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EFFICACY OF EUCALYPTUS PLANT EXTRACTS AGAINST LESSER GRAIN BORER

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ABSTRACT

The efficacy of insecticidal activities of eucalyptus plant extracts was evaluated against lesser grain borer. Four doses viz. 0.5, 1.0, 1.5 and 2.0% along with control were applied. All tested extracts showed significant efficiency against lesser grain borer with respect to adult mortality, residual and repellency test but stem extracts was the most effective. Adult's mortality was increased proportionally with the increased time intervals and the toxicity was dose dependent. The stem extracts showed the highest toxic effect (mortality 40.3%) whereas leaf extract showed the lowest toxic effect (mortality, 17.4%). In case of residual study, the highest number of adult emergence was recorded in control (100.0) whereas the lowest (45.5) was in stem extracts. Similarly, the highest infestation inhibition (69.9%) was found in stem extract. Among three plant parts of eucalyotus, stem extract showed the highest repellent effect (74.6%), whereas leaf extract showed the lowest effect (59.3%). On the basis of LD_{50} values, the stem extract also showed the highest toxic effects. The results suggested the ability of plant extracts for store grains protection as a safe alternative to insecticides.

Keywords: Lesser grain borer, repellent, mortality, plant extract

Introduction

The lesser grain borer, *Rhyzopertha dominica* F. (Coleoptera: Bostrychidae) is a common and most destructive pest in stored grains. Both the adults and grubs are serious pest of rice, wheat, maize, sorghum, barley, lentil, biscuits, dried potatoes, corn flower, beans, pumpkin seeds, millets, etc (Edde 2012). It is a field-to-store pest and cause economic damages the grain, causing weight losses up to 40% (Adedire 2001).

Several insecticides reported for treating godown, store house and containers for managing stored product pests such as organophosphates, pyrethroids (Hashem *et al*. 2012). Moreover, applications of insecticides to control these pests have serious drawbacks including direct toxicity to beneficial insects, fishes and human, pesticides induced resisance, health hazards and increased environmental and social costs (Ileke and Bulus 2012). Recently Arifuzzaman *et al.* (2014) reported the use of neem, biskatali, karabi, akanda and ata leaves as botanical insecticides against lesser grain borer.

An increasing public awareness of 'green issues', plant volatile oils, including those from eucalyptus, offer an eco-friendly alternative to conventional formulations in a number of sectors where antimicrobial action is desirable. There is a need to develop alternative safe and economical non chemical methods for controlling insect pests of stored products. The administration of aqueous extract of eucalyptus induced undesired behavior of mice and also decrease blood glucose level (Aglal *et al.* 2010). Leaves, stem-bark and roots were rich in steroid but absent in fruit in aqueous extract while in ethanol extract all the sections of the plant contain steroids (Oparaeke *et al.* 2005). Surprisingly a few research journal articles have supported the eucalyptus plant extracts as a stored grain protectant (Mulungu *et al.* 2007). Therefore, the study was an attempt to assess the comperative toxicity effect of leaf, bark and stem extracts of the eucalyptus against lesser grain borer with regards of insect bioassay, residual toxicity and repellent effect.

Materials and Methods

The study was conducted in the laboratory of the department of entomology, Hajee Mohammad Danesh Sciencce and Technology University (HSTU), Dinajpur during March to October 2017.

Collection and preparation of plant extracts: The fresh leaves and bark were collected from Hajee Mohammad DaneshSciencce and Technology University (HSTU) campus, Dinajpur, stem dusts were collected from different sawmills of Dinajpur. After collection, leaves and bark were kept in the laboratory for air drying followed by one-day sun drying before making powder. Powder was made by an electric grinder (Nova Blackberry Blender, AD999, Bangladesh). The extracts were prepared according to the procedure of Talukder and Howse (1993).

Collection and rearing of test insects: The Lesser grain borer adults were collected from the naturally infested wheat grains from the local market of Dinajpur and were mass reared in the laboratory at ambient laboratory temperature (28±3°C) in separate glass jars. Mass culture of lesser grain borer was done according to Arifuzzaman *et al*. (2014). Only 3 to 5 days old insects were used for the insect bioassay study.

Insect bioassays: Four concentrations (0.5%, 1.0%, 1.5% and 2.0%) along with control of each category of leaf, bark, and stem extracts were prepared in the methanol solvent prior to insect bioassay.

Direct toxicity tests (Film residue method): Toxicity tests were conducted according to the Film residue method describe by Busvine (1971). Accordingly, 1 ml solution of each leaf, bark, and stem extracts was applied to the petridish (60 mm dia.) and were kept in air for drying for a few minutes. After fully evaporated the solvent, 3-days old 10 adults were released and kept at ambient temperature (28±3°C) in the laboratory. Three replications were made for each treatment and each concentration including control. Equal number of insect with methanol solvent only was treated as control. Insect mortality was recorded at every 24 hours after treatment (HAT) upto 192 HAT. The percentage of mortality was corrected using by Abbott's (1987) formula before analysis.

$$P = \frac{\acute{P} - C}{100 - C} \times 100$$

Where,
P = Percentage of corrected mortality, P' = Observed mortality (%), C = Mortality (%) at control.

Residual test: Residual toxicity test was done according to Talukder and Howse (1993). Briefly, 1 ml of four different concentrations of each leaf, bark, and stem extracts were mixed with 25 gm wheat grain separately and five pairs of 3 days old adult were released into the pot. The pot was covered with perforated lid. Same number of adult insects was used in control treatments with only methanol solvent mixed with 25 gm wheat grain. Three replications were maintained for each of the concentration of leaf, bark and stem extracts along with control. All treated pots were kept at ambient temperature (28±3°C) in the laboratory for after adults emerged. The number of adult was counted after every 7 days interval upto 49 days. Percent inhibition rate (% IR) was calculated by the following formula Talukder and Howse (1993):

$$\% \text{ IR} = \text{Cn-Tn/Cn x } 100$$

Where,
% IR=Percentage of inhibition rate, Cn= Number of insect on control treatment, Tn= Number of insect on treated treatment.

Repellency test: The repellent activities of the test plant extracts were evaluated using the filter paper impregnation method described by Talukder and Howse (1994). Five pairs of 3 days old insects were released at the centre of each Petridish (90 mm diameter) and a cover was placed on the Petridish. Three replications were used for each extracts and concentration. The number of insects on each portion was counted at hourly intervals upto the 5th hour. The data was expressed as % of repulsion (%PR) using the following formula:

$$\%\text{PR} = (\text{Nc-}50) \times 2$$

Where,
% PR= Percentage repulsion, Nc= Percent of insects present in the control half.

Positive values expressed repellency and negative values attractant. The average values were categorized according to the scale described by McDonald *et al.* (1970). The scales are as follows,class 0: repellency 0 > 0.01 to 0.10%, class I: repellency 0.10 to 20.00%, class II: repellency 20.10 to 40.00%, class III: repellency 40.10 to 60.00%, class IV: repellency 60.10 to 80.00% and class V: repellency 80.10 to 100.00%.

Statistical analysis: The data were statistically analyzed by completely randomized design (CRD) with the help of MSTAT-C statistical program. The mean values were adjusted by Duncan's New Multiple Range Test (DMRT). The insect mortality data was also subjected to probit analysis program.

Results and Discussion

Mortality effect: The adult mortality at 24, 48, 72, 96, 120, 144, 168 and 192 hours after treatment (HAT) indicated that stem extract possessed the highest mortality (67.3%) toxic effect but leaf extract possessed the lowest mortality (32.0%) toxic effect and no adult mortality was observed in control treatment up to 192 HAT (Table 1).Insect mortality was increased proportionally with the increased time intervals. The order of toxicity of different parts of the eucalyptus plant extracts were stem> bark> leaf. Mortality of lesser grain borer was also differed significantly among all the concentrations level at different time interval (Table 1) and mortality was directly proportional to the level of concentration of the extracts. The interaction effects of plant, dose and time is also presented in Table 1. Adult mortality was observed 100% at 192 HAT in stem extracts where the highest average mortality (60.8%) of lesser grain borer was also found from the extracts of stem at 2.0% concentration. No adult mortality was found at control treatments.

Table 1. Toxicity effect of eucalyptus plant extracts against lesser grain borer at different hours after treatment (HAT)

Extracts used		Insect mortality (%) at different HAT								Aver. mort. (%)
		24	48	72	96	120	144	168	192	
Leaf		4.7 b	7.3 b	10.0 c	14.7 c	20.7 c	23.3 c	26.7 c	32.0 c	17.4 c
Bark		5.3 b	10.7 b	18.7 b	21.3 b	27.3 b	33.3 b	40.7 b	50.7 b	26.0 b
Stem		11.3 a	20.7 a	28.0 a	35.3 a	45.3 a	52.7 a	61.3 a	67.3 a	40.3 a
Control		0.0 c	0.0 c	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d	0.0 d
LSD		3.2	3.9	3.7	3.7	3.9	3.6	4.2	3.9	3.1
Doses (%)										
0.5%		4.2 b	7.5 c	12.5 b	15.8 c	21.7 c	25.8 d	31.7 c	37.5 d	19.6 d
1.0%		5.8 ab	10.0 bc	15.0 b	19.2 c	27.5 b	32.5 c	37.5 b	44.2 c	23.9 c
1.5%		7.5 ab	14.2 ab	20.0 a	25.0 b	31.7 ab	36.7 b	44.2 a	49.2 b	28.6 b
2.0%		9.2 a	16.7 a	23.3 a	29.2 a	35.8 a	41.7 a	47.5 a	56.7 a	32.5 a
Control		0.0 c	0.0 d	0.0 c	0.0 d	0.0 d	0.0 e	0.0 d	0.0 e	0.0 e
LSD		3.5	4.3	4.1	4.1	4.3	3.9	4.6	4.3	3.4
Extracts	Doses (%)									
Leaf	0.5	3.3 cd	6.7 fg	10.0 f	13.3 e	20.0 f	23.3 e	26.7 f	30.0 i	16.7 f
	1.0	6.7 cd	6.7 fg	10.0 f	16.7 de	23.3 f	26.7 e	30.0 ef	36.7 hi	19.6 f
	1.5	6.7 cd	10.0 ef	13.3 ef	20.0 de	26.7 ef	30.0 de	36.7 ef	43.3 gh	23.3 ef
	2.0	6.7 cd	13.3 def	16.7 def	23.3 cd	33.3 de	36.7 d	40.0 de	50.0 g	27.5 e
	Control	0.0 d	0.0 g	0.0 g	0.0 f	0.0 g	0.0 f	0.0 g	0.00 j	0.0 g
Bark	0.5	3.3 cd	6.7 fg	16.7 def	16.7 de	23. 3 f	30.0 de	36.7 ef	50.0 g	22.9 ef
	1.0	6.7 cd	10.0 ef	20.0 cde	23.3 cd	33.3 de	36.7 d	46.7 d	60.0 f	29.6 de
	1.5	6.7 cd	16.7 cde	26.7 bc	30.0 bc	36.7 cd	46.7 c	56.7 c	66.7 ef	35.8 cd
	2.0	10.0 bc	20.0 cd	30.0 b	36.7 b	43.3 c	53.3 c	63.3 c	76.7 cd	41.7 bc
	Control	0.0 d	0.0 g	0. 0 g	0.0 f	0.0 g	0.0 f	0.0 g	0.0 j	0.0 g
Stem	0.5	10.0 bc	16.7 cde	23.3bcd	33.3 b	43.3 c	50.0 c	63.3 c	70.0 de	38.7 c
	1.0	10.0 bc	23.3 bc	30.0 b	36.7 b	53.3 b	66.7 b	73.3 b	80.0 bc	46.7 b
	1.5	16.7 ab	30.0 ab	40.0 a	50.0 a	63.3 a	70.0 ab	83.3 a	86.7 b	55.0 a
	2.0	20.0 a	33.3 a	46.7 a	56.7 a	66.7 a	76.7 a	86.7 a	100.0 a	60.8 a
	Control	0.0 d	0.0 g	0.0g	0.0 f	0.0 g	0.0 f	0.0 g	0.0 j	0.0 g
LSD		7.0	8.7	8.2	8.2	8.7	7.9	9.2	8.7	6.8

HAT= Hours after treatment. Data expressed as mean. Means within column values followed by different letter(s) are significantly different by DMRT at 5 % level of probability.

From the above results it was observed that the eucalyptus plant extracts were effective for controlling the lesser grain borer but stem extract was the most effective. The present results agreed with the findings of Sultana *et al*. (2020). They studied on the comparative toxicity of leaf, bark and stem extracts of eucalyptus against *Sitophilus oryzae* L. (Curculionidae: Coleoptera) and found that stem extacts showed the highest performance against rice weevil. Aref and Valizadegan (2015) evaluated essential oils of *E. dundasii*, *E. floribunda* and *E. kruseana* against the adults of *R. dominica*. Results of fumigant toxicity showed that as the concentration and exposure time increased, the mortality also increased.

Probit analysis for mortality effects: The results of the probit analysis for the estimation of LD_{50} values, chi-square values and their 95% fiducial limits at 24, 48, 72, 96, 120, 144, 168 and 192 HAT for the mortality of lesser grain borer are presented at Table 2. The LD_{50} values of stem extracts were 25.0, 6.4, 2.4, 1.5, 0.7, 0.4, 0.2 and 0.2% showed the lowest among all the parts of eulayptus extracts applied at 24, 48, 72, 96, 120, 144, 168 and 192 HAT respectively. On the other hand, the highest LD_{50} values of 472.9, 223.0, 146.4, 30.5, 13.6, 8.7, 5.9 and 2.2% was found in leaf extracts at 24, 48, 72, 96, 120, 144, 168 and 192 HAT respectively (Table 2). The chi-square values of eucalyptus plant extracts at different HAT were

Table 2. Probit analysis of eucalyptus plant extracts against lesser grain borer at 24, 48, 72, 96, 120, 144, 168 and 192 hours after treatment (HAT)

Plant extract used	No. of insect used	LD_{50} values (%)	95% fiducial limits		χ^2 values with 2 df
			Lower	Upper	
		24 HAT			
Leaf	30	472.9	6.3E-06	3.5E+10	0.26
Bark	30	55.0	0.1	87846.2	0.14
Stem	30	25.0	0.1	4009.3	0.39
		48 HAT			
Leaf	30	223.0	3.1E-04	1.6E+08	0.19
Bark	30	11.4	0.6	199.5	0.14
Stem	30	6.4	0.6	62.7	0.04
		72HAT			
Leaf	30	146.4	8.16E-04	2.6E+07	0.25
Bark	30	6.1	0.8	44.7	0.02
Stem	30	2.4	1.1	5.7	0.22
		96 HAT			
Leaf	30	30.5	0.1	17492.7	0.01
Bark	30	4.6	0.9	22.4	0.07
Stem	30	1.5	0.8	2.8	0.42
		120 HAT			
Leaf	30	13.6	0.1	1406.1	0.11
Bark	30	3.1	0.8	11.3	0.04
Stem	30	0.7	0.4	1.4	0.07
		144 HAT			
Leaf	30	8.7	0.2	322.2	0.15
Bark	30	1.8	0.8	3.7	0.16
Stem	30	0.4	0.2	1.1	0.15
		168 HAT			
Leaf	30	5.9	0.3	124.05	0.14
Bark	30	1.9	0.6	1.68	0.20
Stem	30	0.2	0.1	0.90	0.23
		192 HAT			
Leaf	30	2.2	0.7	6.4	0.07
Bark	30	0.5	0.2	1.1	0.33
Stem	30	0.2	0.1	0.6	1.29

HAT = Hours after treatment, Values were based on four concentrations, three replications of 10 insects each, χ^2 = Goodness of fit. The tabulated value of χ^2 is 5.99 (d. f = 2 at 5% level)

insignificant at 5% level of probability and did not show any heterogeneity of the mortality data.

The findings of probit results are in agrement with those findings of Aggarwal *et al.* (2001). They observed that the lethal dose and lethal concentration required to kill 50 % of the beetles (LD_{50} and LC_{50}, respectively) varied with the toxicity assay method. LD_{50} values of 0.03, 0.04, and 0.04 ml/insect against *C. maculatus*, *R. dominica* and *S. oryzae*, respectively, were found in the topical application assay, while the LC_{50} values in the fumigant assay were 0.28, 0.33, and 0.46 ml/l against *C. maculatus*, *R. dominica,* and *S. oryzae*, respectively.

Residual effect: The average numbers of adult emergence were statistically different among the plant parts (Table 3). The highest number of adult emergence was recorded in control (100.0). Among the plant extracts, the lowest average numbers of adult emergence were found in stem (45.5) whiles the highest from leaf extract (48.1). The highest average infestation inhibition was found in stem (69.9%) and the lowest average infestation inhibition was found in leaf (65.0%) extract. The lowest number of adult emergence was found on 2.0% dose of stem extract (24.2) where the highest infestation inhibition was found in stem (76.4%) while the highest number of adult emergence was found on 0.5% dose of leaf extract (40.5) and the lowest infestation inhibition was found in leaf (59.5%)

Table 3. Residual toxicity effect of eucalyptus plant extracts on lesser grain borer at different days after treatment (DAT)

Extracts used 35 DAT		Number of adult emergence (DAT) and inhibition rate (%)						Aver. adult emerg	Aver. Inhibition rate (%)
		35 DAT	IR (%)	42 DAT	IR (%)	49 DAT	IR (%)		
Leaf		37.6 b	66.9 c	48.2 b	64.7 c	58.6 b	63.4 c	48.1 b	65.0 c
Bark		36.4 c	68.8 b	47.1 c	66.1 b	57.5 c	64.5 b	47.0 c	66.5 b
Stem		34.8 d	73.4 a	45.7 d	69.3 a	56.2 d	67.1 a	45.5 d	69.9 a
Control		81.0 a	-	100.0 a	-	119.0 a	-	100.0 a	-
LSD		1.1	1.5	1.0	1.1	1.0	1.0	1.0	1.2
Doses (%)									
0.5%		43.4 b	62.4 d	54.3 b	61.3 d	65.0 b	60.7 d	54.2 b	61.5 d
1.0%		42.0 c	66.4 c	52.9 c	64.3 c	63.6 c	63.2 c	52.8 c	64.6 c
1.5%		37.2 d	72.0 b	48.8 d	68.2 b	59.8 d	66.3 b	48.6 d	68.8b
2.0%		33.5 e	78.0 a	45.1 e	73.1 a	56.5 e	69.9 a	45.1 e	73.7 a
Control		81.0 a	-	100.0 a	-	119.0 a	-	100.0 a	-
LSD		1.2	1.8	1.1	1.3	1.1	1.1	1.1	1.4
Extracts	Doses (%)								
	0.5	32.3 b	60.0 g	40.6 b	59.3 g	48.6 b	59.1 i	40.5 b	59.5 g
	1.0	29.6 c	63.3 efg	37.6 c	62.3 ef	45.6 c	61.6 gh	37.6 c	62.4 ef
Leaf	1.5	24.3 d	69.9 d	33.6 d	66.3 d	41.6 d	64.9 ef	33.2 d	67.0 d
	2.0	20.6 e	74.5 c	29.0 ef	71.0 bc	38.0ef	68.0bc	29.2 fg	71.1 bc
	Control	81.0 a	-	100.0 a	-	119.0 a	-	100.0 a	-
	0.5	31.3 bc	61.3 fg	39.3 bc	60.6 fg	47.3 bc	60.2 hi	39.3 bc	60.7 fg
	1.0	28.6 c	64.6 ef	37.0 c	63.0 ef	45.0 c	62.1 gh	36.9 c	63.2 ef
Bark	1.5	23.0 de	71.6 cd	32.0 d	68.0 d	40.3de	66.1cde	31.8 de	68.6 cd
	2.0	18.0 f	77.8 b	27.0 f	73.0 b	36.0 f	69.7 b	27.0 g	73.5 b
	Control	81.0 a	-	100.0 a	-	119.0 a	-	100.0 a	-
	0.5	29.0 c	65.8 e	37.3 c	64.0 e	45.3 c	63.0 fg	37.2 c	64.3 e
	1.0	28.6 c	71.2 cd	37.0 c	67.6 d	45.0 c	65.8 de	36.9 c	68.2 d
Stem	1.5	20.6 e	74.5 c	29.6 e	70.3 c	38.3 ef	67.7 bcd	29.5 ef	70.8 c
	2.0	14.6 g	81.9 a	24.6 g	75.3 a	33.3 g	72.0 a	24.2 h	76.4 a
	Control	81.0 a	-	100.0 a	-	119.0 a	-	100.0 a	-
LSD		2.5	3.1	2.2	2.2	2.3	2.0	2.3	2.4

DAT = Days after treatment. Data expressed as mean. Means within column values followed by different letter (s) are significantly different by DMRT at 5% level of probability.

followed by bark extract at the dose level of 0.5% (39.5) and infestation inhibition was found 60.7% which was statistically different.

In a residual toxicity test, the stem extract also showed the lowest number of *Sitophilus oryzae* adult emergence (36.53) and the highest percent of infestation inhibition (67.42%), but the highest number of adult emergence was recorded in the control (78.3) treatment (Sultana *et al.* 2020).

Repellency effect: The repellency rate of eucalyptus plant extracts at different HAT is presented in Table 4. Stem extract showed the highest mean repellent effect (74.6%) followed by bark (67.3%) whereas leaf extract showed the lowest mean repellent effect (59.3%). Stem and bark extracts were in the same repellency class i.e. class IV and leaf extracts was in class III. However, these differences were statistically significant. The repellency action increased proportionally to the concentration. Interaction repellent effect of eucalyptus plant part extracts and their doses at different HATs had significant difference. The highest mean repellency effect was found on 2.0% dose of stem extract (86.6%) whereas the lowest mean repellency effect was found on 0.5% dose of leaf extract (46.6%). The repellency class at different dose level varied between III to V.

The present study agreed with those of previous findings of Aref and Valizadegan, (2015). They reported that essential oils of *E. dundasii*, *E. floribunda* and *E. kruseana* have repellent effect at concentrations of 70, 140 and 280 µl/l air and *E. kruseana* oil showed the highest repellency as compared to other essential oils against the adults of *R. dominica*.

Table 4. Repellent effect of eucalyptus plant extracts on lesser grain borer at different hours after treatment (HAT)

Extracts used		Repellency rate 9%) at different HAT					% Mean repell.	Repell. classes
		1 HAT	2 HAT	3 HAT	4 HAT	5 HAT		
Leaf		46.6 b	55.0 b	65.0a	65.0 b	65.0 b	59.3 c	III
Bark		56.6b	63.3 ab	70.0a	71.6 ab	75.0 a	67.3 b	IV
Stem		71.6 a	71.6 a	75.0a	76.6 a	78.3 a	74.6 a	IV
LSD		10.5	11.9	13.7	10.5	9.7	6.7	
Doses (%)								
0.5%		40.0 c	48.8 c	62.2 a	64.4 b	64.4 b	56.0c	III
1.0%		57.7 b	60.0 bc	66.6 a	68.8 ab	71.1 b	64.8 b	IV
1.5%		62.2 ab	66.6 ab	73.3 a	73.3 ab	71.1 b	69.3 b	IV
2.0%		73.3 a	77.7 a	77.7 a	77.7 a	84.4 a	78.2 a	IV
LSD		12.1	13.7	15.8	12.3	11.2	7.83	
Extracts	Doses (%)							
Leaf	0.5	33.3 d	33.3 c	60.0 a	53.3 b	53.3c	46.6 f	III
	1.0	46.6 cd	53.3 bc	60.0 a	66.6 ab	66.6 bc	58.6 def	III
	1.5	46.6 cd	60.0 abc	66.6 a	66.6 ab	66.6 bc	61.3 cdef	IV
	2.0	60.0 bc	73.3 ab	73.3 a	73.3 ab	73.3 abc	70.6 bcde	IV
Bark	0.5	33.3 d	53.3 bc	60.0 a	66.6 ab	66.6 bc	56.0 ef	III
	1.0	53.3 bcd	60.0 abc	66.6 a	66.6 ab	73.3 abc	64.0 bcde	IV
	1.5	66.6 abc	66.6 ab	73.3 a	80.0 a	73.3 abc	72.0 abcd	IV
	2.0	73.3 ab	73.3 ab	80.0 a	73.3 ab	86.6 ab	77.3 ab	IV
Stem	0.5	53.3 bcd	60.0 abc	66.6 a	73.3 ab	73.3 abc	65.3 bcde	IV
	1.0	73.3 ab	66.6 ab	73. a	73.3 ab	73.3 abc	72.0 abcd	IV
	1.5	73.3 ab	73.3 ab	80. a	73.3 ab	73.3 abc	74.6 abc	IV
	2.0	86.6 a	86.6 a	80.0 a	86.6 a	93.3 a	86.6 a	V
LSD		21.0	23.8	27.5	21.0	19.4	13.5	

HAT = Hours after treatment. Data expressed as mean. Means in a column followed by different letter(s) are significantly different by DMRT at 5% level of probability.

Conclusion

It was concluded that the eucalyptus plant extracts of leaf, bark and stem having strong insecticidal effects against lesser grain borer provided a simple and environment friendly alternatives to stored grain products. Among the three plant parts extracts of eucalyptus, stem extract was the most effective with 2% concentration. Insect mortality increased with the increased of time intervals.

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