

Statistical analysis

Data were analyzed by one way analysis of variance (ANOVA) using IBM SPSS 19. Mean differences were evaluated using Tukey's Posthoc Statistics.

Results and Discussion

The insecticidal activities, such as the repellent effect of neem, eucalyptus, telakucha, mahagony, and joba plant extracts on fruit fly (*B. cucurbitae)* maggots at different hours after treatment are shown in Table 1. The repellent rates of the plant extracts at 1 HAT showed significant differences ($F_{14, 60} = 9.1$, $p < 0.001$) and the results varied from 20.0 ± 3.2 to 60.0 ± 3.2%. The highest and the lowest repellent rates at 1 HAT were observed in 4% neem and 1% joba Petri dishes, respectively.

The plant extracts in different concentrations had significant effect ($F_{14, 60} = 5$, $p < 0.001$) on the repellent rates of cucurbit fruit fly maggots at 2 HAT. The results varied from 18.0 ± 2.0 to 52.0 ± 3.7%, and the treatments 1% joba and 4% neem extracts had the lowest and the highest repellency rate, respectively. Significant differences ($F_{14, 60} = 2.9$, $p < 0.01$) were found among the repellent rates of the treatments at 3 HAT, and the results varied from 14.0 ± 2.4 to 42.0 ± 4.9%, where the highest and the lowest repellent rates at 3 HAT were found in 4% neem and 1% joba extracts, respectively (Table 1).

The repellent rates of the fruit fly maggots at 4 HAT differed significantly ($F_{14, 60} = 2.9$, $p <$

Table 1. Repellent rates of *Bactrocera cucurbitae* larvae reared on ash gourd treated with different doses of plant extracts

Plant	Dose	% Repellency at				
		1 HAT	2 HAT	3 HAT	4 HAT	5 HAT
Neem	1%	48.0 ± 3.7ac	40.0 ± 3.2ab	32.0 ± 2.4ab	30.0 ± 3.2a	26.0 ± 2.4ab
	2%	50.0 ± 3.2ac	42.0 ± 4.9ab	34.0 ± 5.0ab	30.0 ± 0.0a	26.0 ± 2.4ab
	4%	60.0 ± 3.2a	52.0 ± 3.7a	42.0 ± 4.9a	40.0 ± 3.2a	34.0 ± 2.4a
Eucalyptus	1%	46.0 ± 2.4ac	44.0 ± 4.0ab	23.0 ± 3.0ab	22.0 ± 4.9ab	18.0 ± 3.7ac
	2%	50.0 ± 3.2ac	44.0 ± 4.0ab	30.0 ± 3.2ab	30.0 ± 4.5a	22.0 ± 2.0ab
	4%	52.0 ± 3.7ab	38.0 ± 5.8ab	34.0 ± 5.1ab	34.0 ± 4.0a	26.0 ± 2.4ab
Telakucha	1%	34.0 ± 2.4cd	34.0 ± 2.5ac	25.0 ± 2.2ab	28.0 ± 2.0ab	14.0 ± 2.4bc
	2%	54.0 ± 4.0ab	46.0 ± 2.4ab	24.0 ± 4.0ab	32.0 ± 5.8a	16.0 ± 4.0bc
	4%	58.0 ± 2.0a	52.0 ± 2.0a	28.0 ± 5.8ab	36.0 ± 8.1a	22.0 ± 5.8ab
Mehagony	1%	38.0 ± 3.7bc	28.0 ± 2.0bc	26.0 ± 2.4ab	22.0 ± 3.8ab	18.0 ± 5.8ac
	2%	44.0 ± 4.0ac	42.0 ± 5.8ab	34.0 ± 8.1ab	26.0 ± 6.8ab	22.0 ± 3.7ab
	4%	54.0 ± 4.0ab	44.0 ± 6.0ab	41.0 ± 6.8a	32.0 ± 7.3a	26.0 ± 2.4ab
Joba	1%	20.0 ± 3.2d	18.0 ± 2.0c	14.0 ± 2.4ab	6.0 ± 2.4b	4.0 ± 2.4c
	2%	38.0 ± 3.7bc	36.0 ± 2.4ac	34.0 ± 2.4ab	32.0 ± 2.0a	16.0 ± 2.4bc
	4%	44.0 ± 4.0ac	38.0 ± 3.7ab	38.0 ± 2.0a	32.0 ± 2.0a	28.0 ± 2.0ab

Data expressed as mean ± SE. Means within a column followed by no common letter(s) are significantly different by Tukey's HSD Posthoc Statistics at $p \leq 0.05$. HAT: Hours after treatment

0.01). The observed repellent rates at 4 HAT ranged from 6.0 ± 2.4 to 40.0 ± 3.2% and the highest and the lowest rates were found in 4% neem and 1% joba extracts, respectively. The plant extract had also significant effect ($F_{14, 60} = 4.6, p < 0.001$) on the repellent rates of the fruit fly maggots at 5 HAT and the results ranged from 4.0 ± 2.4 to 34.0 ± 2.4%, where 4% neem extract showed the highest repellent rate.

Results showed that the repellency rate of the cucurbit fruit fly maggot varied with plant species, extract concentrations, and exposure periods. Here all the tested extracts acted as a repelling source of plant materials. Amin *et al*. (2000) studied the repellent effect of biskatali (*Polygonum hydropiper)*, neem (*Azadirachta indica),* and akanda (*Asclepias clotropis)* leaf extract on lesser grain borer and observed significant repellent effect. The n-hexane extracts of different weed leaves showed repellency effect on *Callosobruchus chinensis* (Ahad *et al.,* 2015; Ahad *et al.,* 2016). The leaf extracts of common cocklebur (*Xanthium strumarium)* revealed repellent properties on the pulse beetle (*Callosobruchus chinensis)* (Roy *et al.,* 2014). Shahjahan and Amin (2000) studied the repellency effect of biskatali, neem and akanda plant extract on rice weevil and reported that 4% neem extract showed the highest repellency (73.6%). The petroleum ether extract of shiyalmutra (*Blumea lacera)* leaf was reported as repellent on lesser grain borer and rice weevil (Roy *et al.,* 2005).

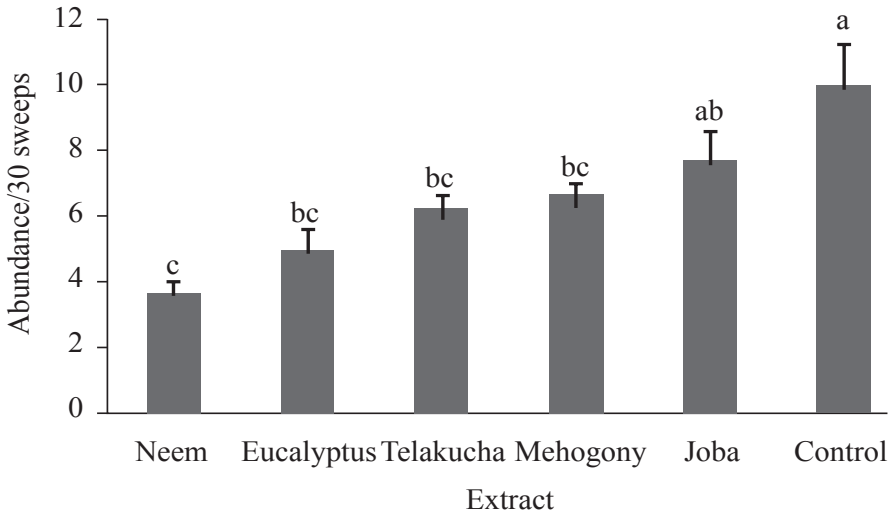

Fig. 1. Effect of different plant extracts on the abundance of fruit fly in ash gourd field. Data expressed as mean ± SE. Bars with no common letter(s) are significantly different by Tukey's Posthoc Statistic at *p ≤ 0.05.*

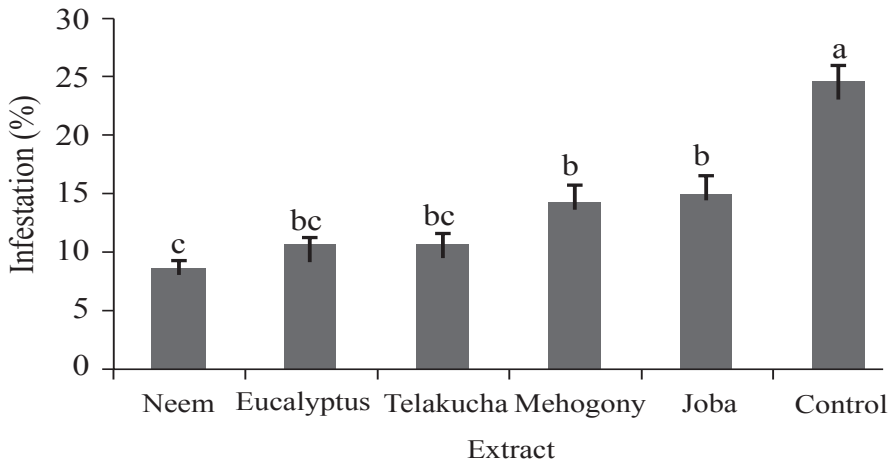

Fig. 2. Effect of different plant extracts on the ash gourd fruit infestation by fruit fly. Data expressed as mean ± SE. Bars with no common letter(s) are significantly different by Tukey's Posthoc Statistic at *p ≤ 0.05.*

Figure 1 & 2 present the effect of different plant extracts on the abundance of fruit fly in ash gourd field. Fruit fly abundance in the field varied from 3.7 ± 0.3 to 10.0 ± 1.2/30 sweeps and the results differed significantly ($F_{5, 12} = 10.3$, $p < 0.01$). All the treatments revealed significantly lower abundance compared to control and joba leaf. Due to the repellent action of the plant extracts, adult flies move to the untreated plots which resulted in lower abundance in the treated plots.

Significant differences ($F_{5, 12} = 25.2$, $p < 0.001$) in fruit infestation were found in the plant extract treated plots. The fruit infestation rates varied from 8.7 ± 0.7 to 24.7 ± 1.3% and all extracts caused significantly lower levels of infestation. Amin *et al*. (2011) observed the infestation levels of *B. cucurbitae* on ash gourd, ridge gourd, sweet gourd, bitter gourd and snake gourd as 21.0 to 71.5 ± 3.7%, when the crops were kept free from pest management treatment. In the present study, infestation rate ranged from 8.3 ± 1.7 to 23.3 ± 3.3% and the extract treatments provided lower level of infestation as compared to the findings of Amin *et al*. (2011). The alkaloid compounds of the plant, such as Azadirachtin, Azdirol, Cymarin, Digitoxin, Kulactone, Limocinin, Salanin, Toosendanin, Xanthotoxin etc. showed toxicity and repelling action on different insect species. These compounds acted as feeding inhibitors on insects (Menezes, 2005).

The present study revealed the potential repellent effect of neem and eucalyptus leaf extracts against *B. cucurbitae*. These plant extracts reduced the abundance of the fruit fly in the ash gourd field and resulted in lower level of infestation compared to other treatments. These plant extracts might be incorporated as a component of IPM against fruit fly infesting ash gourd in the field. This might reduce control costs and environmental effects associated with the use of broad spectrum chemical insecticides.

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