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Repellency and Toxicity of Some Plant Extracts Against *Tribolium castaneum* (Herbst)

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ABSTRACT *Dichloromethane extract of Lantana camara L., Jatropha curcas L., Calotropis procera Ait. and Datura metel were evaluated for their repellent effects and mortality on the stored grain pest, Tribolium castaneum (Herbst). The plant extracts exhibited significant effects on T. castaneum. Highest repellency (80%) was recorded when 8mg/ml extract from Jatropha curcas was used for 24 hour exposure time against T. castaneum followed by Calotropis procera (72%), Lantana camara (62%) and Datura metel (52%). The extracts showed significant toxic effects against T. castaneum producing higher mortality than the control. J. curcas showed strongest toxicity with LC 50 value of 40mg/g followed by C. procera (46.5mg/g) and L. camara (53mg/g). Of the four extracts studied, D. metel showed the least toxicity with LC 50 value of 66mg/g.*

KEYWORDS : Repellency • Mortality • Botanical pesticides • *Tribolium castaneum*

INTRODUCTION

Tribolium castaneum is a stored grain pest causing post harvest crop loss and quality deterioration leading to economic damage and is a serious problem in grain storage. For their control, use of synthetic pesticides has imposed numerous detrimental effects on human health, environment and non-target organisms. [1], [2], [3], [4] Hence, there is need to develop non-chemical methods. Botanicals being compound of natural origin, without any adverse effect on human health, no anticipated problem of persistence in the environment [5], products based on plant extracts, phyto-oils and purified substances of plant origin can be an alternative to the conventional pesticides. [6] The safety of these biopesticides has been well documented [7]. A number of studies have evaluated the efficacy of these plant based products for their repellency, insecticidal and ovicidal properties. [8], [9], [10], [11], [12], [13] The objective of the present study is to evaluate the repellency and toxicity of *Jatropha curcas*, *Lantana camara*, *Calotropis procera* and *Datura metel* extracts on *T. castaneum.*

MATERIALS AND METHODS

Insect rearing: *T.castaneum* was maintained in the laboratory at ambient environmental conditions of temperature (30±2° C), relative humidity (70±5%) and photoperiod (12:12, L: D) conditions. Leaves of *L.camara, J.curcas, D.metel* and *C.procera* were collected, washed and dried for 3-5 days and then in an oven at 40°C for 24 hours. Dried leaves were powdered; extraction was carried out with Dichloromethane in a Soxhlet apparatus. The extract was collected and the solvent was air-dried, then sealed with aluminum foil and stored at 4°C.

Repellency test: This was performed as described by Mc Donald *et al.* [14] Whatman no.1 filter papers were cut in two parts. In first part, 1ml of four different concentrations viz. 1, 2, 4 and 8mg/ml of extracts were applied uniformly with a micropipette. Another part was taken as control and treated with 1ml acetone. These were air-dried. A full disc was carefully remade by attaching the treated part to the control part with cellotape and placed in a petridish. Ten *T.castaneum* adults were released in the centre of each filter paper disc and covered so that the insects could not escape. Each test was replicated five times. Numbers of insects present on control(NC) and treated(NT) strips were recorded after 1,2,3,4,12 and 24 hours. Percent repellency(PR) was calculated as

PR=NC-NT/NC+NT×100 [15]

Effect of extracts on mortality of adults

Tests for contact toxicity were conducted [14] with slight modifications [16]. Stock solutions were prepared by dissolving 100 mg of the four individual extracts in 1ml of acetone. A concentration of 15, 30, 60 and 100mg/ml were standardized to calculate the median-lethal dose.

Twenty unsexed adult insects were placed in a petridish and 1µl of solution (100,60,30,15µg/insect) was applied to the dorsal surface of the thorax of the insect using a micropipette fitted with a capillary tube at the tip. Each test was replicated five times. In control, only solvent was applied. After treatment, insects were transferred to petridishes (20 insects/petri dish) containing food (whole meal wheat flour). Insects were examined after 24 hours of initial exposure and mortality was recorded. The mortality was evaluated by direct observation of the insects and corrected formula where necessary. [17]

Corrected Mortality = (1 – n in T after treatment) / (n in C after treatment) X 100, where n = insect population, T = treated, C = control.

Concentration – mortality lines were calculated using probit analysis [18] for the data with a $\log_{10}$ transformation of concentration of the plant extracts tested.

RESULTS AND DISCUSSION

The tested plant extracts exhibited significant repellency against *Tribolium castaneum*. Repellency was observed to be dependent upon duration of exposure and concentration of extracts. Higher repellency was recorded for *Lantana camara* when 1-4 mg/ml concentration was used for 1-24 hours of exposure time as compared to *Jatropha curcas* (Table 1). However, when 8mg/ml concentration was used for the exposure time of 1-24 hours, *J. curcas* was found to be more effective, exhibiting higher repellency compared to *L. camara* for the same concentration and exposure time. 80% repellency was observed when adults of *T. castaneum* were exposed to 8mg/ml of *J. curcas* extract for 24 hours. Only 60% repellency was observed when *T. castaneum* were exposed to *L. camara* extract of 8mg/ml concentration and duration of 24 hours. 72% repellency was observed when *T. castaneum* were exposed to 8mg/ml of *Calotropis procera* extract for duration of 24 hours. Repellency of *T. castaneum* was found to be 52% against extract of *Datura metel* for the maximum concentration and time duration. The order of repellency was found to be *J. curcas* > *C. procera* > *L. camara* > *D. metel* (Graph 1). The efficacy of the extracts was found to be directly proportional to their concentration and on the time interval for which it is applied. Earlier studies have shown that essential oils from mentha, carvacryl, citronella and eucalyptus have shown good repellent effects against *Aedes albopictus* [8], while *Artemisia princeps* and *Cinnamomum camphora* oils have shown repellent and insecticidal activity against *S. oryzae* and *Bruchus rufimanus* Bohemann [10].

Dichloromethane extracts of the tested plants resulted in appreciable lethal effects against *T.castaneum* producing higher mortality than the control. Of the doses tested (100, 60, 30 or 15µg/insect), mortality increased in a dose dependent fashion, with the highest contact toxicity at 100µg/insect for all the extracts (Graph 3). The DCM extract of *Jatropha curcas* consistently gave the lowest LC_{50} value indicating its superior potency amongst all the other extracts tested. *J. curcas* extract applied at 100µg/insect was significantly more toxic to the beetles producing >96% mortality within 24 hours of application. The order of toxicity to *T. castaneum* for the four plants were *J. curcas* > *L. camara* > *C. procera* > *D. metel.* In a similar study, seed oil, root and leaf extracts of *Jatropha nana*, *J. gossypifolia* and *J. glandulifera* were reported to have significant larvicidal and adulticidal activity against *Triboium castaneum* [13]. Apart from *Jatropha*, few other plant extracts have been reported to exhibit insecticidal activity against *Tribolium castaneum* [9], [19]. Effect of *J. gossypifolia* seed extract on the fecundity and fertility of *T. castaneum* and *T. confusum* has also been reported [11]. Leaf powders of *Annona squamosa* and *Balanites aegyptica* caused high mortality in *T. castaneum* and provided protection against seed damage [12]. Volatile oils isolated from leaves and flowers of *Lantana camara*, *Callistemon lanceolatus*, *Cymbopogon winterianus*, *Eucalyptus* sp., *Nerium oleander*, *Ocimum basilicum*, *Ocimum sanctum* and *V. negundo* [20], *S. hortensis*, *Thymus serphyllum* and *Origanum* sp. [21] have shown insecticidal, antifeedant and growth inhibitory activities against insect pests.

CONCLUSION

Present study indicates the efficacy of the tested plant extracts against the storage grain pest *Tribolium castaneum*. All the four plant extracts were found to have significant repellent effect on *T. castaneum* with *J. curcas* showing the highest repellency as well as significant lethal effects on *T.castaneum* producing higher mortality with lower LC50 value compared to the other tested plant extracts. Utilization of botanicals will help in designing bio-rational approaches in combating pests of grains and to a great extent in eliminating residues by cutting down the pesticidal load.

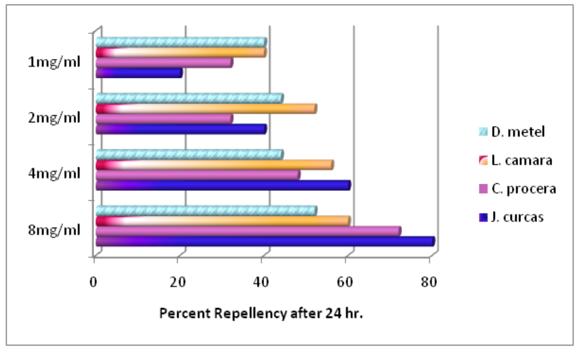
TABLES AND FIGURES

Table- 1 Repellent effects of the plant extracts against *T. castaneum*

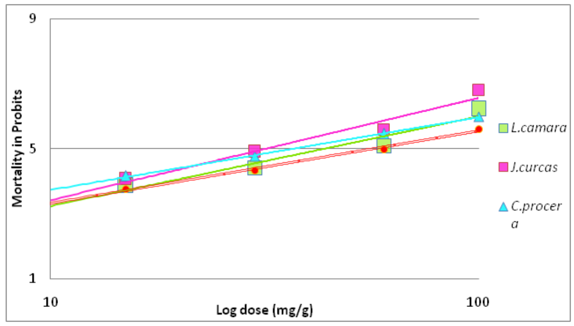
NC	NT	NC	NT	NC	NT	NC	NT	Treatment	NC	NT	NC	NT	NC	NT	NC	NT
1mg/ml		2mg/ml		4mg/ml		8mg/ml		HOUR	1mg/ml		2mg/ml		4mg/ml		8mg/ml	
5.2±.84	4.8±.84∞	5.2±.84	4.8±.84∞	5.8±.84	4.2±.84∞	7±.71	3±.71*	1	6.0±0.71	4±0.71*	6.6±0.55	3.4±0.55*	6.6±0.55	3.4±0.55*	6.8±0.45	3.2±0.45**
5.4±.89	4.6±.89∞	5.4±.89	4.6±.89∞	6.4±.55	3.6±.55*	7.2±.84	2.8±.84*	2	6.4±0.55	3.6±0.55*	6.6±0.55	3.4±0.55*	6.8±0.84	3.2±0.84*	7.2±0.84	2.8±0.84*
5.6±.55	4.4±.55*	5.4±.55	4.6±.55∞	6.6±1.1	3.4±1.1*	7.6±.55	2.4±.55**	3	6.6±0.55	3.4±0.55*	6.8±0.45	3.2±0.45**	6.8±0.45	3.2±0.45**	7.2±0.84	2.8±0.84*
5.6±.55	4.4±.55*	5.6±.55	4.4±.55*	7±.71	3±.71*	8.2±.45	1.8±.45**	4	6.6±0.55	3.4±0.55*	6.8±0.45	3.2±0.45**	7±0.71	3±0.71*	7.4±0.55	2.6±0.55**
6±.71	4±.71*	6.2±.45	3.8±.45*	7.2±.84	2.8±.84*	8.4±.55	1.6±.55**	12	6.8±0.45	3.2±0.45**	7.2±0.45	2.8±0.45**	7.4±0.55	2.6±0.55**	7.6±0.55	2.4±0.55**
6.6±.55	3.4±.55*	6.6±.55	3.4±.55*	7.4±.55	2.6±.55**	8.6±.55	1.4±.55**	24	7.0±1.0	3±1.0*	7.6±0.55	2.4±0.55**	7.8±0.84	2.2±0.84**	8±0.71	2±0.71**
			C. procera									*L. camara*				
6±.71	4±.71∞	6±.71	4±.71∞	6.4±.55	3.6±.55∞	6.8±.45	3.2±.45*	1	5.2±1.3	4.8±1.3∞	5.6±.55	4.4±.55*	6.4±.55	3.6±.55*	8±.71	2±.71**
6±.71	4±.71∞	6.4±.55	3.6±.55∞	6.8±.45	3.2±.45∞	6.8±.45	3.2±.45*	2	5.2±1.3	4.8±1.3∞	5.8±.45	4.2±.45*	7±1	3±1*	8±.71	2±.71**
6.4±.55	3.6±.55∞	6.6±.55	3.4±.55*	6.8±.45	3.2±.45∞	7.2±.45	2.8±.45*	3	5.4±1.1	4.6±1.1∞	5.6±.55	4.4±.55*	7.2±.84	2.8±.84*	8.4±.55	1.6±.55**
6.4±.55	3.6±.55∞	6.6±.55	3.4±.55*	6.8±.45	3.2±.45*	7±.71	3±.71*	4	5.6±.55	4.4±.55*	6±.71	4±.71*	7.4±.89	2.6±.89*	8.6±.55	1.4±.55**
6.8±.45	3.2±.45*	7±.71	3±.71*	7.2±.45	2.8±.45*	7.4±.55	2.6±.55**	12	5.8±.84	4.2±.84*	6.4±.55	3.6±.55*	7.6±.55	2.4±.55**	8.6±.55	1.4±.55**
7±.71	3±.71*	7.2±.45	2.8±.45*	7.2±.45	2.8±.45*	7.6±.55	2.4±.55**	24	6±1	4±1*	7±.71	3±.71*	8±.71	2±.71**	9±.71	1±.71**
			D. metel									*J. curcas*				

(Figures represent the mean of individual 5 sets ± S.D. ∞, non significant; *, significant; **, highly significant at p<0.05 level)

Graph - 1 Percentage repellencies of DCM extracts of tested plants against *T. castaneum* (24 hours) on filter paper bioassay.



Graph- 2 Log concentration – probit mor tality graph for four different plant extracts against *T. castaneum*



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