Oviposition deterrent and adult emergence activities of some plant aqueous extracts against *Callosobruchus maculatus* F. (Coleoptera : Bruchidae)

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ABSTRACT

The present study was undertaken to study the effect of aqueous extracts of *Acorus calamus* root (Acoraceae), *Artemisia nilagirica* (Asteraceae), *Cassia auriculata* (Fabaceae), *Cassia siamia* (Caesalpiniaceae), *Citrus aurantium* peel (Rutaceae) and *Percularia daemia* (Asclepiadaceae). Oviposition deterrent, F1 adult emergence and weight loss were carried out at four different concentrations (1.25%, 2.5%, 5% and 10%) on cowpea, *Vigna unguiculata* (L.) against *C. maculatus*. Maximum oviposition deterrent activity was observed in *C. siamia* (84.66%) followed by *C. aurantium* peel (82.11%) at higher concentration. Notably these two extracts showed above 50% oviposition deterrent activity even at lower concentration. Reduction in F1 adult emergence was higher in *P. daemia* (91.25%) treated seeds. The other plant extracts also exhibited their higher potential against *C. maculatus.* Weight loss due to insect infestation was drastically reduced when compared to the control. All extracts did not affect the germination of the seeds.

Key words: *Callosobruchus maculatus*, oviposition deterrent activity, aqueous extracts

INTRODUCTION

The cowpea beetle, *Callosobruchus maculatus* is a cosmopolitan insect pest of cowpea. It is a field -to-store pest as its infestation of cowpea often begins in the field as the mature pods dry (Huignard *et al.*, 1985; Sathyaseelan *et al.*, 2008) and when such seeds are harvested and stored, the pest population increases rapidly and results in total destruction with in a short duration of 3-4 months (Rahman and Talukder, 2006). It multiplies very rapidly in storage (Ouedraogo *et al*., 1996) and reported 8.5% loss in pulses during post harvest handling and storage in India. Synthetic chemical insecticides have proved very effective in the control of the beetle. However, the problems associated with chemical insecticides such as health hazards, insect resistance, pest resurgence, residual toxicity, widespread environmental hazards and increasing costs of application have directed the need for effective, biodegradable pesticides (Talukder and Howse, 2000; Elhag, 2000). The use of plant materials for the protection of field crops and stored commodities against insect attack has a long history (Golob and Webley, 1980). It appears to be quite safe and promising (Jilani *et al.*, 1988). Earlier, Petroleum ether extract of Neem (Ranjana Saxena and Beenam Saxena, 2000), dichloromethane and methanol extract of *Acorus calamus* and *Cassia siamia* (Jayakumar *et al.*, 2005a), *Jatropha curcas* seed oil (Adebowale and Adedire, 2006), powdered leaves and extracts of *Vitex negundo* (Rahman and Talukder, 2006), plant lectins derived from *Cicer arietinum* (Sadeghi *et al.*, 2006) and powder of *Terminalia chebula* and *Cassia auriculata* (Govindan and Jeyarajan Nelson, 2008) were reported to have significant oviposition deterrent and other biological activity against *C. maculatus*. In this context, based on the earlier literatures and easy availability of the plants, six plants were screened *viz*. *Acorus calamus* root, *Artemisia nilagirica*, *Cassia auriculata*, *Cassia siamia*, *Citrus aurantium* peel and *Percularia daemia* for their oviposition deterrent and adult emergence activity against *C. maculatus*.

MATERIALS AND METHODS

Insect culture

Cowpea seeds infested by the *C. maculatus* were colleted from the grocery shop and brought to the laboratory. The infested seeds were set aside in a plastic container and covered with muslin cloth till the emergence of adult. Healthy adults emerged from the container were shifted to another plastic container (24.5 X 11.5 cm) and provided cleaned cowpea seed for oviposition and maintained at 28 ± 2°C and 70 ± 5°C % R.H. The container was undis turbed until the emergence of adults. Freshly emerged subsequent generations were used for further experiments.

Preparation of plant extracts

Fresh leaves of selected plants (*A. calamus* root, *A. nilagirica, C. auriculata, C. siamia, C. aurantium* peel and *P. daemia*) were collected at their respective places and brought to the laboratory. Each plant material was dried under shade and powdered by using electric grinder and pass through a 20 mesh sieve and kept in a 1 kg capacity polypropylene bag. 300 g of each powdered plant material were taken into a 2 litre capacity conical flask and 1000 ml of distilled water was added to it and shaken for 8 h in a mechanical shaker and then kept it for 24 h. The extract was separated using fine muslin cloth and then filtered. The filtrate was collected in a 2 litre capacity conical flask and volume was made up to 1000 ml. This was considered as stock solution. Required concentrations (1.25%, 2.5%, 5% and 10%) were prepared from the stock solution.

Oviposition deterrent activity

Cowpea seeds were cleaned and sterilized at 45° C for 6 h in order to kill the eggs and developing larvae. For each concentration, 250 cowpea seeds were taken in a conical flask and mixed with each concentration of aqueous extracts and seeds treated with water alone used as control. After through mixing the seeds were air dried and they were separated into five lots each having 50 seeds, stored in plastic containers (8 X 6.5 cm) and 5 pairs of newly emerged adult *C. maculatus* were introduced in each container. Five replicates were maintained for each concentration and controls. After 15 days, number of eggs laid on treated seeds (Ts) and control seeds (Cs) were recorded and the percentage of oviposition deterrence (POD) was calculated as POD=[(Ts-Cs)/Cs] X 100.

Adult Emergence activity

After the eggs were counted the experimental set up was kept undisturbed till the emergence of F1 adults from the treated and untreated seeds. The number of F1 adults emerged from the control seeds (Ac) and treated seeds (At) were recorded. The percentage reduction in F1 adult (PRA) emergence (F1) was calculated as PRA=[(Ac-At)/ Ac] X 100.

Measurement of loss of weight

After complete emergence of F1 adults, the weight losses due to *C. maculatus* infestation on cowpea seeds were recorded. The weight of the treated seeds (Wt) and control seeds (Wc) were observed before and after experiment and the percentage protection in weight loss (PPW) was calculated as PPW=[(Wc-Wt) / Wc] X100

Germination test

To study the viability of treated seeds, 700 seed were selected randomly and treated with higher concentrations of plant extracts and controls as mentioned earlier. After treatments the seeds were air dried and were placed in a petridish containing moist cotton and rewetted with water. Percentage of seeds germinated was recorded after 5 days and compared with control. All germination experiments were conducted at room temperature. The experiments were replicated four times for all concentrations with 25 seeds per replication.

Data analysis

Mean number of eggs laid on treated and control seeds, F1 adult emergence and weight loss were calculated using the above said formula. The data obtained from the experiments were subjected to two-way analysis of variance (ANOVA). Further the significant difference between the means was separated using Least Significant Difference (LSD) test.

RESULTS AND DISCUSSION

Many methods have been adopted to control *C. maculatus*. Traditionally the seeds can be mixed with ash, sand, or other dry fine substances that fill up the space between the seeds and provide a barrier to insect

Table 1. Oviposition deterrent activity of selected plant aqueous extracts against the pulse beetle, *C. maculatus*

Plants	Concentrations (%)			
	1.25	2.5	5	10
Acorus calamus root	24.97 (29.93)^{ab}	20.77 (27.06)^{a}	27.30 (31.50)^{a}	32.61 (34.82)^{b}
Artemisia nilagirica	12.66 (20.79)^{a}	14.35 (22.22)^{a}	17.44 (24.65)^{a}	19.25 (25.99)^{a}
Cassia auriculata	12.31 (20.53)^{a}	16.28 (23.73)^{a}	23.34 (28.86)^{a}	30.92 (33.77)^{b}
Cassia siamia	55.37 (48.04)^{c}	65.69 (54.09)^{b}	77.19 (61.41)^{d}	84.66 (67.70)^{e}
Citrus aurantium peel	55.89 (48.33)^{c}	64.35 (53.31)^{b}	70.25 (56.91)^{c}	82.11 (65.05)^{d}
Percularia daemia	19.08 (25.84)^{a}	20.48 (26.85)^{a}	29.93 (33.15)^{ab}	47.61 (43.62)^{c}

Within in the column different alphabets was statistically significant ($p<0.05$) by LSD.

Table 2. F1 adult emergence of selected aqueous plant extract against *C. maculatus*

Plant name	Concentrations (%)							
	1.25%		2.5%		5%		10%	
	No. of F1 emerged	% reduction in adult emergence	No. of F1 emerged	% reduction in adult emergence	No. of F1 emerged	% reduction in adult emergence	No. of F1 emerged	% reduction in adult emergence
Acorus calamus root	78.8±58.16^{c}	45.28	112±30.4^{c}	22.22	67.8±13.04^{c}	52.92	27.8±27.76^{b}	80.69
Artemisia nilagirica	131.2±34.24^{a}	8.89	125.8±27.36^{ab}	12.64	97.6±22.32^{b}	32.22	33.4±12.88^{b}	76.81
Cassia auriculata	137.8±23.44^{a}	4.31	130.8±29.36^{a}	9.17	105.4±17.68^{b}	26.81	37.8±25.76^{b}	73.75
Cassia siamia	97±24.8^{b}	32.64	63.8±11.36^{e}	55.69	46.4±8.88^{d}	67.78	25.8±7.76^{b}	82.08
Citrus aurantium peel	61.6±10.08^{c}	57.22	51.8±8.64^{e}	60.42	43.4±11.52^{d}	80.56	36.8±5.12^{b}	72.92
Percularia daemia	99±24.4^{b}	31.25	87.2±16.56^{d}	39.44	49±8^{d}	65.97	12.6±9.68^{b}	91.25
Control	144±17.2^{a}	—	144±17.2^{a}	—	144±17.2^{a}	—	144±17.2^{a}	—

Within in the column different alphabets was statistically significant ($p < 0.05$) by LSD.

movement (Golob and Webley, 1980). Fresh, dry or processed plant materials can be applied as insecticides or to repel the pest insects (Boeke *et al.*, 2004). Earlier literature indicate the importance of plant extract is protecting seeds by way of direct mixing of the dried leaves, plant powders, solvent extracts, vegetable/ essential oils on seeds during post harvest storage (Rajapakse, 1996; Ngamo *et al.*, 2007; Meera Srivastava and Lalitha Gupta, 2007; Zahra Sahaf and Moharramipour, 2008; Othira *et al.*, 2009).

The reduction in oviposition was increased with the increase in dosage of each treatment. Earlier, Olaifa and Erhun (1998) found that higher concentration of the powder of *Piper guineense* significantly reduced the oviposition. These earlier findings are in conformation with present study at higher concentrations were found to be effective as compared to lower ones in bringing down the egg laying by the pest insect. Present study revealed that, maximum oviposition deterrent activity was observed in *C. siamia* followed by *C. aurantium* peel (Table 1). It is noteworthy that these two plant extracts showed more than 50% of deterrent activity even at lower concentration. It appears that these plant extracts might possess repellent and/or oviposition deterrent principles. Oviposition deterrency may be due to the changes induced in physiology and behaviour in the adult of *C. maculatus* as reflected by their egg laying capacity. Similar results were also obtained from *Andrograpis peniculata* (Annie bright *et al.*, 2001), *Hyptis suaveolens* (Jayakumar *et al.*, 2005b), *Jatropha curcas* (Adebowale and Adedire, 2006), *V. negundo* (Rahman and Talukder, 2006) and *T. chebula* (Govindan and Jeyarajan Nelson, 2008) against *C. maculatus.*

The data shown in Table 2 revealed the effect of leaf extracts on adult emergence of cowpea beetle shows a significant reduction among the treatments. It is added that efficacy of these selected plant extracts was much stronger against F1 than egg laying. Jayakumar *et al.* (2003) reported that plant extracts have obvious effects on postembryonic survival of the insect and resulting reduction in adult emergence. In the present study, maximum reduction in the adult emergence was observed in the seeds treated with *P. daemia* (91.25%) followed by *C. siamia* (82.08%) and *A. calamus* (80.69%). Earlier, Prabu Seenivasan *et al.* (2004) recorded 86.5% reduction in adult emergence due to petroleum ether extract of *C. colocynthis.* Annie Bright (2001) and Raja *et al.* (2001) reported that botanicals inhibited adult emergence in *C. maculatus* in cowpea. They further stated that, when the eggs lay on treated seeds, the toxic substance present in the extract may enter in to the egg through chorion and suppressed further embryonic development. It is in agree with the present study that adult emergence was greatly reduced in treated seeds than control seeds. Similar results were observed by Jayakumar *et al.* (2005a), Ajayi and

Wintola (2006) and Sathyaseelan *et al.* (2008). Harvesting adversely influenced almost all vital aspects of the pest, the weight loss in treated grains was remarkably reduced. Weight loss indicated the quantitative loss in stored grains due to insect feeding showing a direct relationship between insect population and weight loss. Present observation revealed that the weight loss for treated grain ranged from 0.6 to 3.29 and in control it was about 4.88. Minimum weight loss was observed in the cowpea seeds treated with *P. daemia* and *A. calamus* at higher concentration (Fig 1).

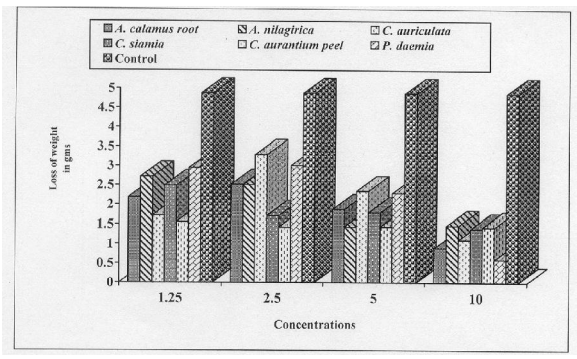

Figure 1. Weight loss caused by *C.maculats* as influenced by aqueous extracts of selected plants

The reductions of germination of treated seeds can be explained by the problem of water absorption by seeds (Mbaiguinam *et al.*, 2006). Onu and Aliyu (1995) and Keita *et al*. (2001) reported that seeds treated with botanical extract/oils did not loose their viability. The present study revealed that no significant harmful effect was observed even at higher concentration. Raja *et al.* (2001), Keita *et al*. (2001) and Sathyaseelan *et al*. (2008) reported that though various plant products were effective in reducing oviposition and damage of *C. maculatus*, seed quality and germination were not affected. These results are in general agreement with our findings.

The present investigation has brought out the efficacy of *A. calamus* root, *A. nilagirica, C. auriculata, C. siamia, C. aurantium* peel and *P. daemia* against *C. maculatus*. Preparation of these aqueous extracts and application on the seeds are so easy and cheaper. Hence, effectual plant extract can be used as one of the component in Integrated Pest Management especially in small godowns or shop retailer for short term storage.

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