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Efficacy of different plant products against *Sitophilus oryzae* (Linn.) (Coleoptera: Curculionidae) infestation on stored rice

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ABSTRACT

Efficacy of volatile oils, powders, ethanol extracts and water extracts were tested on the basis of per cent mortality, final adult population of *Sitophilus oryzae* and grain weight loss of rice. Volatile oil of *Citrus reticulata* resulted in 100.00 per cent mortality after 24 hours of exposure followed by *Curcuma longa* (90.00 per cent), *Psidium guajava* (52.50 per cent) and *Pogostemon cablin* (20.00 per cent). Among powders, powder of *Zingiber officinale* was proved to be effective to some extent resulting in 23.34 per cent mortality followed by *P. guajava* and *C. reticulata* at 6.67 per cent respectively after 72 hours of exposure. However, powders of *C. reticulata* and *Z. officinale* were comparatively effective in reducing the adult population 12.67 respectively and grain weight loss at 4.35 and 4.50 per cent respectively after 35 days of exposure. Ethanol extract of *P. cablin* was found to be effective to some extent resulting in 40.00 per cent mortality after 72 hours of exposure while the extract of *C. reticulata* was comparatively effective in reducing the adult population (12.00) and grain weight loss (3.49 per cent) after 35 days of exposure. Though water extracts of different plant parts had no significant effect on mortality of the pest but *Polygonum* sp. was found to be effective in reducing adult population (12.33) and grain weight loss (5.01 per cent) after 35 days of exposure.

Key words : Efficacy, plant extract, *Sitophillus oryzae*, crop pest, mortality, grain weight loss.

INTRODUCTION

Insects cause a lot of damage to stored seeds, grains and their products. There is a continuous need to protect the stored products against deterioration, especially loss of quality and weight during storage. Quantitative and qualitative losses of stored grains may result from the feeding and waste production by insects, mites, rodents and birds or from the growth of microorganisms all of which are influenced by environmental conditions (Mohale *et al.*, 2010). Insects, mites and fungi may cause hydrolysis and oxidation and decrease the level of certain nutrients in stored products or even form toxic substances such as mycotoxins. Mould contamination in stored groundnuts has been found to be closely associated with insect infestations (Lisker and Lillehoj, 1991; Lynch and Wilson, 1991; Sinha and Sinha, 1992 and Franzolin *et al.*, 1999). In India, unscientific storage, rodents, insect pests, mites, microorganisms account for 10 per cent wastage of food grains. In comparison to other regions of the country, storage of food grains in North East India is very difficult due to high humidity, encouraging infestation of stored grains by insect pests. In storage rice is damaged by a number of insect pests, particularly by rice weevil, *Sitophillus oryzae* (L.) (Coleoptera: Curculionidae); angoumois grain moth, *Sitotroga cerealellea* (Olivier); lesser grain borer, *Rhizopertha dominica* (Fabricius); rust red flour beetle, *Tribolium castenium* (Herbst) and khapra beetle, *Togoderma granarium* (Everts) (Agarwal *et al.*, 1979) while *S. oryzae* caused heavy damage to wheat, rice, maize and sorghum grains (Atwal, 1976). Food grains can be stored safely by following proper maintenance of moisture content of grains and temperature gradients developed within the grain along with oxygen circulation in the store (Pradhan, 1969). But high humidity of Assam makes it difficult in maintaining moisture content of the stored grain at low level as results grains suffer from varying degree of deterioration by storage insect pests.

To overcome the problem of storage insect pests, plant products have the potentiality to play an important role. Botanical pesticides are emerging as a possible alternative to chemical pesticides and a viable component of Integrated Pest Management (IPM) strategies on all crops in view of their efficacy to pests, easy biodegradability, and photo stability etc. Various botanicals have been found to be effective against different pests, especially insects, and among them neem is well proven and extensively documented. According to Bora (1982) plant products like powder form of neem leaf and fruit (*Melia azadirach* L.), curry leaf (*Murraya koenigii* L.), jute leaf (*Corchorus capsularis* L.), siam weed leaf (*Eupetorium odoratum* L.) and chick weed leaf (*Ageratum conyzoides* L.) could be used as seed protectants to reduce the infestation of rice weevil and grain moth in stored wheat. Apart from this, the extract of *urmoi* (*Sapium sebiferum* L.), neem (*Azadirachta indica* L.) and turmeric (*Cucuma longa* L.) proved as repellant against store grain pests like *S. oryzae* and *S. granarius* in Bangladesh (Rahman *et al.*, 1999). Deka (2003) reported about few plants species like neem (*A. indica*), siam weed [*E. odoratum* (*Chromolaena odorata*)] and chick weed (*A. conyzoides*) against the stored pest complex of rice of Assam.

With growing realization of limitation of insecticide application in stored grains, efforts have been made in different directions to control insect pests. The global interest in this field is partly a response to concern about health hazards associated with chemical insecticides. Though the North eastern region, especially Assam, is rich in flora diversity, perusal of literature reveals that reports on botanical pesticides and its efficacy are scanty. Only a few works has been done by different workers from this region. Hence, feeling the paucity of the work an attempt has been made to taste the efficacy of different traditional plant products against *S. oryzae* in stored rice.

MATERIALS AND METHODS

Various common/ traditional plants, its different parts viz., *Bihlongoni, Polygonum* (Leaf); Guava, *Psidium guajava* (Leaf); Ginger, *Zingiber officinalae* (Leaf); Turmeric, *Curcuma longa* (Leaf); Patchouli, *Pogostemon cablin* (Leaf); Orange, *Citrus reticulate* (Rind); *Bortengechi, Oxalis debilis* (Leaf); *Kolmou, Ipomoea aquatic* (Leaf); *Meteka Eichhornia crassipes* (Leaf); *Bihgoch, Acontium ferox* (Bark) were collected from different places of Assam and different extracts of each plant were selected for the study.

Preparation of plant extract

Preparation of powder

For the preparation of powder, the collected plant parts were shade dried in room temperature for about a month. Thereafter, powders wee prepared using pestle and mortar followed by sieving through 60 mesh size sieve. Powders were kept in polythene bags at room temperature and properly sealed to prevent quality loss.

Preparation of ethanol extract

The shade dried fine powder of plant parts were treated with 90 per cent ethanol for 24 hours at room temperature and thereafter filtered through muslin cloth. Filtrates were collected in glass vials and closed tightly to check quality loss followed by refrigeration.

Extraction of volatile oil

The selected aromatic plant parts were shade dried and than coarse powders were prepared using pestle and mortar. 100 g powder was mixed with 1000 ml distilled water and then through hydro distillation method volatile oil was extracted. The volatile oil was refrigerated.

Preparation of water extract

The extracts were prepared by grinding fresh non-aromatic plant parts by adding minimum quantity of distilled water.

Table 1. Effect of powders of different plant parts on final adult population of *S. oryzae* and grain weight loss after 35 days

Treatment	Dose (g)	Final adult population	Grain weight loss (%)
P. cablin	1.5	16.33	4.83 (2.30) [c]
C. longa	1.5	15.33	4.93 (2.33) [b]
P. guajava	1.5	14.33	4.50 (2.23) [f]
C. reticulata	1.5	12.67	4.35 (2.20) [g]
Polygonum sp.	1.5	14.33	4.58 (2.25) [e]
O. debilis	1.5	15.00	4.91 (2.32) [b]
I. aquatica	1.5	14.33	4.67 (2.27) [d]
Z. officinalae	1.5	12.67	4.50 (2.23) [f]
Control	-	16.33	5.49 (2.44) [a]
S.Ed.±			0.0015
$CD_{0.01}$		NS	0.0045

NS P = Non - significant

Data within the parentheses are square root of transformed values

Mean within the column separated by DMRT, P = 0.01

Means followed by same letter are not significantly different

Table 2. Effect of ethanol extracts of different plant parts on final adult population of *S. oryzae* and grain weight loss after 35 days.

Treatment	Dose (ml)	Final adult population	Grain weight loss (%)
C. longa	0.2	12.33	3.73 (2.05)^{g}
C. reticulata	0.2	12.00	3.49 (1.99)^{h}
Z. officinalae	0.2	12.67	4.09 (2.14)^{f}
O. debilis	0.2	15.33	5.57 (2.46)^{c}
P. cablin	0.2	12.67	4.78 (2.29)^{d}
Polygonum sp.	0.2	15.00	6.29 (2.60)^{b}
P. guajava	0.2	12.33	4.09 (2.14)^{f}
A. ferox	0.2	12.33	4.17 (2.16)^{e}
Control (Ethanol)	0.2	15.67	6.89 (2.17)^{a}
S.Ed.±			0.0018
$CD_{0.01}$		NS	0.0052

NS P = Non - significant
Data within the parentheses are square root of transformed values
Mean within the column separated by DMRT, P = 0.01
Means followed by same letter are not significantly different

The extracts were filtered by muslin cloth and the filtrates were collected in vials, securing the mouth tightly to check the quality loss.

Rearing of test insects

For maintaining laboratory culture of *S. oryzae*, the collected specimens were kept in a number of plastic jars half - filled with rice, with their mouth covered with muslin cloth.

Bioassay

In all cases 5 pairs of *S. oryzae* were introduced into each container/ Petri dish and the mouth of the same was secured with top cover. Each experiment was replicated thrice. Mortality of *S. oryzae* was reported at 1, 6, 12, 24, 48 and 72 hours. Whereas, the final adult population and loss in grain weight were recoded after 35 days. For dried powder application, 1.5 g of dried powder was placed in a plastic container (164.81 cm^3). 50 g grains were added to it and shake thoroughly for proper mixing powder. In extract application, a filter paper was placed at bottom of each Petri dish (89.01 cm^3). 0.2 ml of ethanol extract, 0.1 ml of volatile oil and 0.2 ml of water extract of each sample was applied to filter paper of each Petri dish and then 5 g of grain was put into each Petri dish.

Data analysis

The data obtained were converted to angular transform values and square root transform values (Gomez and Gomez, 1968). Statistical analyses of angular transformation data were done using Fischer's method of analysis of variance (ANOVA).

Table 3. Effect of water extracts of different plant parts on final adult population of *S. oryzae* and grain weight loss after 35 days.

Treatment	Dose (ml)	Final adult population	Grain weight loss (%)
C. longa	0.2	12.33	3.73 (2.05)^{g}
A. ferox	0.2	15.67	6.41 (2.62)^{c}
O. debilis	0.2	12.67	5.13 (2.37)^{e}
Polygonum sp.	0.2	12.33	5.01 (2.34)^{f}
E. crassipes	0.2	15.33	6.89 (2.71)^{b}
I. aquatica	0.2	15.00	5.61 (2.47)^{d}
Control (water)	0.2	16.00	8.17 (2.94)^{a}
S.Ed.±			0.0016
$CD_{0.01}$		NS	0.0048

NS P% Non-significant
Data within the parentheses are square root of transformed values
Mean within the column separated by DMRT, P = 0.01
Means followed by same letter are not significantly different

RESULTS AND DISCUSSION

Effect of volatile oil on mortality

The results illustrated in Fig. 1 showed a trend of increasing mortality with the increase of exposure time with different volatile oils. Volatile oil of *C. reticulata* at

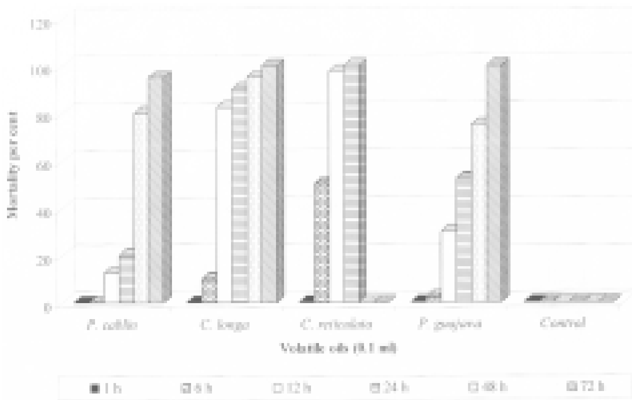

Figure1. Effect of volatile oils of different plant parts on mortality of *S. oryzae* at different time intervals

0.1 ml was the most effective among the treatments reaching up to 50.00, 97.50 and 100.00 per cent mortality after 6, 12 and 24 hours of exposure respectively. Similar results were also observed by Ivbijaro *et al.*, 1985. The adult mortality might be attributed to the contact toxicity or to the abrasive effect on the pest cuticle (Mathur *et al.*, 1985), which might also interfere with the respiratory mechanism of insect and they might die of suffocation (Agarwal *et al.*, 1988). This results also confirms with the findings of El - Sayed *et al.* (1989) who reported the mortality as 63.70 and 75.00 per cent for novel orange and sweet orange respectively against *S. granarius* 16 days after treatment. Again volatile oil of *P. cablin, C. longa* and *P. guajava* at 0.1 ml gave 95.00, 100.00 and 100.00 per cent mortality respectively after 72 hours of treatment. Adult mortality might be due to contact toxicity of the oil. Ivbijaro *et al.*, 1985 reported (67.00 to 100.00 per cent) high mortality (67.00 to 100.00 per cent) by application groundnut, coconut and palm oil against *S. oryzae.*

Effect of powders on mortality

Treatment with powder of *Z. officinale* showed mortality to some extent i.e. 23.34 per cent followed by *P. guajava* and *C. reticulata* at 72 hours of exposure (Fig. 2). The mortality might be due to the effective adhesion of dust or powder particles on micropyle of eggs which either create obstacle in their rupturing or induce some unknown physiological changes resulting in failure of hatching (Mathur *et al.*, 1985).

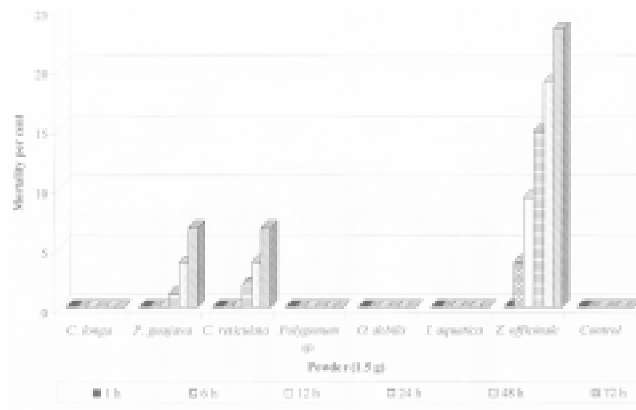

Figure 2. Effect of powders of different plant parts on mortality of *S. oryzae* at different time intervals**.**

Powders on *S. oryzae* and grain weight loss after 35 days

Perusal of data presented in Table 1 revealed that powder of *C. reticulata* and *Z. officinalae* reduce the adult population and grain weight loss as compared to other treatments including control. The reduction in adult population is probably due to egg mortality or larval mortality or even reduction in hatching of eggs and also might be due to the presence of toxic substances (Mathur *et al.*, 1985). Grain weight loss indicated the quantitative loss in stored grains due to the insects showing a direct relationship between insect population and weight loss. These findings were also supported by Misra (2000) who reported that treatment with powder of *Citrus lemon, Annona squamosa, Acorus calamus, Capsicum annuum, Ocimum sanctum, Lantana camara, Datura stramonium, A. indica, Vitex negundo, Aegle marmelos* resulted in lower *Callosobruchus chinensis* fecundity and weight losses than the untreated control.

Ethanol extract on mortality

It is evident from the findings that the treatment with ethanol extract of *P. cablin* was found to be effective to

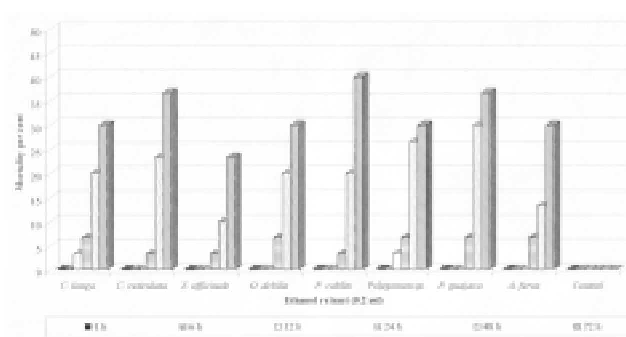

Figure 3. Effect of ethanol extracts of different plant parts on mortality of *S. oryzae* at different time intervals.

some extent resulting mortality up to 40.00 per cent followed by *C. reticulata* after 72 hours of exposure (Fig. 3). The adult mortality is probably due to the presence of bioactive chemical components in plant products.

S. oryzae adult and grain weight loss after 35 days

It was observed that the ethanol extracts of different plant parts reduce the adult population and grain weight loss to some extent as compared to other treatments. Among the ethanol extracts, extract of *C. reticulata* was found to be effective followed by *C. longa* to reduce adult population and grain weight loss (Table 2). These results were supported by Adedire and Lajide, 2000 who stated that ethanolic extract of *Dinnettia tripetala* fruits, roots, barks and leaves inhibited the ovipositon and adult emergence of *C. maculatus*. Rahman *et al.* (1999) reported that the ethanol extract of *Sapium sebiferum*, *A. indica* and *C. longa* used against *S. oryzae* and *S. granarius* showed repellant effect. Srivastava and Mann (2002) also reported that the different extracts of *Peganum harmla* against *C. chinensis* reduce the adult emergence and weight loss in grains. It is also supported by Bhaduri *et al.* (1985).

Water extracts on insect mortality and grain weight loss after 35 days

It is seen from the findings that the treatments with water extracts of different plant parts have no significant effect to cause mortality of *S. oryzae*. It might be due to the loss of some volatile components or various unstable components present in different plant products. Experiment data presented in Table 4 showed that the treatment with water extract of *Polygonum* sp. was found to be effective followed by *O. debilis* which reduce the adult population (12.33 and 12.67 respectively) and grain weight loss. Similar results were also observed by Srivastava and Mann. (2002). The reduction in adult emergence is probably due to egg mortality or larval mortality or even reduction in hatching eggs. The egg mortality has been attributed to the toxic compound present in the plant materials (Su, 1977) while Singh *et al.*, 1978 considered the physical properties cause changes in the surface tension and oxygen tension in the egg. Disruption of water balance of egg and developing embryo may also result in lethality as suggested by Messina and Renwick (1983).

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