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Efficacy of Four Different Indigenous Plants against *Rhizopertha Dominica* (F.) (Coleoptera : Bostrichidae)

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Abstract
Current experiment was conducted to evaluate the efficacy of four different plant extracts, i.e. Aak (Calotropis procera.), Niazbo (Ocimum basilicum), Sufaida (Eucalyptus globulus) and Gajar Botti (Parthenium hysterophorus) for their repellence and mortality against R. dominica. The experiment was laid out under complete randomize design (CRD) with four treatments and three replicates. Five concentrations (1, 2, 4, 8 and 10%) of each plant extract were tested at three different exposure periods against R. dominica. Results showed that the maximum mortality was obtained by Calotropis procera (77.26%) and minimum mortality was achieved by Eucalyptus globulus (58.10%) after 72 hours at 10% concentration. Maximum repellency was obtained by Ocimum basilicum (93.33%) and minimum repellency was achieved by Eucalyptus globulus (76.66%) after 60 minutes at 10% concentration. Results conclude that plant extracts can be used for the effective management of stored product insects.

***Keywords**: Rhizopertha dominica. Calotropis procera, Eucalyptus globulus, Ocimum basilicum, Parthenium hysterophorus, Indigenous plants*

1. Introduction

Pakistan is an agricultural country whose 70% population is totally depended directly or indirectly to agriculture for their needs and agriculture also contributed less than 21% GDP of Pakistan for its progress in the world (Majeed *et al*., 2016). Majority of the population in the world used cereals as a staple food due to the major source of protein and carbohydrates (Bajaj, 1990). Cereals found the most important component in the diet of the majority of people in the tropics and are usually stored to provide food and feed reserves as well as seed for planting (Obeng-Ofori and Reichmuth, 1997). In Pakistan it has been estimated that due to poor storage conditions food grains losses range from 5 to 7% (Jilani G and Ahmad H, 1982).

Among cereals, wheat is stored in silos and bins or at household level in the gunny bags for future use. Qualitative and quantitative losses are caused by different stored pest like *Sitotroga cerealella, Tribolium castaneum and Sitophilus oryzae* during storage conditions (Anjula *et al*., 1990). Due to great economic losses caused by stored grain pests, control of infestation in warehouses, factories, ships and mills is of main interest to the food manufacturers and distributors (Frenmore *et al* 1992). Stored grains and their products are severely damaged by the *Sitophilus oryzae* and *Rhyzopertha dominica. S. oryzae* and *R. dominica* have been considered most dominant and destructive causal agents of diseases in stored grains as well as products under storage (Mishra *et al*., 2013).

Stored products are damaged by about 39 species of stored pests. Larval as well as adult stages of *Rhyzopertha dominica* are very destructive and serious threat for the stored products (Irshad, 1990)**.** It is a primary pest, which means that adults and larvae of this species can easily infest sound seeds. The adult females of this species lay their eggs among grain seeds and the young larvae feed primarily on grain debris and dust, and then enter into grain kernels to complete their development. *R. dominica* can be developed and reproduce even in grain with low moisture content, such as at a level of 8% (Golebiowska, 1969). Wheat is attacked by various insect pests between harvest and storage. The most economically important insect pests of stored wheat are the granary weevils (*Sitophilus granarius*), maize weevils (*Sitophilus zeamais*), rice weevils (*Sitophilus oryzae*), lesser grain borer (*Rhyzopertha dominica*), larger grain borer (*Prostephanus* truncatus), Angoumois grain moth (*Sitotroga cerealella*), Indian meal moth (*Plodia interpunctella*), rice moth (*Corcyra cephalonica*) and red flour beetle (*Tribolium castaneum*) (Adedire 2000). *Rhyzopertha dominica* is an important insect pest of wheat *Triticum spp*. This insect is a field to store pest which its infestation on wheat has led to the reduction in quality, quantity and marketability of this important crop (Ileke, 2011). *Rhizopertha dominica* can penetrate different kinds of packaging material like jute bags and both larvae and adults consume grain-based products resulting in fragmented kernels, powdery residues and a specific pungent fragrance. It has been reported that complete life history of *R. dominica* to be approximately one month under optimum conditions (Howe, 1950; Rajendran, 2005). For a nation always needed better quality of wheat for their healthy life (Ahmad, 2009).

Crop production has been greatly affected by insect pest population worldwide. Fumigation is still one of the most effective methods for the protection of stored food, feedstuffs and other agricultural commodities from insect infestation. Fumigants like Phosphine and methyl bromide are being broadly used against the insect pests for controlling their activities and to save the agricultural and stored products (Athanassiou *et al.*, 2015). Methyl bromide has been identified as a major contributor to ozone depletion (WMO, 1995). On the other hand, resistance was developed against phosphine (Abouseadaa *et al.*, 2015). Due to the carcinogenetic, residual and ozone depleting activities of synthetic insecticides, use of these have been banned (Rajashekar *et al*., 2014).

The control of insects includes all that makes life hard for insects and be likely to kill them. The chemical control is a very quick, effective and widespread method of pest control (Gundu Rao & Majumdar, 1962; Ahmed & Eapen, 1986; Nawrot *et. al.*, 1982; Behal 1998) but, chemicals cause several problems, viz. Chronic and acute toxicity, development of insect resistance, environmental pollution, etc. (Adedire and Lajide, 2003; Ashamo and Odeyremi, 2001; Ileke *et al*., 2012).

So**,** there is a need to develop bio-pesticides against *R. dominica* which are environment friendly (Fang *et al*., 2002). Plant extracts are considered to be non-pollutant, less toxic and easily bio-degradable (Gundu Rao & Majumdar, 1962; Ahmed & Eapen, 1986; Nawrot et. al., 1982; Behal 1998). The plant having the Insecticidal and other properties gain attention in the last few decades. The situation has led to research on potential and safe plant extracts as alternative to toxic fumigants. Present work has also been conducted to evaluate the efficacy of four different plant extracts, *i.e.* Aak (*Calotropis spp.*), Niazbo (*Ocimum tenuiflorum*), Sufaida *(Eucalyptus globulus)* and Gajar Botti (*Parthenium hysterophorus)* for their repellence and mortality against *R. dominica.*

2. Materials and methods

Collection and rearing of *Rhizopertha dominica*

Adult insects of lesser grain borer, *R. dominica* (Fabr), were collected from the grain market in Faisalabad and reared in the stored grain laboratory to get the homogenous population at optimum conditions. Clean, healthy and uninfested grains of wheat in plastic jars covered with muslin cloth were used for rearing purpose of *Rhyzopertha dominica* insect species. Laboratory conditions were (28±2°C), temperature along with (75±5% RH) and 12: 12 (L: D), for maintenance of culture. Rearing of insects were done in sterilized plastic jars along with 1kg per1000 gm. The insects were allowed to grow in natural environment as in traditional structure and checked at regular intervals. After five days the adults were sieved and grains along with eggs were again put into jars and kept again under optimum conditions to develop a homogenous population.

Preparation of plant extracts:

Weighed quantity of each indigenous plant material (*Calotropis procera, Ocimum basilicum, Eucalyptus globulus* and *Parthenium hysterophorus*) was used to make leaf extracts. Plant materials were washed with distilled water, dried under shade and ground with the help of electric grander to a powdered form. Powder was sieved out through a fine mesh sieve. Extraction of plant materials were done using acetone as a solvent by adding 50 gram of powder of each plant powder in 250 ml of acetone in conical flasks. The mouth of each flask will be closed by aluminum and cotton plug to prevent evaporation. Flasks were placed on rotary shaker at 220 rpm for 24 hours. Whiteman filter papers were treated with plant extracts of different concentration and were kept in lab to rotatory evaporator for few hours to evaporate solvent. Different concentrations of each plant extract i.e. 1, 2, 4, 8 and 10% were prepared using acetone against *R. dominica.*

Bioassay for % Mortality:

To check the mortality of adults of *R. dominica*, experiment was carried out using Petri dishes and Whitman's filter paper for bioassay. Different concentrations (1%, 2%, 4%, 8% and 10%) of plant extracts were applied on the filter paper and then the filter paper was allowed to get dry. Twenty adults of test specimen were released in petri dishes and cover with lid. Mortality of the adults was recorded three times after equal intervals of 24 hours.

Mortality % was calculated using Abbott's formula (Abbot, 1925),

$$\text{Corrected Mortality (\%)} = \frac{\text{Mo(\%)} - \text{Mc(\%)}}{100 - \text{Mc(\%)}} \times 100$$

Mo = Observed mortality

Mc = Mortality in Control

Repellency tests on filter paper:

Area preference method was used to check the repellent effect of different plant extracts against *R. dominica*. The filter paper of 9 cm diameter was cut in two equal parts. Different concentrations (1%, 2%, 4%, 8% and 10%) of plant extracts were applied at one halves of each filter paper by using a micropipette. The other half was treated with distill water and used as a control. Filter paper was dried for 10 minutes. Both treated and untreated were placed together. Twenty adult insects were released in the center of each Petri dish to check the repellency of these extract. There were three replications for each treatment and the number of insects on both halves was counted after each 10 minutes in an hour.

Repellency (%) was calculated by Asawalam *et al.* (2006):

$$\text{Repellency(\%)} = \frac{(\text{Nc} - \text{Nt})}{(Nc + Nt)} \times 100$$

Nc = number of insects on the untreated area

Nt = number of insects on the treated area.

Data analysis:

Data regarding mortality and repellency were analyzed statistically by using software Statistics 8.1. Means were compared by using Tuckey-HSD test. (Gomez and Gomez 1984)

3. Results

Table 1: Percent Mortality of adult of *Rhyzopertha dominica* against different indigenous plants concentrations of *Calotropis procera, Ocimum basilicum, Eucalyptus globulus* and *Parthenium hysterophorus*

Time (hr.)	Concentration (%)	Mean mortality ± S.E			
		C. procera	*O. basilicum*	*E. globulus*	*P. hysterophorus*
24	1	28.333±1.666c	26.667±1.667d	11.667±1.667d	6.667±1.666d
24	2	33.333±1.666bc	36.667±1.667c	21.667±1.667c	16.667±1.666c
24	4	38.333±1.666b	41.667±1.667bc	26.667±1.667bc	23.333±1.666bc
24	8	46.667±1.666a	46.667±1.667ab	31.667±1.667ab	28.333±1.666ab
24	10	51.667±1.666a	51.667±1.6674a	38.333±1.667a	33.333±1.666a
48	1	38.333±1.666d	31.667±1.666d	21.667±1.667d	16.667±1.666d
48	2	41.667±1.666d	38.333±1.666cd	26.667±1.667cd	21.667±1.666cd
48	4	53.333±1.666c	43.333±1.666c	31.667±1.667bc	28.333±1.666c
48	8	63.333±1.666b	53.333±1.666b	38.667±1.667b	36.667±1.666b
48	10	71.667±1.666a	61.667±1.666a	46.667±1.667a	46.667±1.666a
72	1	39.133±1.646d	21.133±1.105d	23.4467±0.9474d	21.767±0.484d
72	2	47.833±2.348c	38.233±0.635c	32.5367±1.4468c	30.833±0.693c
72	4	58.833±1.738bc	59.900±1.563b	32.3133±0.536cd	38.200±1.975bc
72	8	65.000±1.789b	70.367±2.472a	43.3267±2.7994b	44.600±1.975b
72	10	77.267±4.387a	72.967±2.935a	58.1067±2.7070a	61.400±2.7574a

3.1 Insecticidal effect of indigenous plants against *R. dominica*

All indigenous plants studied in this research revealed significant toxicity against *R. dominica*. Mean toxic effect of *C. procera* was higher than other plants against *R. dominica*. Higher concentrations of plant extracts were found more lethal as increase in concentration significantly increased mortality against *R. dominica*. Similar trend was observed in exposure time. It was obvious from results that contact insecticidal efficiency was significantly higher when insects were exposed to plant extracts for longer period of time. All the plant extracts expressed significant lethal actions against *R. dominica*. It is clear from the Table 1 that application of highly concentrated (10%) *C. procera* showed maximum mortality (77.26%) after 72 h of treatment while minimum mortality was observed by *E. globulus* (58.10%) at lowest concentration of 1%. maximum mortality of *Rhizopertha dominica* adults were attained at 10 % concentration of *C. procera* which was 77.26 followed by 72.96% *O. basilicum*, 61.40% *P. hysterophorus* and 58.10% mortality was obtained on *E. globulus* after exposure time for 72 hours.

Table 2: Mean values of the data regarding % repellency of test insect *Rhizopertha dominica* using different concentration of *Calotropis procera, Ocimum basilicum, Eucalyptus globulus* and *Parthenium hysterophorus*

Time (min.)	Concentration (%)	Mean repellency ± S.E			
		C. procera	*O. basilicum*	*E. globulus*	*P. hysterophorus*
15	1	3.33±3.33c	3.33±3.33c	3.3333±3.333e	3.333±3.33b
15	2	10.00±5.77bc	23.33±3.33b	6.6667±3.333b	10.000±5.77b
15	4	30.00±5.77ab	40.00±5.77ab	16.667±3.333c	20.000±5.77ab
15	8	40.00±5.77a	43.33±3.33a	20.000±5.773d	36.667±3.33a
15	10	43.33±3.33a	46.66±3.33a	33.333±3.333a	40.000±5.77a
30	1	23.33±3.33d	36.66±3.33c	20.000±5.773c	20.00±3.33c
30	2	33.33±3.33cd	53.33±3.33b	26.667±3.333c	30.00±5.77c
30	4	43.33±3.33bc	56.66±3.33b	36.667±3.333bc	40.00±5.77bc
30	8	60.00±5.77ab	66.66±3.33ab	53.333±3.333ab	53.33±3.33ab
30	10	66.66±3.33a	76.66±3.33a	66.667±3.333a	66.66±3.33a
45	1	26.66±3.33c	53.33±3.33c	26.667±3.333c	33.33±3.33c
45	2	40.00±5.77bc	63.33±3.33bc	36.667±3.333c	50.00±5.77bc

45	4	43.33±3.33bc	66.66±3.33bc	43.333±3.333bc	56.66±3.33b
45	8	56.66±3.33ab	76.66±3.33ab	60.000±5.773ab	66.66±3.33ab
45	10	73.33±3.33a	83.33±3.33a	63.333±3.333a	80.00±5.77a
60	1	40.00±5.77c	56.66±3.33c	36.667±3.333c	43.33±3.33d
60	2	46.66±3.33bc	66.66±3.33bc	56.667±3.333b	53.33±3.33cd
60	4	60.00±5.77abc	80.00±5.77ab	66.667±3.333ab	66.66±3.33bc
60	8	70.00±5.77ab	83.33±3.33ab	70.000±5.773ab	76.66±3.33ab
60	10	80.00±5.77a	93.33±3.33a	76.667±3.333a	86.66±3.33a

3.2 Repellent effect of indigenous plants against *Rhizopertha dominica*

Data concerning % repellency of *R. dominica* against Aak (*C. procera.*), Niazbo (*O. basilicum*), Sufaida *(E. globulus)* and Gajar Botti (*P. hysterophorus)* showed that maximum percent repellency (93.33) was recorded at 10% concentration after 60 min of initial application of *O. basilicum* and minimum repellency (76.66) was showed by *E. globulus* at 10 % concentration after 60 mint of initial application. It is obvious that with the increase in concentration of plants repellency increased. In case of *C. procera* and *P. hysterophorus* highest repellency was 80% and 86.66% at 10% concentration after 60 min of initial application respectively.

4. Discussion

The present study was carried out to evaluate the efficacy and repellency of indigenous plants *i.e.* Aak (*Calotropis spp.*), Niazbo (*Ocimum basilicum*), Sufaida *(Eucalyptus globulus)* and Gajar Botti (*Parthenium hysterophorus)* against *Rhizopertha dominica* F. Data illustrated significant toxicity and repellency of four indigenous plant extracts against stored grain insect pest to acquire prospects as alternative compounds to presently used pest control agents. Similar biological actions of these plant extracts have also been evidenced by Khan and Marwat, 2004; Mishra *et al.*, 2012; Abbasi *et al.*, 2013 and Tesfu and Emana, 2013. All the plant extracts evaluated in this research showed significant concentration and exposure time dependent mortality against *Rhizopertha dominica* adults, while *Calotropis procera* was established more effective with (77.26%) mortality however *Ocimum basilicum* showed more repellency (93.33%) against *Rhizopertha dominica*. Similar prospect was also distinguished by Abbasi *et al.* (2013) who reported repllency and mortality of *Datura alba* and *Calotropis procera* leaf extracts and concluded *Calotropis procera* gave maximum mortality (70a) of *Tribolium castaneum* at 100% concentration. Targeted insect pest mortality was significantly caused by dose rate. Concentration was directly proportional to insecticidal potential. Tesfu and Emana. (2013) were also in accordance this investigation who outlined *Parthenium hysterophorus* plant powder against *Callosobruchus chinensis*. The highest dose of stem, inflorescence and leaf powder showed mortality of 56.67%, 76.67 and 73.33% respectively. Previous study evidenced *Calotropis procera* as repellent for the sotred grain pest (Khan and Marwat, 2004). Keeping in view of above results it is suggested that there is a need to develop bio-pesticides which will not only control the insect pest of stored products but also environment friendly as well as less hazards to human health.

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