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Effect of stem formulations of plant *Leptadenia pyrotechnica* (Family: Apocynaceae) on mortality of *Callosobruchus chinensis* Linn.

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Abstract

The pulse beetle, *Callosobruchus chinensis* Linn. is a major pest that causes significant damage to stored pulses resulting in economic losses. The present study was undertaken to study the efficacy of plant *Leptadenia pyrotechnica* belonging to family *Apocynaceae* on adult mortality of *C. chinensis* raised on grains of *Vigna aconitifolia* (moth bean). The different formulations of the stem of the selected plant were prepared in the form of aqueous extract, ethanol extract, petroleum ether extract, and aqueous extract prepared by adding Triton-x 100 surfactant at dose concentrations of 1, 2.5, 5 and 10%. Significant reduction ($p < 0.05$) in adult mortality was observed in sets treated with ethanol extract and aqueous Triton-x 100 extract showed 100% mortality of the pulse beetle. Further, treatments of 10% concentration were found to be very effective in causing high mortality.

Key words: *Leptadenia pyrotechnica*, *Callosobruchus chinensis* Linn., extracts, adult mortality and dose concentration.

Introduction

In India, pulses are the most important source of protein and play a very significant role in the diet of common men but full yield potential of these is seldom realized due to various constraints including damage by pests in storage. India is the largest producer of pulses in world producing 19.98 million tons of pulses (GOI, 2016). Though a number of insect pests cause varying degrees of losses to pulses, bruchids with cosmopolitan distribution affect both qualitative and quantitative losses right from field to storage. One such economically important insect species which causes considerable damage to pulses in storage is *Callosobruchus chinensis* Linn. (Coleoptera: Bruchidae). Chemical

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means of management would not be advisable to control this pest and therefore the botanical pesticides seem to be the next best alternate to check the pest population. Plant based insecticides are easily biodegradable and ecologically safe for treating the stored pests to prevent from further damage or loss of stored products (Wink, 1993). Many plant species produce substances that protect them by killing or repelling the insects that feed on them. Natural pesticides seem to have many advantages over synthetic ones and may be more cost-effective as a whole, considering the environmental cost of chemical alternatives. *L. pyrotechnica* is a desert drought resistant herb reaching up to 3 m. It is found worldwide from Senegal to India. Chemically *L. pyrotechnica* has been reported to consist of alkaloids, flavonoids, cardiac glycosides (Idrees *et al*., 2016). The herb is considered to be antioxidant, anti-inflammatory, antibacterial, antihelmenthic, anti-lipoxygenase, cytotoxic, antitumour and antiatherosclerotic activity (Verma *et al*., 2014).

Material and methods

The test insect selected for the study was pulse beetle *Callosobruchus chinensis* Linn. The culture of *C. chinensis* was raised on moth bean *Vigna aconitifolia*. The seeds of the grain for culture were purchased from the local market, cleaned and then exposed to a temperature of 60°C for four hours in an incubator to remove infestation, if any. The culture of pest insect on the host grains was developed by releasing a single pair of adult insects. The insects were reared on these grains kept in glass jars covered with muslin cloth tied with the help of rubber band. The adults emerging from this initial culture were used for maintaining subsequent cultures. These jars were kept in BOD incubator maintained at 28±2°C temperature and 70% relative humidity. 10 pairs of insects were inoculated per 10 g of pulse. Ten replicas of each set were taken. The plant material used for the study was collected from Bikaner city situated between (27°11' & 20° 03' North latitude and 71°54'& 74°12' East longitude) and its vicinity and was cleaned and shade dried. The stem formulations were applied in four forms namely aqueous, ethanol, petroleum ether and aqueous Triton x 100 extract at different dose concentrations viz., 1%, 2.5%, 5% and 10%. For comparison, normal and control sets

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were also kept. Observations were recorded on third day of treatment. The observations were subjected to statistical analysis employing ANOVA using SPSS (2017).

Results and discussion

The results of effect of various formulations on the adult mortality have been presented in Table 1. and Fig.1. During the present study the overall mean adult mortality (%) of *C. chinensis* in sets treated with 5 and 10% Aq. Triton-x-100 extract as well as ethanol extract of stem of *L*. *pyrotechnica* was found to be 100%.

Table 1. Effect of stem extracts of *Leptadenia pyrotechnica* on adult mortality (%) of *Callosobruchus chinensis* Linn.

Plant part	Concentrations	Aqueous extract	Ethanol extract	Petroleum ether extract	Triton x 100 extract
Stem	Normal	12±1.225			
	Control	14±1.871			
	1%	66±1.871	82±1.225	63±1.225	87±1.225
	2.5%	69±1.871	92±1.225	68±2	89±1.871
	5%	78±1.225	100±0	80±1.581	100±0
	10%	88±1.225	100±0	91±1.871	100±0

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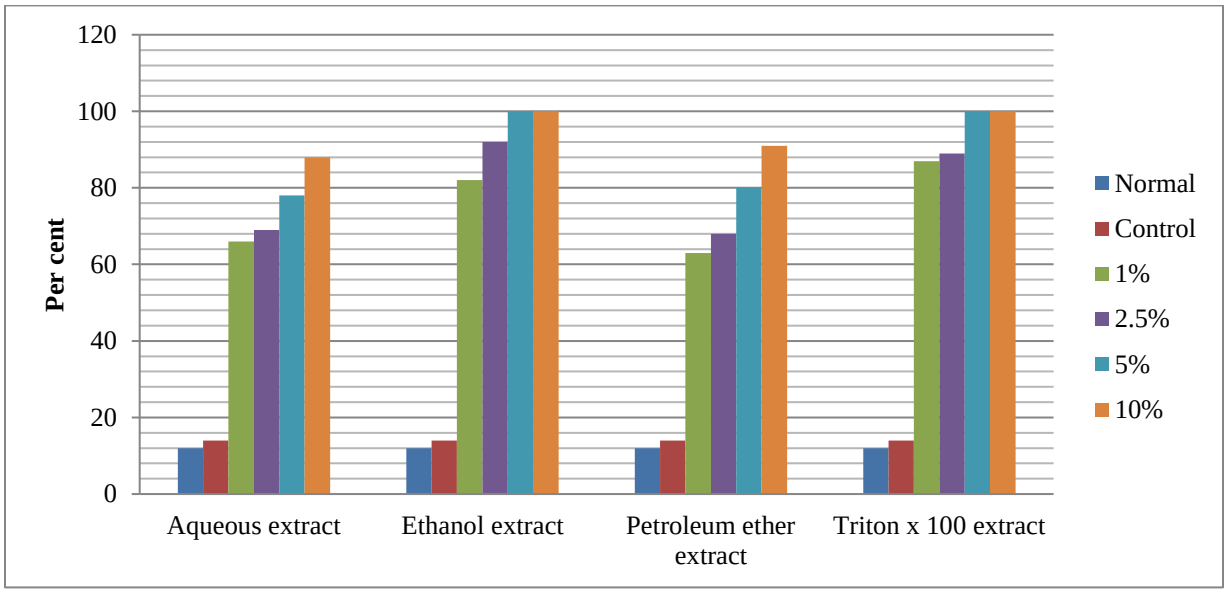

Fig. 1. Effect of stem extracts of *Leptadenia pyrotechnica* on adult mortality (%) of *Callosobruchus chinensis* Linn.

Earlier various plants belonging to different plant families have been suggested to possess insecticidal properties by various workers from time to time. Kaur & Srivastava (2004) found leaves of *P. harmala* to be most effective among the different plant parts studied. Three plants viz *Solanum surattense, S. nigrum* and *Withania sominifera* were screened for their insecticidal efficacy against pulse beetle by Gupta (2004) who observed *S. surattense* to result in significantly higher mortality.

Ofuya & Osadahun (2005) observed 100% mortality of *C. maculatus* when treated with powder from dry flower buds of *E. aromatica*. Complete adult mortality of *C. maculatus* was also documented by Okonkwo & Okoye (1992) when treated with dried ground leaves *R. communis*. Kaur & Srivastava (2004) found leaves of *P. harmala* to be most effective among the different plant parts studied. The present findings are also in conformation with the reports of Juneja & Patel (1994) who observed 100% adult mortality of *C. analis* after three days of treatments with various plant/products including leaves of mint. The extracts of leaves of *O. basilicum* were found to result in highest mortality of *C. chinensis* by Kiradoo (2009). A high kill of adult *C. chinensis* by the

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treatment of oil vapours of *M. spicata*, *M. piperita* and *M. citrata* has also been reported by Mishra et al. (1992).

Certain solanaceous plants, namely *Tephrosia purpurea, Trigonella foenum graecum* and *Crotolaria burhia* were used by Ghei (2001) against *C. chinensis* who observed plants *Tephrosia* and *Trigonella* to result in higher mortality as compared to *Crotolaria.* Mann (1997) reported the extracts of plants *Aerva, Peganum, Tribulus* and *Fagonia* to significantly affect the mortality of *C. chinensis*. Ofuya & Osadahun (2005) observed 100% mortality of adult *C. maculatus* beetles within 16h when treated with powders from dry flower buds of *Eugenia aromatica.* Juneja & Patel (1994) observed 100% adult mortality of *C. analis* after 3 days of treatments with seed powder of custard apple, black pepper, leaves of mint and peels of orange, seed extract of pithraj. Pandey & Singh (1997) observed that neem bark powder possesses insecticidal property and effectively controls the increase of population of *C. chinensis* on chickpea in storage. Ivbijaro (1990) observed 100% mortality of *C. maculatus*, when treated with pepper seed oil. All these reports also support the present finding.

Ghei (2001) who studied *T. purpurea, T. foenum graecum* and *C. burhia* against *C. chinensis* found aqueous extract to be more effective as compared to ether extract and aqueous suspension. Gupta (2004) screened *S. surattense, S. nigrum and W. sominifera* for their insecticidal efficacy against *C. chinensis* and observed that the sets treated with ether extract and aqueous suspension showed high adult morality as compared to aqueous extract. Methonol extracts from thirty aromatic plants and five essential oils were tested against *S. oryzae* and *C. chinensis* by Kim et al. (2003) over 90% mortality was achieved from extracts of *A. calamus* rhizome, *A. gramineus* rhizome*, Illicium verum* fruit and *Foeniculum vulgare* fruit. Extracts of eight plants local to Oman were tested against *C. chinensis* by Al Lawati et al. (2002). They found that seeds of *A. squamosa* recorded 100% mortality of beetles within 20 and 4 hours of their exposure to methanol and ethanol extracts respectively. Bhaduri et al. (1985) found that *Tridax procumbens* extracted in petroleum ether to be most effective in checking the population of pulse beetle.

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The mortality of the bruchid during the present study was found to be significantly affected by the extract concentration, being maximum when treated with 10% formulations. These results are in agreement with the earlier observations, of Koshiya & Ghelani (1993) who observed that extracts of seeds of *P. glabra* were highly effective at 15% concentration. Minjas & Sarda (1986) found aqueous extracts of pods to result in over 90% mortality at a concentration of 0.25% of the powder/litre. Ghei (2001) who used *T. pupurea, T. foenum graccum* and *C. burhia* against *C. chinensis* also found 10% extracts to be most effective.

Similar trend was reported by Gupta (2004) who observed a direct relationship of adult mortality with the concentration of the formulation being maximum when treated with extract of 10% concentration of plants *S. surattense, S. nigrum,* and *W. sominifera* against *C. chinensis.* Nandagopal et al. (1990) tested the effects of neem oil, neem leaf extract and neem decoction and dried groundnut leaves and observed highest mortality of cicadellid from neem oil at 25% and the most cost-effective treatments was neem leaf extract at 5% with a resulting mortality of 83.4%. The bioactivity of dried leaves, bark and root of *Zanthoxylum xanthoxyloides* was assessed by Udo et al. (2004) at a concentration of 5% and was found to induce 100% mortality of *C. maculatus* on cowpea.

Mann (1997) observed highest mortality ranging from 60 – 80% of the three insect sviz. *Tribolium, Rhyzopertha* and *Callosobruchus* when treated with 10% extract of plant *Peganum*. Pareek & Bhatta (1998) evaluated various plant products against *Chilo partellus* and observed neem oil to be most effective in causing highest mortality at 10% concentration and after 12, 24 and 48 hours of treatment. Singh et al. (1998) investigated various plant extracts at 10% concentration and reported that *S. dulcamara* was superior followed by *S. lappa* which elicited 46.41 and 40.04% mortality of *L. erysimi*, respectively. Zhang & Zhao (1983) observed the root and bark powder of *Calestrus angulatum* and *Tripteryaium wilfordii* when mixed with rice at 0.5% or oil of *A. indica* when mixed at 5 ml/kg, the population growth of *S. oryzae* and *S. zeamais* was inhibited by about 90%. They further reported that volatile essence and orange used at 0.5 ml per petridish killed adult weevils in three days and completely suppressed

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population build up. Veeraval & Jaganathan (2001) reported 1% neem oil to cause the maximum population reduction in aphids (42.87%) followed by *Datura, Ipomoea, Agave, Parthenium* and *Pongamia*.

The powder and ethanol extract of *Tithonia diversifolia* leaves were tested for their efficacy at five concentrations. (0.0%, 0.5%, 1.0%, 1.5% and 2%) against *C. maculatus* by Adedire & Akinneye (2004). Mortality was 100% at higher concentrations of 3%, 4% and 5% within 24h of extract application but at lower concentration mortality was 73.3% and 93.37 at 1% and 2% respectively after 24h. After 48 h of application 100% mortality of adult *C. maculatus* was obtained at all concentrations. Ahad *et al*., 2012 tested N-hexane solvent extracts of 13 local plants for their insecticidal activity against pulse beetle, *Callosobruchus chinensis* Linn. *Emblica officinalis* and *Annona reticulata* extracts showed 100% mortality within 72 hours and *Nerium oleander* showed 90% and 96.67% mortality in 2%, and 3%, respectively. The extracts from the seeds of *A. squamosa* resulted in 100% mortality of *C. chinensis* within 24 hours of their exposure to methanol and ethanol extracts, respectively. Murasing *et al*. (2017) found petroleum ether extract of *Aegle marmelos* to be significantly superior over rest of the solvent extracts against *C. chinensis* causing highest percent of mortality (82%) at 5% concentration after 96 hour of treatment followed by methanol (80%), ethanol (76%) and water extract (74%) respectively.

The present findings therefore suggest that the plant/stem of *L. pyrotechnica* possesses certain chemicals which result in the mortality of pest insect and could be a potent source for managing the population of *C. chinensis* but need further investigation. The ethanol extract as well as Aq. Triton x 100 extract resulted in higher adult mortality followed by aqueous and petroleum ether extracts suggesting that solvent play an important role in dissolving the plant constituents and therefore are of great significance.

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