Int.J.Curr.Microbiol.App.Sci (2017) *6*(8): 2067-2075

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 8 (2017) pp. 2067-2075**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.608.246

Bio Efficacy of Bael (*Aegle marmelos*) Correa (Rutaceae) Leaf Extracts against Pulse Beetle (*Callosobruchus chinensis* L.) in Stored Green Gram Seed (*Vigna radiata* L.)

C. Murasing*, P. Das, K. Sathish and L.K. Hazarika

Department of Entomology, College of Agriculture, Jorhat, Assam Agricultural University, Jorhat, 785013, Assam, India
**Corresponding author*

Keywords

Adult mortality, Aeglemarmelos, *Callosobruchus chinensis* and Solvent.

Article Info

Accepted:
19 June 2017
Available Online:
10 August 2017

A B S T R A C T

Experiments were carried out to determine the insecticidal activity of *Aegle marmelos* Correa against *Callosobruchus chinensis* L. in the laboratory. Plants were extracted with petroleum ether, methanol, ethanol and water by using Soxhlet apparatus and tested against adult of *C. chinensis*. Plant extracts were showed insecticidal activity by affecting through mortality, oviposition deterrence and inhibition of F_1 adult emergence. Among the solvent extracts petroleum ether was found to be significantly superior over rest of the solvent extracts, registered the highest percent of mortality (82%) at 5% conc. after 96 hour of treatment followed by methanol (80%), ethanol (76%) and water extract (74%) respectively. Highest oviposition deterrence was found in petroleum ether extract (59.74%), followed by methanol (57.32%), ethanol (56.07%) and water extract (55.28%) respectively at 5% conc. after 7days of seed treatment. In terms of inhibition rate, petroleum ether extract at 5% conc. was found to be most effective (75.91%), followed by methanol (74.50%), ethanol (73.87%) and water extract (70.28%) respectively from 1st day to 10th days of adult emergence. The leaf extract at different doses significantly reduced oviposition and adult emergence of *C. chinensis* in treated green gram seeds.

Introduction

In the being time in the most part of the world especially in the third world countries the food deficit and its quality is one of the biggest problems and related to that the protection of crops post-harvest is one of the most important difficulties. In India there are about 200 species of pest insects which cause damage to stored grains and grain products in storage (Maniruzzaman, 1981). Among these, the pulse beetles *Callosobruchus* spp. are the major pests in stored pulse (Ahad, 2003 and Bhalla *et al.,* 2008). Although synthetic insecticides have been successfully used to protect stored grains from insect infestations, their indiscriminate and massive use have created serious problems (Sighamony *et al.*, 1980), residues in food grains (Fishwick, 1988), environmental pollution (WMO, 1995), and development of resistant strains (Zettler,1982; Zettler and Cuperus, 1990; Yusof and Ho, 1992).

Recently, attention has been given to the possible use of plant products or plant derived compounds as promising alternatives to synthetic insecticides in controlling insect

pests of stored products (Rajapakse *et al.*, 1998; Rajapakse *et al.*, 2002; Rajapakse and Ratnasekera, 2009).

A. marmelos (C.) belongs to family Rutaceae, is commonly known as Bael in indigenous systems of medicine and has been regarded to possess various medicinal and insecticidal properties. *A. marmelos* (C.) is a slow-growing, medium sized tree, up to 12-15m tall with short trunk, thick, soft, flaking bark and spreading, sometimes spiny branches, the lower ones drooping. Leaf extract are acaricidal and insecticidal (Narasimhan and Mariappan, 1988; Hazarika *et al.*, 2000). *A. marmelos* contains several active compounds *viz*., alkaloids, terpenoids, coumarins, phenylpropanoids, tannins, polysaccharides and flavonoids. The pesticidal activities of the leaves of *A. marmelos* are aeglein, marmesin, d-limonene and ethyl-*p*-cumarate.The constituents of *Aegle* are used in heart diseases (Kakiuchi *et al.*, 1991), inflammatory and wound healing (Udupa *et al.*, 1994). Leaves of *A. marmelos* have been reported as hypoglycemic effect (Santhoshkumari and Devi, 1990; Sharma *et al.*, 1996). The essential oil from the leaves of *A. marmelos*is known to exhibited antifungal properties (Renu *et al.*, 1986; Rana *et al.*, 1997). Keeping this in view, the present investigation of insecticidal activity of *A. marmelos* were evaluated against *Callosobruchus chinensis* L. on oviposition, hatchability and mortality in stored green gram seed.

Materials and Methods

Rearing of the test insect

The experiments were conducted at the Physiology Laboratory, Department of Entomology, Assam Agricultural University (AAU), Jorhat. Rearing of *C. chinensis* was maintained on green gram seed. For maintaining the culture of adult *C. chinensis*, 1kg green gram seed were put in a 5 lit capacity plastic jar and released five pairs of adult male and female in 1:1 ratio. For proper growth and development of the insect during winter season, the plastic jar containing green gram seed and *C. chinensis* were kept on BOD incubator at temperature 29±2°C.

Extraction of bioactive compounds

The leaves of *A. marmelos* were collected in and around Jorhat district of Assam, India.The collected leaves were washed and dried in the shade at room temperature, grounded finely and hydro distilled in a Soxhlet apparatus as well as extracted separately with methanol, ethanol and petroleum ether as per method described by Bora *et al.*, (1999).The solvent were removed under reduced pressure using rotary vacuum evaporator (JSGW) and the residues were further dissolved in respective solvents on weight by volume (W/V) basis making it 100% stock solutionand stored in a sealed glass bottle at 4ºC refrigerator. Similarly the aqueous extract were prepared grinding leaves in distilled water with weight by volume basis after washing thoroughly with running water which served as 100% stock solution.

Direct toxicity test

The bioassays of *A. marmelos* on *C. chinensis* were performed by following the method of Talukdar and Howse (1993) with some modifications. The adult insect were picked up from the stock culture and transferred to 9 cm diameter petriplate. Then 0.1ml solutions of different concentrations (1%, 1.5%, 2%, 2.5%, 3.5 %, 4%, 4.5% and 5 % W/V) were applied topically to the dorsal surface of the thorax of each insect by using hand atomizer (100ml). Released the treated insect immediately in the plastic container containing 20g green gram seeds, insect mortality rates were recorded after 24hr, 48hr,

72hr and 96hr after treatment. Insect were examined daily and those that do not move or respond to gentle touch were considered dead. All the experiments were conducted Completely Randomized design with five replications containing five pairs in each replication and subjected to statistical analysis.

$$\text{Mortality \%} = \frac{\text{Total no. of mortality of Pulse beetle in treated plastic container}}{\text{Total no. of insect recorded in each plastic container}} \times 100$$

Total residual toxicity test

Plant extracts were mixed with 20g green gram seed @ 1%, 1.5%, 2%, 2.5%, 3 %, 3.5%, 4%, 4.5% and 5 % W/V. The treated seeds were air dried for 20 min and then put in to separate plastic pot (6cm×7cm). Fresh insect were released in each plastic pot containing 20g treated seed and closed it immediately after released of the insect. The whole experiments were replicated 5 times with 5 pairs of insects.

Oviposition deterrence activity

Five pairs of newly emerged beetles were released in pot containing (6cm×7cm) 20g green gram seed treated with different concentrations of each plant extracts allowed to remain in container for 7 days till they lay eggs. After one week of oviposition the number of eggs laid on treated seed (Et) and control seed (Ec) were counted and the percentage of oviposition deterrence (POD) were calculated using the following formula

$$\text{POD (\%)} = \frac{\text{Ec - Et x100}}{\text{Ec}}$$

Where, Et = No. of eggs laid on treated seed
Ec = No. of egg laid on Control seed

Adult emergence test

Pulse beetle starts to emerge after 30-40 days of egg laying. The emerging beetles were counted and removed every day from the container. The numbers of beetles were count daily from the date of first emergence to at least 10 days. The emergence rate were calculated and the inhibition rate (IR %) were calculated using the following formula

$$\text{IR\%} = \frac{\text{Cn - Tn x100}}{\text{Cn}}$$

Where, C_n= Number of insects in control plastic pots
T_n = Number of insects in treated plastic pots

Results and Discussion

The effect of leaf extracts of *A. marmelos* on the adult *C. chinensis* is presented in tables 1 and 2. It is evident from the table that all the treatments differs significantly (P=0.05) and were superior to control in regards of adult mortality. The effect of leaf extracts of *A. marmelos* on the adult mortality *C. chinensis* was evaluated and found to be 82% mortality when treated with petroleum ether extract at 5.00 per cent concentration in 96 HAT. Which was followed by methanol (80%), ethanol (76%) and water extract (74%). The present findings corroborate with the findings of Saxena and Saxena (2000), who reported that petroleum ether extract of neem kernel at 1.5 and 2 per cent level shows 50 and 61.11 per cent mortality of *Callosobruchus maculatus*, whereas methanol extract showed 38.88 and 55.55% mortality with respective concentrations.

The effects of different solvent extracts of *A. marmelos* on ovipositional response of *C. chinensis* are given in table 3. *A. marmelos*

has been found to be having anti-ovipositional properties against *C. chinensis.* The treatments differed significantly amongst themselves. The highest oviposition deterrence (59.74%) was found in the seed treated with petroleum ether extract of *A. marmelos*, followed by methanol, ethanol and water extract recorded 57.32%, 56.07% and 55.28%, respectively at 5.00 % concentrations after 7 days of seed treatment. The finding emphasizes that significant reduction of oviposition of *C. chinensis* decreased with increase in doses in treated green gram seed.

Table.1 Cumulative percentage mortality of adult *C. chinensis* treated with petroleum ether and methanol extracts of *Aegle marmelos* leaf

Conc.(%)	Petroleum ether (Mean ± SE)				Methanol (Mean ± SE)			
	24 HAT	48 HAT	72 HAT	96 HAT	24 HAT	48 HAT	72 HAT	96 HAT
1.00	6±2.45 (14.17)^{g}	14±3.99 (21.96)^{h}	20±5.47 (26.55)^{g}	24±3.99 (29.32)^{h}	6±2.45 (14.17)^{h}	12±3.74 (20.26)^{h}	18±3.74 (25.09)^{g}	22±3.74 (27.96)^{h}
1.50	14±2.45 (21.96)^{f}	24±2.45 (29.32)^{g}	28±2.00 (31.94)^{f}	34±2.45 (35.65)^{g}	12±3.74 (20.26)^{g}	22±5.82 (27.96)^{g}	26±2.45 (30.64)^{f}	32±2.00 (34.44)^{g}
2.00	20±3.16 (26.55)^{e}	36±6.77 (36.86)^{f}	40±4.46 (39.22)^{e}	48±5.82 (43.84)^{f}	16±2.45 (23.57)^{f}	32±3.74 (34.44)^{f}	32±3.74 (34.44)^{e}	48±3.74 (43.44)^{f}
2.50	22±2.00 (27.96)^{de}	40±4.46 (39.22)^{ef}	52±3.74 (46.13)^{d}	56±5.09 (48.43)^{e}	18±4.89 (25.09)^{ef}	36±7.47 (36.86)^{ef}	46±5.09 (42.69)^{de}	58±3.74 (49.58)^{e}
3.00	24±2.45 (29.32)^{cd}	42±5.82 (40.38)^{de}	56±3.99 (48.43)^{cd}	62±2.00 (51.92)^{cd}	22±2.00 (27.96)^{de}	40±3.16 (39.22)^{de}	52±3.74 (46.13)^{d}	60±4.46 (50.75)^{de}
3.50	28±3.74 (31.94)^{bc}	48±7.34 (43.84)^{cd}	60±5.47 (50.75)^{c}	66±5.09 (54.31)^{c}	24±2.45 (29.32)^{cd}	44±5.09 (41.54)^{d}	58±5.82 (49.58)^{c}	64±8.11 (53.11)^{cd}
4.00	30±4.46 (33.20)^{bc}	56±3.99 (48.43)^{bc}	66±3.99 (54.31)^{b}	72±3.74 (58.03)^{b}	26±3.99 (30.64)^{bc}	50±6.31 (44.98)^{c}	64±5.09 (53.11)^{bc}	70±4.46 (56.77)^{b}
4.50	32±3.74 (34.44)^{ab}	58±3.74 (49.58)^{ab}	68±5.82 (55.31)^{b}	76±3.99 (60.64)^{b}	30±3.16 (33.20)^{ab}	56±5.99 (48.43)^{b}	68±4.89 (55.53)^{b}	76±5.09 (60.64)^{a}
5.00	34±2.45 (35.65)^{a}	64±3.99 (53.11)^{a}	76±5.09 (60.64)^{a}	82±3.74 (64.87)^{a}	32±3.74 (34.44)^{a}	62±3.74 (51.92)^{a}	74±3.99 (59.32)^{a}	80±5.47 (63.41)^{a}
Control	0±0.00 (1.28)^{h}	2±2.00 (8.13)^{i}	4±2.45 (11.53)^{h}	4±2.45 (11.53)^{i}	0±0.00 (1.28)^{i}	2±2.00 (8.13)^{i}	4±2.45 (11.53)^{h}	6±2.45 (14.17)^{i}
S. Ed (±)	1.06	1.51	1.56	1.30	1.43	1.74	1.32	1.45
CD (P=0.05)	1.73	2.47	2.56	2.14	2.34	2.86	2.16	2.37

*Data presented are the mean of 5 replications each having 10 nos. of insects.
* Zero and 100% mortality was corrected by using Steel and Torrie formula.
* Data within the parentheses are angular transformed value, compared by DMRT, (P<0.05)
* Means followed by same letter are not significantly different
* HAT= Hours after treatment

Table.2 Cumulative percentage mortality of adult *C. chinensis* treated with ethanol and water extracts of *Aegle marmelos* leaf

Conc.(%)	Ethanol (Mean ± SE)				Water (Mean ± SE)			
	24 HAT	**48 HAT**	**72 HAT**	**96 HAT**	**24 HAT**	**48 HAT**	**72 HAT**	**96 HAT**
1.00	6±3.99 (14.17)^{e}	14±5.09 (21.96)^{g}	20±3.16 (26.55)^{h}	22±3.74 (27.96)^{g}	4±2.45 (11.53)^{g}	14±3.99 (21.96)^{h}	18±2.00 (25.09)^{h}	20±3.16 (26.55)^{g}
1.50	8±3.74 (16.42)^{d}	18±5.82 (25.09)^{f}	24±3.99 (29.32)^{g}	30±3.16 (33.20)^{f}	12±3.74 (20.26)^{f}	20±4.46 (26.55)^{g}	28±5.82 (31.94)^{g}	30±3.16 (33.20)^{f}
2.00	12±3.74 (20.26)^{c}	20±5.47 (26.55)^{f}	30±3.16 (33.20)^{f}	34±6.77 (35.65)^{f}	16±5.09 (23.57)^{e}	28±7.34 (31.94)^{f}	34±5.99 (35.65)^{fg}	38±3.74 (38.04)^{e}
2.50	16±3.99 (23.57)^{bc}	26±2.45 (30.64)^{e}	38±4.89 (38.04)^{e}	40±4.46 (39.22)^{e}	20±3.16 (26.55)^{d}	32±3.74 (34.44)^{e}	42±6.62 (40.38)^{e}	46±5.99 (42.69)^{d}
3.00	18±6.62 (25.09)^{b}	30±8.35 (33.20)^{de}	42±4.89 (40.38)^{d}	46±3.99 (42.69)^{e}	22±3.74 (27.96)^{cd}	36±5.99 (36.86)^{de}	46±6.77 (42.69)^{de}	50±5.47 (44.98)^{d}
3.50	24±5.09 (29.32)^{ab}	34±2.45 (35.65)^{cd}	46±2.45 (42.69)^{c}	50±3.16 (44.98)^{d}	24±5.09 (29.32)^{bc}	38±5.82 (38.04)^{cd}	48±3.74 (43.84)^{cd}	54±5.09 (47.28)^{c}
4.00	26±2.45 (30.64)^{a}	36±2.45 (36.86)^{c}	48±5.82 (43.84)^{c}	54±5.99 (47.28)^{c}	26±2.45 (30.64)^{ab}	40±3.16 (39.22)^{bc}	50±4.46 (44.98)^{c}	58±3.74 (49.58)^{c}
4.50	28±3.74 (31.94)^{a}	44±2.45 (41.54)^{b}	54±2.45 (47.28)^{b}	64±3.99 (53.11)^{b}	30±5.47 (33.20)$_{a}$	46±3.99 (42.69)^{b}	60±3.16 (50.75)^{b}	68±3.74 (55.53)^{b}
5.00	30±3.16 (33.20)^{a}	50±5.47 (44.98)^{a}	62±7.34 (51.92)^{a}	76±3.99 (60.64)^{a}	32±3.74 (34.44)^{a}	50±3.16 (44.98)^{a}	66±3.99 (54.31)^{a}	74±5.09 (59.32)^{a}
Control	0±0.00 (1.28)^{f}	2±2.00 (8.13)^{h}	2±2.00 (8.13)^{i}	4±2.45 (11.53)^{h}	0±0.00 (1.28)^{h}	0±0.00 (1.28)^{i}	2±2.00 (8.13)^{f}	4±2.45 (11.53)^{h}
S. Ed (±)	1.79	1.70	1.29	1.33	1.58	1.44	1.41	1.33
CD (P=0.05)	2.93	2.79	2.11	2.19	2.60	2.35	2.31	2.19

*Data presented are the mean of 5 replications each having 10 nos. of insects.
* Zero and 100% mortality was corrected by using Steel and Torrie formula.
* Data within the parentheses are angular transformed value, compared by DMRT, (P<0.05)
* Means followed by same letter are not significantly different
* HAT= Hours after treatment

Table.3 Ovipositional response of *C. chinensis* female to different extracts of *Aegle marmelos* on treated green gram seed

Conc. (%)	Petroleum ether		Methanol		Ethanol		Water	
	No of eggs/20g seeds (Mean ± SE)	Oviposition deterrence %	No of eggs/20g seeds (Mean ± SE)	Ovi position deterrence %	No of eggs/20g seeds (Mean ± SE)	Ovi position deterrence %	No of eggs/20g seeds (Mean ± SE)	Ovi position deterrence %
1.00	91.80±5.67^{b}	23.78	95.80±4.36^{b}	19.54	102.00±4.50^{b}	15.14	95.20±3.26^{b}	17.14
1.50	87.40±3.32^{c}	26.95	89.00±4.96^{c}	25.33	98.80±5.73^{c}	16.86	91.60±2.37^{c}	20.53
2.00	80.60±3.21^{d}	32.50	78.80±4.57^{d}	33.76	92.60±3.82^{d}	22.53	86.60±4.12^{d}	24.93
2.50	78.20±3.53^{d}	34.55	75.80±5.55^{de}	36.07	88.00±3.50^{e}	26.75	81.20±4.99^{e}	29.79
3.00	72.00±2.81^{e}	39.87	73.00±6.99^{e}	38.60	86.80±2.08^{e}	27.64	79.60±4.43^{e}	30.61
3.50	65.60±4.27^{f}	44.91	66.60±4.43^{e}	43.53	79.60±4.54^{f}	32.97	75.80±5.25^{f}	34.39
4.00	58.40±3.38^{g}	51.02	59.80±4.28^{f}	50.01	70.60±2.71^{g}	41.14	63.60±3.18^{g}	44.57
4.50	52.80±4.30^{h}	55.75	53.60±4.24^{g}	54.82	57.40±3.42^{h}	51.87	59.00±3.41^{h}	48.96
5.00	47.80±4.79^{i}	59.74	51.00±3.47^{g}	57.32	52.40±3.47^{i}	56.07	52.20±4.86^{i}	55.28
Control	120.20±3.16^{a}	0.00	119.60±4.22^{a}	0.00	120.40±5.23^{a}	0.00	116.00±4.50^{a}	0.00
S. Ed (±)	1.76	1.80	2.15	3.31	1.81	1.80	1.85	1.89
CD (P=0.05)	2.89	2.95	3.52	4.88	2.97	2.96	3.04	3.10

*Data presented are the mean of 5 replications each having 10 nos. of insects.
* 20 g seed content approx. 560-565 seeds
* The mean values were compared by DMRT, (P<0.05)
* Means followed by same letter are not significantly different

Table.4 Effect of *Aegle marmelos* leaf extracts on hatching success (%) of *C. chinensis* eggs on treated green gram seed

Conc. (%)	Petroleum ether		Methanol		Ethanol		Water	
	No of insect emergence (% hatching) (Mean ± SE)	Hatching inhibition rate over control	No of insect emergence (% hatching) (Mean ± SE)	Hatching inhibition rate over control	No of insect emergence (% hatching) (Mean ± SE)	Hatching inhibition rate over control	No of insect emergence (% hatching) (Mean ± SE)	Hatching inhibition rate over control
1.00	38.60±0.40 (38.39)^{b}	23.75	39.80±0.91 (39.10)^{b}	22.43	39.80±0.80 (39.10)^{b}	21.31	40.00±1.05 (39.22)^{b}	20.71
1.50	35.00±1.51 (36.26)^{c}	30.96	37.20±1.07 (37.57)^{c}	27.25	35.60±1.69 (36.62)^{c}	29.71	36.20±1.24 (36.97)^{c}	28.08
2.00	31.60±1.91 (34.19)^{d}	36.81	32.40±1.69 (34.68)^{d}	36.87	33.00±1.41 (35.05)^{cd}	34.90	33.20±1.24 (35.17)^{c}	34.09
2.50	30.20±2.81 (33.32)^{de}	39.97	30.60±2.97 (33.57)^{de}	39.39	31.00±1.64 (33.82)^{d}	38.89	31.00±1.64 (33.82)^{d}	38.56
3.00	28.40±2.06 (32.19)^{de}	43.24	29.00±2.05 (32.57)^{de}	43.71	29.40±2.04 (32.82)^{de}	42.03	29.40±2.04 (32.82)^{de}	41.34
3.50	25.40±2.73 (30.25)^{e}	49.79	25.40±2.73 (30.25)^{e}	50.51	26.60±2.33 (31.04)^{e}	47.54	26.60±2.33 (31.04)^{e}	46.34
4.00	17.60±1.36 (24.79)^{f}	65.62	19.40±0.51 (26.12)^{f}	62.21	19.00±1.64 (25.83)^{f}	62.73	23.00±1.79 (28.65)^{f}	54.50
4.50	14.40±0.51 (22.29)^{g}	71.50	16.80±0.86 (24.19)^{g}	66.89	15.80±1.02 (23.41)^{g}	68.74	18.20±0.97 (25.24)^{g}	63.69
5.00	12.00±0.89 (20.26)^{h}	75.91	13.00±0.71 (21.13)^{h}	74.50	13.20±0.58 (21.30)^{h}	73.87	15.00±1.00 (22.78)^{h}	70.28
Control	51.60±3.64 (45.90)^{a}	0.00	51.60±2.35 (45.90)^{a}	0.00	50.80±1.32 (45.44)^{a}	0.00	50.80±2.51 (45.44)^{a}	0.00
S. Ed (±)	0.57	2.44	0.51	1.77	0.45	1.42	0.48	1.78
CD (P=0.05)	0.94	3.99	0.83	2.91	0.74	2.32	0.78	2.92

*Data presented are the mean of 5 replications each having 10 nos. of insects.
* Data within the parentheses are angular transformed value, compared by DMRT, (P<0.05)
* Means followed by same letter are not significantly different

The present investigation was also supported by Deka *et al.,* (1997), who reported that petroleum ether and methanol extract of *Melia azedarach* and *Pongamiaa pinnta* showed significant inhibition of fecundity of tea mosquito bug, *Helipeltis theivora* under laboratory condition. Kumar *et al.,* (2008) also reported that the oil of *A. marmelos* also reduced oviposition of *C. chinensis* in treated cowpea seeds. They observed that significant reduction of oviposition of *C. chinensis* decreased with increase in doses and this supports the result of present investigation.

The effect of different solvent extracts of *A. marmelos* on hatching success of *C. chinensis* eggs are given in table 4. It shows that the ovicidal effect of the different solvent extracts

of *A. marmelos*, where all the treatments were significantly different amongst themselves.

The effect of different solvent extracts of *A. marmelos* were tested on hatching success of *C. chinensis* eggs and found to be most effective when treated with petroleum ether extract of *A. marmelos* at 5.00% concentration. Petroleum ether extract inhibits the adult emergence up to 75.91%, followed by methanol (74.50%), ethanol (73.87%) and water extract (70.28%) respectively from 1 day to 10 day of adult emergence. It was supported by the findings of Kumar *et al.,* (2008), who reported that the oil of *A. marmelos* reduced adult emergence of *C. chinensis* in treated cowpea seeds. They observed that significant reduction of adult emergence of *C. chinensis* decreased with increase in doses. The present investigation also supported by the findings of Bora *et al.,* (1999) and Hazarika *et al.,* (2000), who reported that extracts of *P. pinnata* and *P. hydropiper* were not at all effective as ovicides, *A. marmelos*, *P. thyrsiflorus* and *C. inerme*posssed strong ovicidal properties.

In conclusion, the findings emphasize the efficacy of *A. marmelos* leaf extract as insecticide against insect infestations of stored grains. The effects may be due to the presence of several active compounds present in bael leaves *viz*., alkaloids, terpenoids, coumarins, phenylpropanoids, tannins, polysachharides and flavonoids. The pesticidal activities of the leaves of *A. marmelos* are aegelin, marmesin, d-limonene and ethyl-*p*-cumarate. The findings strengthen the possibility of using it as an alternative to synthetic chemicals for preserving stored grains.

References

Abbot, W.S. 1925. A method of computing the effectiveness of an insecticide. *J. Economic Entomol.,* 18(1): 266-267.

Ahad, M.A. 2003. Pest management in graminicious crops (in Bangla. Bangla Academy, Dhaka, Bangladesh.

Bhalla, S.K., Gupta, B. Lal, Kapur, M.L. and Khetarpal, R.K. 2008. Efficacy of various non-chemical methods against pulse beetle, *Callosobruchus maculatus* Fab. Int. Conf. Diver. cropprote., La Grande-Motte, France- Oral presentations.

Bora, H.R., Hazarika, L.K. and Dutta, N. 1999. Botanicals for forest and tea pest management. In *Green Pesticides Crop Production and Safety Evaluation*, (eds.) Agnihotri, N.P.; Waliga, S. and Sajbhiye, V.T. Society of Pesticides Science, India.

Deka, N.K., Singh, K. and Handique, R. 1997. Indegenous plant solvent extracts: Fecundity and viability of eggs of tea mosquito bug. *Pestol.*, XXI(10): 5-8.

Duncan, D.B. 1951. A significance test for differences between ranked treatments in an analysis of variance. *Virginia J. Sci.,* 2: 171-189.

Fishwick, F.B. 1988. Pesticide residues in grain arising from postharvest treatments. *Appl. Biol.*, 17: 37-46.

Hazarika, L.K., Puzari, K.C., Saikia, S. and Das, P. 2000. Biological control of pests and diseases of tea in NE India. *Annual Report*, DBT Project on Biocontrol, Assam Agricultural University, Jorhat.

Kakiuchi, N., Senaratne, L.R.E., Huang, S.L., Yang, X.W., Hattori, M., Pilapitiya, U. and Namba, T. 1991. Effects of constituents of Beli (*Aegle marmelos*) on spontaneous beating and calcium-paradox of myocardial cells. *Plant Med*., 57: 43-46.

Kumar, R., Kumar, A., Prasal, C. S., Dubey, N.K. and Samant, R. 2008. Insecticidal activity *Aegle marmelos* (L.) Correa Essential Oil Against Four Stored Grain Insect Pests. *Int. J. Food Safety*, 10: 39-49.

Maniruzzaman, F.M. 1981. Plant protection in Bangladesh. National Book house Centre, 67/A, Purana Paltan, Dhaka, pp: 270-276.

Rajapakse, R.H.S., Senanayake, S.G.J.N. and Ratnasekera, D. 1998. Effects of five botanicals on oviposition, Adult emergence and mortality of *Callosobruchus maculatus* Fabr.

Bruchidae) infesting cowpea. *J. Entomol. Res.*, 22(2): 1-6.

Rana, B.K., Singh, U.P. and Taneja, V. 1997. Antifungal activity and kinetics of inhibition by essential oil isolated from leaves of *Aegle marmelos*. *J. Ethnopharmacol.*, 57: 29-34.

Rajapakse, R.H.S., Rajapakse, H.L. de Z. and Ratnasekera, D. 2002. Effect of botanicals on oviposition, hatchability and mortality of *Callosobruchus maculates* L. *Entomon.*, 27(1): 93-98.

Rajapakse, R.H.S. and Ratnasekera, D. 2009. Pesticidal potential of some selected tropical plant extracts against *Callosobruchus maculates* (F) and *Callosobruches chinensis* (L) Coleptera: Bruchidae. Tropical Agricultural Research and Extension, Sri Lanka,11.

Renu, H.V.M., Dubey, N.K. and Dixit, S.N. 1986. Mycotoxic properties of the essential oil of *Aegle marmelos. Beit. Biol. Pflanz*., 60: 325-332.

Santhoshkumari, K.S. and Devi, K.S. 1990. Hypoglycemic effect of new medicinal plants. *Ancient Sci. Life*, IX(4): 221-223.

Saxena, B. and Saxena, B. 2000. Bioactivity of certain plant extracts against *Callosobruchus maculates* (Fabr). *J. Appl. Zool. Res.*, 11(1): 29-32.

Sharma, S.R., Dwivedi, S.K., Varshney, V.P. and Swarup, D. 1996. Antihypoglycemic and Insulin release effects of *Aegle marmelos* leaves in streptozotocin diabetic rats. *Phytother. Res*., 10: 426-428.

Steel, R.G.D. and Torrie, J.H. 1960. Principles and Procedures of Statistics. McGraw Hill Publ. Co. Inc., New York, pp.481.

Sighamony, S., Anees, I., Chandrakala, T. and Osmani, Z. 1980. Efficacy of certain indigenous plant products as grain protectants against *Sitophilusoryzae* L.) and *Rhizoperthadominica* (F). *J. Stored Product Res.*, 22: 21-23.

Talukdar, F.A. and Howse, P.E. 1994. Repellent toxic and food protectant effects of pithraj, *Aphanamixis polystachya* (Meliaceae) against pulse beetle, *Callosobruchus chinensis* (L.) in storage. *J. Chem. Ecol.*, 20(4): 899-908.

Udupa, S.L., Udupa, A.L. and Kulkarni, D.R. 1994. Studies on the anti-inflammatory and wound healing properties of *Moringa oleifera* and *Aegle marmelos. Fitoterapia*, 65: 119-123.

WMO. 1995. Scientific assessment of ozone depletion: World Meteorological Organization global ozone research and monitoring project. Report No. 37, WMO, Geneva, Switzerland.

Yusof, O. and Ho, S.H. 1992. A survey of insecticide resistance in *Sitophiluszeamais* Motsch. in Malaysia and Singapore. *J. Plant Protection of Tropics*, 9: 219-225.

Zettler, J.L. 1982. Insecticide resistance in selected stored product insects infesting peanuts in the southern United States. *J. Economic Entomol*., 75: 359-362.

Zettler, J.L. and Cuperus, G.W. 1990. Pesticide resistance in *Tribolium castaneum* (Tenebrionidae) and *Rhizopertha dominica* (Bostrichidae) in wheat. *J. Economic Entomol*., 83: 1677-1681.

How to cite this article:

Murasing, C., P. Das, K. Sathish and Hazarika, L.K. 2017. Bio Efficacy of Bael (*Aegle marmelos*) Correa (Rutaceae) Leaf Extracts against Pulse Beetle (*Callosobruchus chinensis* L.) in Stored Green Gram Seed (*Vigna radiata* L.). *Int.J.Curr.Microbiol.App.Sci.* 6(8): 2067-2075.
doi: https://doi.org/10.20546/ijcmas.2017.608.246