Bangladesh j. entomol. (2022) 30(1 & 2), 97-116, www.bangladeshes.org *ISSN 1021-1004*

EFFECT OF SIX INDIGENOUS WEED EXTRACTS AGAINST CUCURBIT FRUIT FLY, *BACTROCERA CUCURBITAE* (COQUILETT) (DIPTERA: TEPHRITIDAE)

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ABSTRACT

Effect of six different weed extracts on the repellency and oviposition deterrent were conducted against cucurbit fruit fly, *B. cucurbitae* (Coq.) in the laboratory of the Department of Entomology, HSTU, Dinajpur, during July to December 2021. The study was carried out primarily with 5.0 % concentration for six weed extracts followed by two weed extracts with four concentrations (0.5, 1.0, 2.0 and 4.0 %) on bitter gourd fruit. Results indicated that the tested weed extracts not only cause repellent and oviposition deterrent effects against *B. cucurbitae* but also inhibited the progeny development. The lowest number of larvae (0.67) and pupae (0.67) recovery and adult emergence (0.33) was recorded from water pepper weed extract at 5.0% concentration followed by croton weed extract. The order of toxicity of the weed extracts based on repellency and oviposition deterrent was water pepper > croton > black nightshade > goat weed > common lucas > mexican poppy. However, progeny recovery, percent repellency and oviposition deterrent were found dose dependent manner. The highest repellency (53.05%) and oviposition deterrent (95.40%) were found in water pepper as against the lowest repellency (28.73%) and oviposition deterrent (44.96%) was in common lucas. The highest percent reduction of pupae recovery was observed in water pepper (97.53%) whereas the lowest was in mexican poppy weed extract (63.86%). The water pepper weed extract also showed the highest inhibition of adult emergence (98.72%). It is evident from the results that all the weed extracts caused a remarkable decrease in adult emergence, larvae and pupae recovery, and adult settling compared to control.

Keywords: *Bactrocera cucurbitae*, weed extract, repellent, oviposition deterrent, progeny development.

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INTRODUCTION

Bitter gourd (*Momordica charantia* Linnaeus) is one of the most important cucurbitaceous vegetables in Bangladesh for its excellent market value which encourages the farmers to cultivate on large scale. It's total production of 54,443 metric tons from 26,491 acres of land (BBS 2020). It has medicinal properties with appearance an important compound named 'Charantin' which is useful to reduce blood sugar of diabetic patients (Oishi *et al.* 2007). Cucurbits are infested by various insect pests such as cucurbit fruit fly, red pumpkin beetle, epilachna beetle, etc. Among them, cucurbit fruit fly is a major pest causing yield loss in cucurbits and infests about 15 kinds of cucurbit vegetables grown in Bangladesh (Rakshit *et al.* 2011). This pest has a key limiting factor that causes intense qualitative and quantitative losses in bitter gourd (Barnes *et al.* 2004, Biswas *et al*. 2007).

Bactrocera cucurbitae is a very active flying insect and the female flies choose generally soft tender fruit tissues for egg laying. The eggs hatch inside the fruit into maggots which feed on the flesh (pulp) of the fruit and make tunnels in fruits. The infested fruits become rotten, dry up, and finally shed prematurely. About 41-95% fruit infestation by cucurbit fruit fly in bitter gourd crop has been recorded (Sapkota *et al*. 2010). The extent of losses varies between 30 and 100 percent depending on the environmental conditions and susceptibility of the crop variety (Gupta and Verma 1992, Dhillon *et al.* 2005b, Shooker *et al.* 2006). It has been reported to infest 95% of bitter gourd fruits in Papua New Guinea, 90% of snake gourd and 60 to 87% of pumpkin by *B. cucurbitae* in Solomon Islands (Hollingsworth *et al.* 1997). Therefore, the effective management of fruit flies is very important for successful cultivation of bitter gourd. However, farmers are applying different types of chemical insecticides to control cucurbit fruit fly. Even though, in some areas about 25% of the cultivation cost of bitter gourd production were estimated only to buy synthetic pesticides (Nasiruddin *et al.* 2004). Repeated and long-time uses of toxic insecticides has some serious drawback such as pesticides resistance, toxic residues, increasing costs of the application, environmental pollution, health hazards to human being and domestic animal (Ahmed *et al.* 1981, Khanam *et al.* 1990). Therefore, it is desirable to explore alternative methods to control this notorious pest.

During last two decades many evaluation studies on IPM based and ecofriendly management options against key insect pests were adopted among which some were ineffective, unaffordable and created environmental hazards (Manjunathan 1997, Singh and Singh 1998). Studied on the evaluation of different management practices against cucurbit fruit fly (*B. cucurbitae*) in bitter gourd revealed that bagging of fruits showed the lowest percent infestation of 19.49%, 7.48%, and 23.15% at early, mid and late fruiting stages, respectively followed by pheromone trap treatment (Islam *et al.* 2015).

Various botanicals are effective against different pests; especially water pepper (*Polygonum hydropiper* L.) and neem (*Azadirachta indica* A. Juss.) are examples of such plants, which can possess medicinal, insecticidal, repellent, or antifeedant properties (Salimon and Abdullah 2008, Scott *et al*. 2008). Botanicals have bioactive chemicals that may provide a potential alternative to currently used insect controlling agents (Yankanchi and Patil 2009). Neem leaf dust and a commercial formulation of neem can minimize the population and reduce the damage of fruit fly species. It also blocks the ovary development (Mahfuza *et al.* 2007). The botanical insecticides are biodegradable and harmless to the environment (Rehman *et al*. 2009). Innumerable efforts have been made to study the insecticidal efficacy of different plant extracts against cucurbit fruit fly (Bachchu *et al.* 2017, Siddique *et al.* 2019) but a lot of knowledge is still wanting and indispensable to the understanding of these pests for successful managements. Therefore, considering the above facts, the present research work was designed to evaluate the anti-ovipositional and repellent effects of six weed extracts against cucurbit fruit fly under natural field conditions.

METHODS AND MATERIALS

The study was conducted in the research laboratory of the Department of Entomology, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during the period of July to December 2021.

Planting of bitter gourd: The land was ploughed and cross-ploughed several times to obtain good tilth. During land preparation, all weeds and stubbles were removed from the field. The size of each plot was 2.5 m × 2 m with an inter plot distance of 1m and fertilizer was applied according to Nasreen *et al*. (2013). The quality seeds were collected from Lal-Teer seed company, Dhaka. The seeds were soaked overnight in water at Petri dishes prior sowing to soften the seed-coat for better and quick germination. Two seeds were sown directly in each pit and covered with breezy soil immediately after placing seed in the pit. Before sowing, the seeds were treated with vitavax 200 @ 2.0 g per kg seed. A light irrigation was applied and bamboo macha was made for propping, allowing easy creeping and preventing the plant from lodging. Damaged and virus infected seedlings were replaced by healthy one. The bagging of fruits was applied by using transparent polythene bag provided with few holes made by an ordinary pin. These tiny holes were provided for aeration. The size of the perforated polythene bag was large (30 cm × 20 cm) enough for normal growth and provides sufficient aeration. The open mouth of the bag were wrapped and closed by thread near the peduncle of the fruit. After 5 days, the polythene bags were removed and the fruits were harvested for experimental uses.

Collection and preparation of plant extracts: The leaves of the weeds namely, common lucas (*Leucas aspera*), goat weed/billygoat-weed (*Ageratum conyzoides*), croton plant/bon mirchi (*Croton sparsiflorus*), water pepper (*Polygonum hydropiper*), black nightshade (*Solanum americanum*) and mexican poppy (*Argemone mexicana*) were collected from the surrounding area of HSTU, Dinajpur. After collection, the leaves were thoroughly washed with tap water and dried in shade under room temperature (27.0 ± 2°C) Before making powder these leaves were oven dried at 60°C for 6 hours. Then these leaves were separately ground with the help of grinder (Nova Blackberry Blender AD999, Bangladesh). The dust was passed through a 60 mesh sieve to obtain fine powder. For extract preparation, 100g of each powder were separately taken in 600 ml glass beaker and mixed with 300 ml of methanol solvent and the mixture was stirred for 30 minutes in a magnetic stirrer (600 rpm) and left to stand for 72 hours and shaking several at intervals. Afterward the mixture was filtered through a filter paper (Whatman no. 42) and was allowed to evaporate the solvents at 70°C under low pressure with the help of a rotary evaporator. Finally, the different colored semi liquid crude extracts were obtained. These crude extracts were collected in clean glass vials and kept in refrigerator at 4 ˚C temperature for the experimental uses.

Mass rearing of *B. cucurbitae*: To keep a ready supply of fruit flies and meet the experimental needs, mass rearing of cucurbit fruit fly were done as described by Siddique *et al.* 2019. First of all, infested cucurbit fruits were collected from the experimental field of HSTU campus, Dinajpur and were placed in glass-jar with soil and covered with fine cloth to prevent from escape of emerged larvae. To get fruit fly pupae, daily observation was made. After pupae formation, they were transferred in the Petri dishes carefully for adult emerge. After adult emerged, the newly emerged adult were put in to the metallic frame cage (60 cm × 50 cm × 45 cm) covered with nylon net. Artificial diet was supplied for the adult with the help of water soaked cotton. The artificial diet was prepared according to Siddique *et al.* (2019). The elements and quantity for the preparation of artificial diet were sweet gourd pulp (2 slices), honey (4 table spoon), multi-vitamin syrup (2 table spoon) and sugars (8 table spoon). The prepared artificial diet was kept in plastic pot and stored in a refrigerator for continuous uses.

Application of treatments for primary screening: Six weed extracts viz., common lucas, goat weed, croton plant, water pepper, black nightshade and mexican poppy were used for primary screening. In primary screening 5.0% concentration of the crude extracts were used. Dose was prepared by weight by volume basis. Fresh healthy bitter gourd fruits were sprayed individually with six weed extracts at 5.0% concentration and dried at room temperature for two hours. After that 3 treated bitter gourd fruits were offered separately to 5 pairs of 12 days old gravid flies in each plastic cages (measuring 45 cm × 40 cm × 40 cm) for left 48 hours in a free choice bioassay for settling and ovipositing response. In untreated control, only methanol solvent was used. Three replications were made for each treatment. Number of fruit fly settled on the treated and untreated bitter gourd fruits were counted after every one hour interval up to 10 hours as suggested by Rehman *et al*. 2009. After 10 hours, both treated and untreated fruits were removed from the cages and were kept in the Petri dishes for larval growth and development. Number of larvae was counted in each replication separately of the treated and untreated fruits after 8-10 days. Then it was kept in Petri dishes with sand and soil for pupa formation and adult emergence. Finally, the emerged adults were counted from the treated and untreated fruits.

Application of treatments for secondary screening: Water pepper and croton plant extracts showed the better performance than other plant extracts in the primary screening. Four different concentrations (4.0, 2.0, 1.0 and 0.5 %) along with control were prepared. Fresh healthy bitter gourd fruits were sprayed individually with each concentration of water pepper and croton weed extracts and dried at room temperature for two hours. After that 3 treated bitter gourd fruits were separately offered to 5 pairs of 12 days old gravid flies in each plastic cages (measuring 45 cm × 40 cm × 40 cm) for 48 hours in a free choice bioassay for settling and ovipositing response. In untreated control, only methanol solvent was used. Three replications were maintained for each concentration of each treatment.

Data collection: Number of flies settled on treated and untreated bitter gourd fruits were counted after every one hour interval up to 10 hours. Then these bitter gourd fruits were removed from the cages and were kept for larval growth and development at room temperature. After 8-10 days, number of larvae were also counted in each replication separately of the treated and untreated fruits. After counting the larvae, they were kept in Petri dishes with sand and soil for pupae formation and adult emergence. Finally, the emerged adults were counted from the treated and untreated fruits.

Percent repellency: Fruit flies settled on treated and untreated fruit were counted and the percent fruit repellency was calculated by using the following formula described by Siddique *et al.* 2019:

% Repellency = [{Half of the number of flies settled on both treated and untreated fruits - number of flies settled on treated fruit} / Half of the number of flies settled on both treated and untreated fruits] × 100.

Percent oviposition deterrent: Percent oviposition deterrent was calculated was described by Siddique *et al.* (2019) with the following formula:

% Oviposition deterrent = [{Half of the number of eggs laid on both treated and untreated fruits - number of eggs laid on treated fruit}/ Half of the number of eggs laid on both treated and untreated fruits] × 100.

Percent inhibition rate: Percent inhibition rate (% IR) of pupae recovered and adults emerged was calculated by a described formula suggested by Talukder and Howse (1993):

$$\% IR = (Cn - Tn) / Cn \times 100$$

Where,

% IR=Percentage of inhibition rate

Cn= Number of pupae and adult on control treatment

Tn= Number of pupae and adult on treated treatment

Statistical analysis: The collected data were statistically analyzed in accordance with completely randomized design (CRD) using MSTATC software program. The mean values among the treatments were separated by Duncan's New Multiple Range Test (DMRT) and between two treatments were done through *t*-test. All graphical works were done through Microsoft Excel Program.

RESULTS AND DISCUSSION

Primary Screening

Effect of six different weed extracts on adult settled upon treated bitter gourd fruits at different time interval: Number of adult settled on bitter gourd fruits treated with six tested weed extracts in different time intervals are shown in Table 1. Total adult settled was significantly ($P < 0.01$, $F = 10.18$, $df = 6$) differed among all six tested weed extracts at 5.0% concentration. Number of adult settled ranged from 0.00 to 3.00 and all the six weed extracts were significantly different at 1 HAT ($P < 0.01$, $F = 4.67$, $df = 6$). The highest number of adult settled (3.00) was recorded in control treatment followed by 1.33 in common lucas and 1.33 mexican poppy whereas the lowest number (0.00) was in croton weed and water pepper (0.33) at 1 HAT. But the adult settled was not significantly different at 2 to 10 HATs among different weed extracts. The highest number of adult settled were recorded in control (20.00), followed by common lucas (11.00) and mexican poppy (9.33) whereas the lowest number was found in black nightshade (6.33) which was statistically similar to water pepper (6.67) and croton weed extract (6.67) .

Effect of six different weed extracts on larvae and pupae recovery, and adult emergence on bitter gourd fruit: Number of larvae and pupae recovery, and adult emergence from bitter gourd fruits treated with six tested weed extracts was shown in Table 2. Larvae recovery from all six treatments along with control was significantly different ($P < 0.01$, $F = 10.08$, $df = 6$). The highest number of larvae recovery was found in untreated control (25.33) followed by mexican poppy (9.67) and common lucas (9.33) while the lowest were found in water pepper (0.67) and croton plant (4.00). Similarly, pupae recovery and adult emergence was significantly different among all treatments ($P < 0.01$, $F = 9.24, 10.73$, $df = 6$). The highest number of pupae recovery was found in untreated control (25.00) followed by mexican poppy (9.00) and goat weed (7.00), while the lowest number was found in water pepper (0.67) and croton plant (3.67) extracts. The adult emergence was found the highest in untreated control (24.00) but the lowest in water pepper (0.33) followed by croton plant (2.67) and common lucas (5.67).

Effect of weed extracts on percent repellency and percent oviposition deterrent against *B. cucurbitae*: Fig. 1 represents the percent repellency and oviposition deterrent effects of six tested weed extracts against *B. cucurbitae*. The percent repellency and oviposition deterrent were not significantly differed among all the

Table 1. Number of adult fruit fly settled at different time interval on bitter gourd fruit treated with six different weed extracts

Treatments	Number of adult settled at different time interval										
	1 HAT	2 HAT	3 HAT	4 HAT	5 HAT	6 HAT	7 HAT	8 HAT	9 HAT	10 HAT	Total
Water pepper	0.33 bc (0.88)	0.67 a (1.00)	0.33 a (0.88)	0.67 ab (1.05)	1.67 a (1.46)	0.67 b (1.00)	1.00 a (1.17)	0.33 a (0.88)	0.67 a (1.00)	0.33 a (0.88)	6.67 b
Common Lucas	1.33 bc (1.27)	0.33 a (0.88)	1.33 a (1.29)	1.67 ab (1.44)	1.33 a (1.29)	1.00 b (1.17)	1.00 a (1.22)	1.33 a (1.29)	0.33 a (0.88)	1.33 a (1.34)	11.00b
Goat weed	0.33 bc (0.88)	1.00 a (1.17)	1.00 a (1.17)	0.67 b (1.00)	0.67 a (1.00)	1.00 b (1.17)	0.67 a (1.00)	1.00 a (1.097)	0.67 a (1.00)	1.00 a (1.17)	8.00 b
Croton plant	0.00 c (0.71)	1.00 a (1.17)	1.67 a (1.56)	0.67 b (1.00)	0.33 a (0.88)	1.00 b (1.22)	0.67 a (1.05)	0.00 a (0.71)	0.67 a (1.00)	0.67 a (1.05)	6.67 b
Black nightshade	0.33 bc (0.88)	0.67 a (1.00)	0.33 a (0.88)	1.00 ab (1.22)	1.00 a (1.17)	0.33 b (0.88)	0.67 a (1.05)	0.67 a (1.05)	0.33 a (0.88)	1.00 a (1.17)	6.33 b
Mexican poppy	1.33 ab (1.34)	1.00 a (1.17)	1.33 a (1.34)	1.33 ab (1.29)	0.67 a (1.05)	0.33 b (0.88)	1.33 a (1.01)	1.00 a (1.17)	0.33 a (0.88)	0.67 a (1.05)	9.33 b
Untreated Control	3.00 a (1.86)	1.00 a (1.17)	2.33 a (1.57)	2.67 a (1.77)	1.67 a (1.44)	3.00 a (1.86)	2.00 a (1.52)	1.67 a (1.46)	1.00 a (1.17)	1.67 a (1.44)	20.00a
LSD	0.56	0.77	0.76	0.67	0.68	0.62	0.78	0.6961	0.73	0.60	4.60
CV %	28.62	40.75	35.17	30.36	32.77	30.37	38.82	36.38	42.70	29.70	27.05
Level of sig.	0.008	-	0.331	0.207	-	0.061	-	0.372	-	-	0.0002

Where, HAT= Hour after treatment, within column values followed by different letter(s) are significantly different at 5% level of probability by DMRT. Fig.s in the parenthesis are square root transform $\{\sqrt{(x + 0.5)}\}$ value.

Table 2. Number of larva-pupa recovery and adult emergence on bitter gourd treated with six different weed extracts

Treatments	Number of larva recovered (mean ± SE)	Number of pupa recovered (mean ± SE)	Number of adult emerged (mean ± SE)
Water pepper	0.67 c ± 0.67	0.67 b ± 0.67	0.33 c ± 0.33
Common Lucas	9.33 b ± 0.88	6.00 b± 2.00	5.67 bc± 1.86
Goat weed	7.67 bc ± 1.20	7.00 b± 1.15	6.67 bc± 0.88
Croton plant	4.00 bc ± 3.06	3.67 b± 3.18	2.67 bc± 2.67
Black nightshade	8.67 bc ± 5.21	8.00 b± 5.29	7.67 bc± 4.98
Mexican poppy	9.67 b ± 1.20	9.00 b± 1.00	9.00 b± 1.00
Untreated Control	25.33 a ± 1.20	25.00 a± 1.15	24.00 a± 1.00
LSD (0.05)	7.43	7.79	7.09
CV (%)	45.46	52.51	50.59
Level of sig.	0.0002	0.0003	0.0001

Column values followed by different letter(s) are significantly different at 5% level of probability by DMRT.

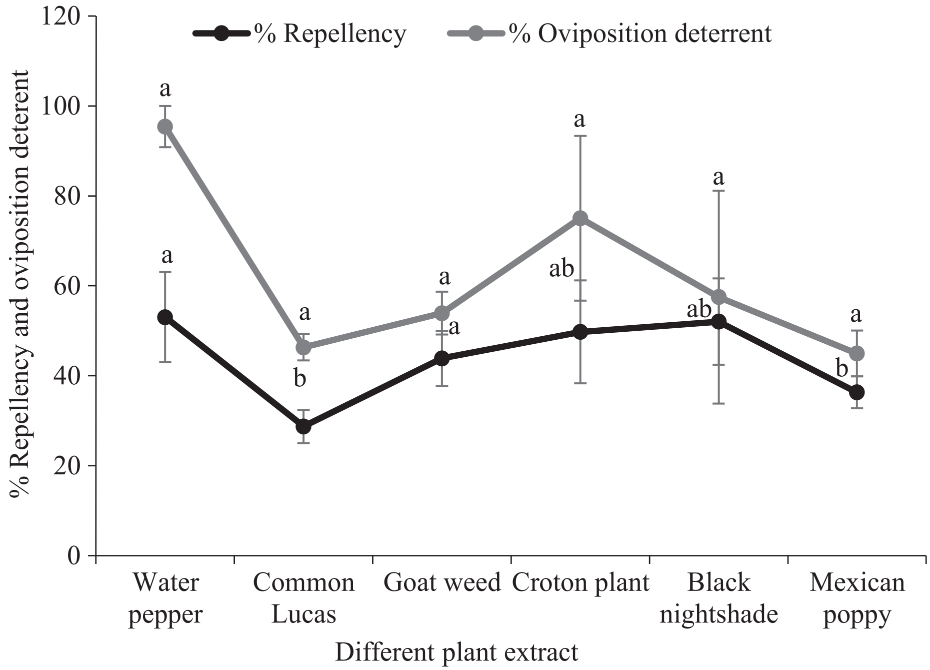

Fig. 1. Repellency and oviposition deterrent effect of six different weed extracts tested against *B. cucurbitae* on bitter gourd fruit

treatments applied at 5.0% concentration. The highest percent repellency was observed in water pepper (53.05%) followed by black nightshade (52.04%) and croton weed (49.76%) whereas the lowest was found in common lucas weed extract (28.73%) treated bitter gourd fruits. The water pepper weed extract also showed the highest oviposition deterrent (95.40%) followed by croton weed extract (75.03%) while the lowest was in mexican poppy (44.96%) followed by common lucas (46.31%) treated bitter gourd fruits.

Effect of weed extracts on percent inhibition of pupa recovery and adult emergence against *B. cucurbitae*: Fig. 2 represents the percent inhibition on pupa recovery and adult emergence against *B. cucurbitae* treated with six weed extracts on bitter gourd fruits. The percent inhibition of pupa recovery and adult emergence against *B. cucurbitae* were not significantly differed among the treatments applied at 5.0% concentration. The highest percent inhibition of pupa recovery was observed in water pepper (97.53%) followed by croton weed extract (84.17%) whereas the lowest was found in mexican poppy weed extract (63.86%) treated bitter gourd fruits. Water pepper weed extract was also showed the highest inhibition of adult emergence (98.72%) while the lowest was in mexican poppy (62.21%) followed by black nightshade (67.67%) treated bitter gourd fruits.

According to the findings, all the plant extracts examined showed insecticidal properties against *B. cucurbitae.* The highest repellency and oviposition deterrent

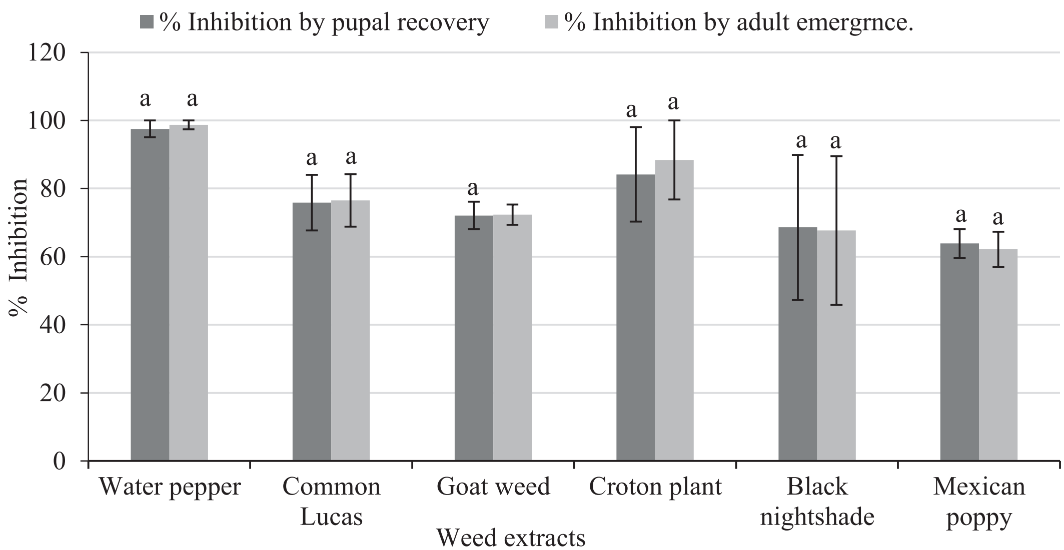

Fig. 2. Inhibition by pupal recovery and adult emergence effects of six different tested weed extracts against *B. cucurbitae* on bitter gourd.

effects and the lowest adult settled was recorded in water pepper and croton weed extract at 5% concentration. Many plant species have been identified to have insect repellant properties (Tripathi *et al*. 2000). Hussain (1995) found the highest toxicity of water pepper (*P. hydropiper*) leaf powder extract on the larvae of *T. castaneum* under laboratory condition. Kundu *et al.* (2007) tested the toxicity, repellency and residual effects of bishkatali (*P. hydropiper)* plant extracts in chloroform and ethyl alcohol solvents against the red flour beetle. The lowest numbers of F_1 adult progeny (32.7, 25.3 and 27.0) emerged from the wheat flour treated with 500 mg/10 g chloroform extract when parent released at 7, 12, 17 days after treatment, respectively. Maria *et al.* (2008) reported that the essential oils present in four species of a genus, *Croton* is responsible for their larvicidal activity against the mosquito, *A. aegypti*. The larvicidal property of the leaf extract of the study species, *C. bonplandianum* may be due to the presence of phorbol derivatives, the secondary metabolites of diterpenoids category (Chandel *et al.* 2005). Jeeshna *et al.* (2010) observed the highest toxicity concentration of croton plant (*C. bonplandianum*) leaf extract on the larvae of *A. aegypti* under laboratory condition. The study revealed that the leaf extracts of *C. bonplandianum* at 124 ppm is better for mosquito control.

Shanmugapriya *et al.* (2015) evaluated the larvicidal activity of plant powders of *Bauhinia variegata* and *C. sparsiflorus* against the fourth instar larvae of *A. aegypti*. This investigation demonstrate that *C. sparsiflorus* showed 100 percent mortality followed by *Bauhinia variegata* against the larvae of *A. aegypti.* Siddique *et al.* (2018) conducted an experiment to evaluate the efficacy of six indigenous plant extracts for their anti ovipositional and repellent effects against cucurbit fruit fly, *B. cucurbitae* (Coqullet). All the plant extracts had different effect of repellent and anti oviposition as well as effective for controlling *B. cucurbitae.* However, the highest percent repellency and anti oviposition were observed at 4.0% concentration.

Secondary screening

Effect of different doses of water pepper and croton weed extracts on the adult settled, progeny development, their repellency and oviposition deterrent against *B. cucurbitae*: Number of adult settled, larva recovered, percent repellency and oviposition deterrent of fruit fly treated with different doses of water pepper and croton weed extracts on bitter gourd fruit are shown in Table 3. The number of adult settled was found in water pepper and croton was 10.00 and 7.0, respectively at 0.5% concentration which was statistically similar. On the other hand, the significantly different ($P< 0.05$) adult settled was found in water pepper (9.00) and croton weed (5.00) at 1 % concentration. In 2% concentration, the number of adult settled ranged from 3.33 – 3.67 which was statistically similar but significant by different (P < 0.01) adult settled was recorded at 4.0 % concentration (Table 3).

The percent repellency was not significantly different between water pepper and croton weed extracts at different concentration respectively. The percent repellency of water pepper and croton weed extracts was recorded as 41.80%, 45.93%, 76.11%, 62.20% and 52.37%, 66.04%, 74.24%, 80.28% at 0.5%, 1.0%, 2.0% and 4.0% concentration, respectively. The number of larvae recovered in water pepper (3.33, 4.33, 1.33 and 1.00) and croton extract weed (3.33, 2.33, 2.33 and 0.67) was statistical identical at 0.5, 1.0, 2.0 and 4.0 % concentrations. The highest repellency was observed in croton weed extract (80.28%) at 4% concentration followed by water pepper (76.11%) extract at 2.0% concentration, but the lowest percent repellency (41.80%) was observed in water pepper extracts at 0.5% concentration (Table 3). The minimum number of larvae recovery was found in croton weed extracts (0.67) at 4.0% concentration and pupae recovery, and adult emergence were in croton weed (0.67) and water pepper (0.67) extracts at 4.0% concentration whereas the highest number of larvae (4.33) and pupae (3.67) recovery in water pepper

Table 3. Mean number of adult settled and larvae recovery, % repellency and % oviposition deterrent of fruit fly treated with different doses of water pepper and croton weed extracts on bitter gourd fruit.

Used	No. of adult settled				% Repellency				No. of larvae recovered				% Oviposition deterrent			
extracts	0.5%	1.0%	2%	4%	0.5%	1.0%	2%	4%	0.5%	1.0%	2%	4%	0.5%	1.0%	2%	4%
Water pepper	10.00a	9.00 a	3.33a	5.67a	41.80a	45.93a	76.11a	62.20b	3.33a	4.33a	1.33a	1.00a	63.06a	57.92a	86.67a	87.39a
Croton weed	7.00a	5.00 b	3.67a	2.67b	52.37a	66.04a	74.24a	80.28a	3.33a	2.33a	2.33a	0.67a	67.20a	73.79a	77.05a	92.59a
Level of sig.	NS	**	NS	*	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Mean values within the columns by the same letter(s) are not significantly different at 5% level by *t*-test. * = indicates 1% level of significance, **= indicates 5% level of significance, NS= Non Significant at 1% concentration. The highest number of adult emergence was observed in water pepper (3.33) at 1% concentration. The lowest oviposition deterrent was observed in water pepper (57.92%) extracts at 1.0% concentration. The highest oviposition deterrent was observed in croton weed (92.59%) extracts at 4.0% concentration. The minimum inhibition of pupal recovery and adult emerged were observed in water pepper (75.5% and 77.72%) at 1.0% concentration. But the highest inhibition (95.83%) of pupa recovery and adult emergence was noticed in croton weed extracts at 4% concentration which were statistically similar (Table 4).

Effect of different doses of water pepper and croton weed extracts on the adult settled, progeny development, repellency and oviposition deterrent against *B. cucurbitae*: The effects of different doses of water pepper and croton weed extracts on the adult settled and progeny development against *B. cucurbitae* was shown in Table 5. The number of adult settled, larvae and pupae recovered and adult emerged was significantly different ($P < 0.01$, $F = 312.56$, 189.28, 194.72 and 48.26, $df = 4$) among the doses applied. The highest adult settled (23.33) was recorded in untreated control and the lowest (3.50) was found at 2.00% concentration.

The highest number of larvae and pupae recovery (3.33 and 3.00, respectively) was recorded at 0.5% concentration, but the highest number of adult emergence (2.67)

Table 4. Mean number of pupae recovered, adult emerged, % inhibition of pupae recovery and adult emerged of fruit fly treated with different doses of water pepper and croton weed extracts on bitter gourd fruit.

Used extracts	No. of pupae recovered				% Inhibition of pupae recovery				No. of adult emerged				% Inhibition of adult emerged			
	0.5%	1.0%	2%	4%	0.5%	1.0%	2%	4%	0.5%	1.0%	2%	4%	0.5%	1.0%	2%	4%
Water pepper	3.33a	3.67a	1.33a	1.00a	77.31a	75.5a	91.67a	92.99a	3.00a	3.33a	1.00a	0.67a	79.21a	77.72a	93.75a	95.06a
Croton weed	2.67a	2.00a	2.00a	0.67a	79.97a	86.06a	87.02a	95.83a	2.00a	2.00a	2.00a	0.67a	85.1a	86.06a	87.02a	95.83a
Level of sig.	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Mean values within the columns by the same letter(s) are not significantly different at 5% level by *t*-test. NS= Non Significant

Table 5. Number of adult settled and progeny development on bitter gourd fruits treated with different doses of water weed extracts

Doses (%)	Adult settled (Mean ± SE)	Larvae recovered (Mean ± SE)	Pupae recovered (Mean ± SE)	Adult emerged (Mean ± SE)
4.0	4.17 d± 1.50	0.83b±0.17	0.83b±0.17	0.67 b±0.00
2.0	3.50 d± 0.17	1.83 b±0.50	1.67 b±0.33	1.50b±0.35
1.0	7.00 c±2.00	3.33 b±1.00	2.83 b±0.83	2.67 b±0.67
0.5	8.50 b±1.50	3.33 b±0.00	3.00 b±0.33	2.50 b±0.50
Control	23.33 a± 0.88	14.67 a ±0.88	14.67 a ± 0.88	14.33 a±0.88
LSD(0.05)	1.43	2.88	2.59	2.40
CV(%)	12.45	49.74	46.79	45.96
Level of sig.	0.001	0.001	0.001	0.001

Mean values within the columns by the same letter(s) are not significantly different at 5% level by DMRT.

were found at 1.0 % concentration. In 4.0 % concentration the minimum numbers of larvae and pupae recovery (0.83 and 0.83, respectively) was recorded and the adult emergence (0.67) was the lowest at the same concentration (4.0 %).

Fig. 3 represents the percent repellency and oviposition deterrent effects of different doses of water pepper and croton weed extracts against *B. cucurbitae*.

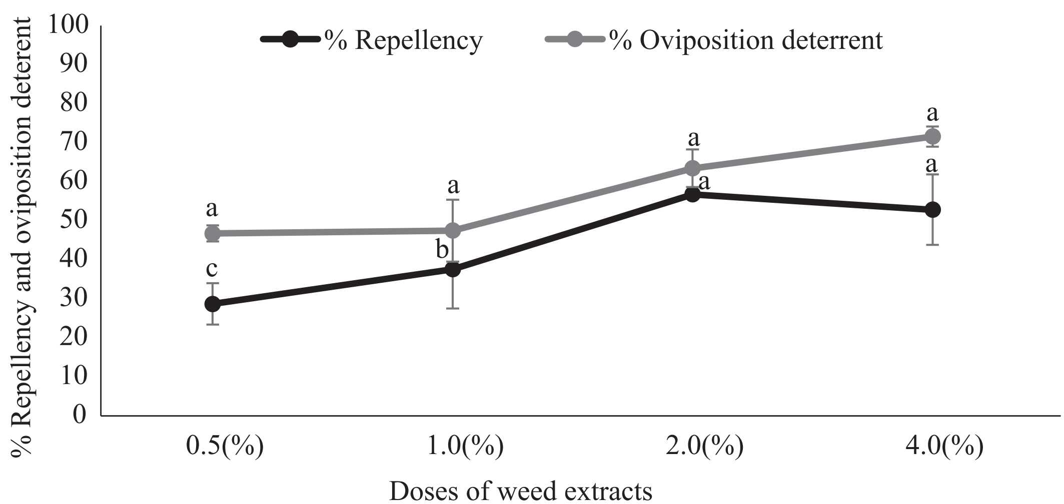

Fig. 3. Repellency and oviposition deterrent effects of different doses of plant extracts against *B. cucurbitae* on bitter gourd

The lowest repellency (47.08%) and oviposition deterrent (65.13%) were observed at 0.5% concentration whereas the highest repellency (75.17%) was observed at 2.0% concentration which statistically similar to 4.0% concentration but the highest oviposition deterrent (89.99%) were found at 4% concentration.

Effect of different doses of water pepper and croton weed extracts on the percent inhibition of pupae recovered and adult emerged against *B. cucurbitae*: Fig. 4 represents the inhibition of pupae recovered and adult emerged of different doses of water pepper and croton weed extracts against *B. cucurbitae*. The percent inhibition of pupae recovered and adult emerged was statistically identical. The lowest inhibition of pupae recovery (78.64%) was observed at 0.5% concentration but the lowest inhibition of adult emerged (81.89%) was observed at 1% concentration. On the other hand, the highest inhibition of pupae recovery (94.41%) and adult emergence (95.44%) was found at 4.0 % concentration.

The active constituents of any botanical insecticidal activities are determined by the chemical components of the plant material. Based on the information given below, lowest repellency and oviposition deterrent was observed in water pepper and croton weed at 4.0% concentration of the extracts. Rouf *et al.* (1996) studied the toxicity of leaf powder of water pepper (*P. hydropipper*), neem (*A. indica*) and nishinda (*V. negundo*) against *C. chinensis* on lentil seeds and showed that 4.0 g

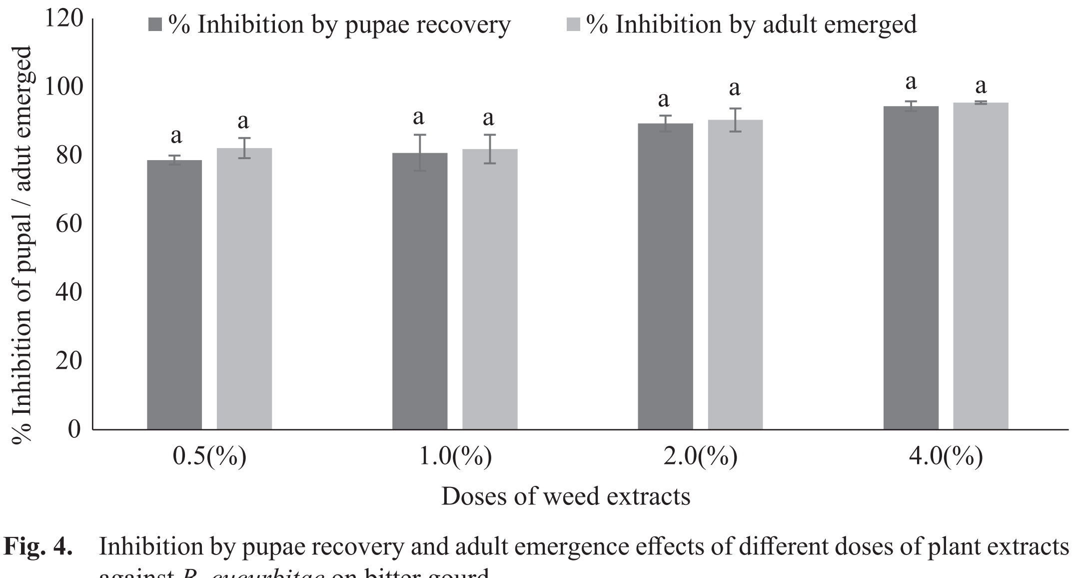

Fig. 4. Inhibition by pupae recovery and adult emergence effects of different doses of plant extracts against *B. cucurbitae* on bitter gourd

of *P. hydropiper* leaf powder per 50g of lentil seeds were the most effective in reducing oviposition and adult emergence. Hussain (1995) found that water pepper (*P. hydropiper*) leaf extract had the maximum toxicity on *T. castaneum* larvae under laboratory conditions. Siddique *et al.* (2018) conducted an experiment to evaluate the efficacy of six indigenous plant extracts for their anti oviposition and repellent effects against cucurbit fruit fly, *B. cucurbitae*. They stated that all the plant extracts had different effect of repellent and anti oviposition as well as effective for controlling *B. cucurbitae.* However, the highest percent repellency and anti oviposition were observed at 4.0% concentration.

Ramar *et al.* (2013) suggested that the leaf extract of *C. sparciflorus was* an effective larvicidal and pupicidal agent against *C. quinquefasciatus.* Shanmugapriya *et al*. (2015) demonstrated that *C. sparsiflorus* showed 100 percent mortality followed by *B. variegata* against the larvae of *A. aegypti*. The studied plant derivatives had a substantial effect on the repellant and oviposition deterrent properties of *B. cucurbitae* in the current research. Among the dose effects 5.0 and 4.0 % concentrations were the most promising against *B. cucurbitae*. Our findings indicated that all of the plant extracts had the potential to be efficient insecticides against *B. cucurbitae* and many of the extracts may contain toxic elements.

CONCLUSION

Results indicated not only had repellent and oviposition deterrent effects of the tested weed extracts against *B. cucurbitae* but also inhibited the progeny development. The repellency and oviposition deterrent actions of the plant extract increased when the dosages of the extract were increased. The present findings clearly showed that the chemical presence in the selected weed extracts might be used as part of a pest management program. This knowledge could aid in the development of economically feasible formulations to control *B. cucurbitae.*

ACKNOWLEDGEMENT

The authors express gratitude to the Institute of Research and Training (IRT), Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, Bangladesh, for their financial support during this investigation.

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(MS Received for Publication 06 October 2022)