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Grain protectant efficacy of certain plant extracts against rice weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae)

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ABSTRACT

In the present study, ethanol extract of *Clerodendrum inerme* L. (Verbenaceae), *Withania somnifera* L. (Solanaceae), *Gliricidia sepia* L. (Fabaceae), *Cassia tora* L. (Caesalpiniaceae) and *Eupatorium odoratum* L. (Asteraceae) were evaluated for their efficacy on mortality and progeny production of rice weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae). Adult insects were exposed to the 2.5 and 5% extracts treated wheat and mortality was assessed after 1, 2, 7, 14 and 21 days. Subsequently, all adults were removed and the treated grains remained at the same conditions for an additional 45 days. After this interval, the commodity was checked for progeny production. All extracts, the beetles mortality was increased in dose dependent manner. Results indicated that *C. inerme* and *W. somnifera* extracts were more effective than *G. sepia*, *C. tora* and *E. odoratum* against adult insects. Interestingly, the progeny production (Fl) was complete by suppressed even in lowest dose. It was concluded that both *C. inerme* and *W. somnifera* can be used for the protection of stored wheat from infestations of *S. oryzae*.

Key words: Plant extracts, mortality, progeny production, *Sitophilus oryzae*

INTRODUCTION

The rice weevil, *Sitophilus oryzae* L. (Coleoptera: Curculionidae), is the most widespread and destructive major insect pest of stored cereals throughout the world. Female rice weevil oviposits directly into the seeds and completes larval development inside the seeds and emerge as adults. To control this pests, synthetic insecti cides are used during storage of grains. Synthetic insecti cides cause residual pollution of the environment, toxicity to consumers and residues on grains. Moreover, *S. oryzae* has been reported to developed resistance to synthetic insecticides (Benhalima *et al.,* 2004). The plant derived chemicals have been used as potential seed protectant (insecticides and antifeedants) often begins with the screening of plant extracts (Pavela, 2007). Certain plant families, particularly *Meliaceae, Rutaceae, Asteraceae, Labiateae, Piperaceae, Verbenaceae* and *Annonaceae* are viewed as exceptionally promising sources of plant-based insecticides (Jacobson, 1989; Isman 1995). The leaves of *C. inerme*, *W. somnifera* and *E. odoratum* have demonstrated antifeedant and insecticidal activities against stored grain pasts of *C. chinensis* and *T. castineum* (Gupta and Srivastava, 2008; Yankanchi and Gonugade, 2009). Therefore, the present study was conducted to investigate the efficacy of these plants leaf ethanol extracts on the impact on progeny production (F1 adult deterrence) of rice weevil.

MATERIALS AND METHODS

Insect culture

Sitophilus oryzae adults were collected from naturally infested wheat grains from a local market in Kolhapur, Maharashtra. The insects were reared on clean and un-infested and sterilized wheat grains (*Triticum aestivum* L. var. NIAW-917). Two hundred adult insects were released in 1 kg wheat seeds in a plastic jar capped with muslin cloth to ensure ventilation. The jar was maintained at 28±2°C and relative humidity at 70±5%. After 48 h, the adults were removed and the jar was left for 45 days to obtain adult beetles and subsequently these beetles were used for the experiments.

Preparation of plant extracts

The leaves of *Clerodendrum inerme* L. (Verbenaceae), *Withania somnifera* L. (Solanaceae), *Gliricidia sepia* L. (Fabaceae), *Cassia tora* L. (Caesalpiniaceae) and *Eupatorium odoratum* L. (Asteraceae) were collected in and around Kolhapur city, Maharashtra. Collected leaves were washed with distilled water and air dried for six days and macerated using domestic grinder. The powdered materials were separately subjected to ethanol extraction with Soxhlet apparatus for 15-18 hrs (Evans and Raj, 1988). Crude extracts were passed through Whatman (No. 1) filter paper and concentrated by a rotatory evaporator under low pressure. Dark-green residue obtained were stored in glass vials and maintained in a refrigerator (4ºC) until further use.

Bioassay

Two concentrations (2.5% and 5%) were made in analytical grade acetone for assay. The extracts were mixed for about five minutes with wheat grains separately (1 ml/50 gm wheat) and air dried for 10 minutes. Twenty four hour old adult *Sitophilus oryzae* (20 number) were released into plant extracts treated wheat containing bottles (21 X 10 cm) covered with perforated lid. Five replications were maintained for each concentration of the individual plant extract. Same volume of acetone treated grains was served as control. Observations were recorded on 1, 2, 7, 14 and 21 days after the treatment. After 21-day mortality observation, dead and live adults were removed from bottles and commodity was left at same conditions for an additional period of 45 days for progeny emergence observed. The percentage of reduction in progeny production was determined using Aldryhim (1995) formula: [(Number of progeny in control – number of progeny in treatment) / Number of progeny in control X 100]. All observations were corrected by using the Abbott's (1925) formula. Corrected observations were subjected to statistical analysis, the one-way ANOVA and T-test.

RESULTS AND DISCUSSION

Most of the treatment revealed significantly ($p<0.05$) higher mortality at 21-day of exposure when compared to the control. Maximum mortality caused by 5% *C. inerme* treatment followed by *W. somnifera* extract. In general, mortality rate was increased with increasing the concentration of plant extracts and exposure time. Among different plant extracts, the grains treated with 2.5% *G. sepia* extract produced low mortality followed by *C. tora* extract (Table 1). Furthermore, both in *C. inerme* and *W. somnifera* extracts (5%) caused high mortality of 56.66 and 46.66 % respectively compared to other plant extracts after 7 days. Minimum mortality (26.66 per cent) recorded in grains treated with 5% *G. sepia* extracts after 7 days. Interestingly, progeny production (Fl) was complete suppressed in all the treated plant extracts at both doses.

Results demonstrated that higher dose of extracts for relatively short periods are more effective than the lower dose for a long period. The decrease in grain damage caused to stored wheat using *C. inerme, W. somnifera* and *E. odoratum* indicates the presence of toxic bioactive principles in these plants which was already reported. For instance, *C. inerme* leaf extract showed maximum insecticidal activity might be due to the presence of diterpenoids (Pandey *et al.,* 2005). Several neo-clerodane diterpenoids have been isolated from genera of *Ajuga, Teucrium, Scutellaria* and *Clerodendrum*. These compounds have caused antifeedant and growth inhibitory activity on economically important lepidopteran and dipteran pests (Pereira and Gurudatta, 1990; Chen *et al.,* 1996; Gibbinck *et al.,* 2002). Ahmed *et al.* (1981) results revealed that *C. inerme* leaves mixed in house fly diet were found to reduce pupal weight and inhibit adult emergence. Roychoudhary, (1994) evaluated ethanol extracts (2.5 and 5%) of different *Clerodendrum* species leaves against *S. oryzae* and recorded the effectiveness up to 21 days which were in confirmation with the present findings. Ethanol extracts of *Eucalyptus, Lantana,* Neem and *Pawpaw* leaves was most effective against stored grain pests of *S. oryzae* and *S. zeamays* (Mulungu *et al.,* 2007). Mortality effect of 5% extract leaf of *C. inerme* was followed by *W. somnifera* in all observations. Gupta and Srivastava (2008) reported that petroleum ether extract of *W. somnifera* leaf and root was effective to control *C. chinensis*.

From the progeny production of *S. oryzae*, emergence of adult insects from all controls indicated that tested insects were capable of effective oviposition. The progeny production was arrested by plant extracts. Thus, the extracts of *C. inerme, W. somnifera, G. sepia, C. tora* and *E. odoratum* either inhibit oviposition and / or killed the larvae at developmental stages after eggs laid in culture.

Table 1. Effect of chosen plant extracts on adult mortality (in %) of *S. oryzae*

Treatments (%)	Exposure time				
	1 day	2 days	7 days	14 days	21 days
W. somnifera (2.5%)	13.33 ± 1.77	20.00 ± 2.31	23.33 ± 2.77	46.66 ± 3.67	63.33 ± 3.77
W. somnifera (5%)	26.66 ± 2.16	40.00 ± 2.41	46.66 ± 3.12	60.00 ± 3.61	73.33 ± 4.12
C. inerme (2.5%)	20.00 ± 1.76	26.66 ± 2.47	36.66 ± 3.14	46.66 ± 3.84	60.00 ± 4.27
C. inerme (5%)	36.66 ± 2.64	40.00 ± 3.21	56.66 ± 4.26	73.33 ± 4.84	86.66 ± 5.76
G. sepia (2.5%)	10.00 ± 0.86	13.33 ± 1.25	20.00 ± 2.21	26.66 ± 2.72	26.66 ± 3.17
G. sepia (5%)	16.66 ± 1.41	20.00 ± 2.28	26.66 ± 2.45	30.00 ± 2.75	36.66 ± 3.10
C. tora (2.5%)	13.33 ± 1.64	20.00 ± 1.86	20.00 ± 2.08	26.66 ± 2.23	30.00 ± 2.46
C. tora (5%)	20.00 ± 0.91	26.66 ± 1.84	36.66 ± 2.57	36.66 ± 2.81	43.33 ± 3.46
E. odoratum (2.5%)	13.33 ± 1.21	20.00 ± 1.68	20.00 ± 1.46	26.66 ± 2.13	30.00 ± 2.46
E. odoratum (5%)	13.33 ± 0.93	23.33 ± 1.65	36.66 ± 2.57	56.66 ± 3.31	66.66 ± 3.74

These results suggest that there may be different bioactive compounds in these extracts.

The present results are in confirmation with earlier works of Khoshnoud and Khayamy (2008) where they also have evaluated the insecticidal and progeny production effect of ethanol extract of *Verbascum cheiranthifoliun* against *S. oryzae* and *T. castineum*, and observed significant mortality and suppression of progeny production. The essential oils from *M. fragrans* and *I. verum* were tested for their biological activity against *S. oryzae* and *T. castineum* by Shukla *et al.*, (2008) and observed the inhibition of oviposition toxic to growing larvae. The present findings suggest that the leaves of these plant possess certain bioactive components which require further investigation to determine the exact mode of action of these active components and their effect on non-target organisms.

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