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TOXICITY OF PLANT BASED CHEMICALS AGAINST *TROGODERMA GRANARIUM*, A DESTRUCTIVE PEST OF STORED-GRAINS

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ABSTRACT

Stored products of agricultural and animal origin are attacked by more than 600 species of beetle pests. Khapra beetle, *Trogoderma granarium* is most destructive causing quantitative and qualitative losses of wheat in Pakistan. In this study, 0, 50, 150, 250, 350 and 450 mg/ ml concentration of extracts of *Azadirachta indica* and *Euclyptus globulus* were tested against *T. granarium*. The extract of *A. indica* was found to be more toxic. The number of emerged adults decreased while mortality of larvae and adults increased with concentration. The number of emerged adults was significantly higher ($p < 0.05$) in control and maximum larval mortality (36.82 ± 2.95% and 30.70 ± 2.90%) was observed with at 450 mg/ml dose of *A. indica* and *E. globulus*, respectively. Each extract showed high toxicity towards the adult stage than larval. Wheat losses were reduced by treating with plant extracts and botanicals are more effective.

Key words: Store grain pest, *Trogoderma granarium*, *Azadirachta indica, Euclyptus globules*, ecofriendly, alternative control, wheat losses, IPM, new approaches, Pakistan

Khapra beetle, *Trogoderma granarium* is a serious pest of stored grain such as rice, sesame, barley, sorghum, wheat, groundnut and many other stored products (Feroz, 2020; Yadav et al., 2021). This destructive pest is found in bins, granaries, farm houses and godowns in many countries like India, China, Pakistan, Africa, and Turkey due to favorable environmental conditions like humidity and temperature (Naseri and Borzoui, 2016; Mutlu et al., 2019). It is primary serious pest of various stored grain products especially wheat under hot dry conditions. Wheat is the cereal and staple crop of various countries especially Pakistan. Several insect pests such as *Sitophilus oryzae*, *Tribolium castaneum*, *Rhyzopertha dominaca, Lasioderma serricorne*, *Sitotroga cereallela*, *Cadra cautella, Stegobium paniceum* and *T. granarium* attack wheat in storage (Kumar et al., 2022; Zafar et al., 2022). Among all these pests, *T. granarium* is the most damaging pest (Borzoui et al., 2015; Golizadeh and Abedi, 2016; Athanassiou et al., 2019). During severe infestation, 5-30% weight loss of wheat occurred. The quality as well as quantity of wheat are badly affected. In Pakistan, wheat is used commercially for many purposes (Zahoor et al., 2016; Hubert et al., 2018). The stored products like wheat can protected through the use of botanical extracts but this practice is not adopted in Pakistan. *Euclyptus globulus* and *Azadirachta indica* are very important alternative and ecofriendly control methods (Kavallieratos et al., 2018; Honey et al., 2017). This study evaluates the efficacy of *A. indica* and *E. globulus* extracts against *T. granarium* on wheat.

MATERIALS AND METHODS

The study was conducted in the MNS-University of Agriculture, Multan at Institute of Plant Protection (IP^2) from May 2019 to February 2020. *T. granarium* was collected from infested wheat stored in the room and brought to laboratory with infested wheat for rearing purposes. The pest was reared on wheat variety Johar 2016 in 1L plastic container. A 1ℓ plastic container was filled with 100 g wheat and all stages of pest (eggs, larvae, pupae and adults) were shifted into container. The lid of container was covered tightly with mesh cloth using rubber band to provide the proper aeration and prevent the escape of pest from container. Culture of pest was maintained at 30± 2°C and 70%± 5 RH with 13L:11D hour photoperiod. Fresh leaves of *A. indica* and *E. globuls* were collected from nearby areas of the University and brought to laboratory for extraction and further bioassay study. The leaves were washed with tap water or flowing water and then shade dried before crushing with mortar and pestle grinded by electric

blender to fine powder. One hundred grams (100 g) powder and five hundred (500 mℓ) mℓ of 95% ethanol were added in conical flask. The flask was shaken for 20 min. and left for 2 days to get extracts. Filtration of extract was done with Whatmans filter paper and shifted to glass tubes which then stored in refrigerator at 4°C. The concentrations of 0, 50, 150, 250, 350 and 450 mg/ mℓ of extract were made and placed in bottles with rubber seals. Sixty grams of wheat were weighed, placed into plastic container and mixed with extracts of *A. indica* and *E. globulus* separately. Each container was shaken for 1 min to allow the proper mixing of extract with wheat and containers were covered with muslin cloth by rubber band. The wheat treated with petroleum ether was considered as control. Each treatment was replicated five times. The experiment was divided into three parts. In first part, two and four male and female beetles, respectively were placed into each jar consisting control and extract-treated wheat. Jars were checked on daily basis for 40 days of treatment to record the seed damage, number of emerged adults and weight loss. In second part, 20 male and female adults were shifted into another jar consisting treated and untreated seeds. By recording the mortality of beetle, the protective effect of the extract was assessed on 5th day of treatment. In third part, 20 Nos of 3rd instar larvae were transferred in each jar consisting treated and untreated grains/ seeds, and mortality recorded and after 36 hrs. Seeds of wheat were sown to check the germination (%). The procedure of early researchers was followed to perform the current experiment (Odeyemi and Ashamo, 2005; Derbalah, 2012; Mahmoud et al., 2015). Collected data were statistically analyzed to 2-way of ANOVA to determine the effect of time and concentration on the mortality. Turkeys HSD test was applied after ANOVA using Statistix 8.1 software to compare the means.

RESULTS AND DISCUSSION

The toxicity of two botanical extracts, *A. indica* and *E. globulus* checked against *T. granarium* was found varying with concentration of plant extract and time duration. Emerged adults were found to reduce but mortality of larvae and adults increased with increase in the concentration or dose of extract. The number of emerged adults was significantly higher ($p < 0.05$) in control. Ali et al. (2022) reported about efficacy of plant based products especially neem, *A. indica*. It was noticed that at 450 mg/mℓ dose of *A. indica* and *E. globulus*, maximum larval mortality was 36.82± 2.95% and 30.70± 2.90%, respectively which was significantly different ($p < 0.05$). Extracts were more toxic towards the adults than larvae and these findings are almost similar to the earlier ones (Mahmoud et al., 2015; Zeinab and Abdelhafiz, 2019). The larval mortality was 10.33± 2.61, 14.38± 3.71, 19.54± 2.91, 27.69± 2.81, and 36.82± 2.95% at 50, 150, 250, 350 and 450 mg/ mℓ dose of *A. indica* extract, respectively. The adult mortality at 50, 150, 250, 350 and 450 mg/ mℓ was 23.76, 25.12, 29.01, 36.09, and 41.11%, respectively. The emerged adults was 89.44± 3.53, 81.10± 3.91, 68.55± 5.28, 67.44± 3.31, and 49.19± 3.71% at 50, 150, 250, 350 and 450 mg/ mℓ dose of *E. globulus* extract, respectively. The mean percentage of adult mortality at 50, 150, 250, 350 and 450 mg/ mℓ was 10.76± 1.27, 12.12± 2.33, 17.01± 3.15, 23.09± 3.54 and 37.11± 2.27, respectively (Table 1). Ali et al. (2022) tested extracts of *Solanum nigrum*, *Citrus reticulate, Datura stramonium*, and *Azadirachta indica* against larvae of *T. granarium.* They reported that *A. indica* showed 79% repellency at 24 hr thus post treatment and *A. indica* has potential to repel larvae, which ultimately reduce the grain damage and weight loss. Singh et al. (2017) and Asiry and Zaitoun (2020) reported the similar findings.

The weight loss and seed damage in wheat was found to be reduced with applications of *A. indica*; no significant difference was observed in weight loss between 0 mg/mℓ and 150 mg/mℓ dose and between 250 mg/ mℓ and 500 mg/ mℓ doses. 97.55% seed germination was recorded at 450 mg/ mℓ concentration, while it was 82.01% in control (Table 1); 1.09, 1.11, 1.19, 1.23 and 2.54% loss were recorded at 450, 350, 250, 150 and 50 mg/ mℓ concentration. The extract of *E. globuls* was recorded the least effective resulting in more weight loss and seed damage than *A. indica* (Table 1). The maximum germination was recorded in seed which treated with *A. indica* than *E. globulus,* germination increased with dose of extract. Both extracts obtained from *A. indica* and *E. globulus* have toxic effects and potential/efficiency to control various insect pests. The pest population can reduce by the application of such chemicals in controlled or field conditions (Zia-ul-Haq et al., 2014; Ali et al., 2022; Hassan et al., 2022). Based on overall findings of the current study, it is concluded that plant-based products especially extracts of *A. indica* and *E. globuls* have potential to reduce the storage pest populations.

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Table 1. Larval and adult mortality and adult emergence of *T. granarium* as effected by plant products and their effect on weight loss and germination of wheat

Plant Products Dosage (mg/ mℓ)	% of larvae mortality	% of emerged adults	% of adults mortality
A. indica			
50	10.33± 2.61a	87.44± 3.53d	23.76± 2.34a
150	14.38± 3.71b	83.10± 3.91cd	25.12± 1.41b
250	19.54± 2.91c	80.55± 5.28c	29.01± 4.08c
350	27.69± 2.81c	71.44± 3.31b	36.09± 4.65cd
450	36.82± 2.95c	57.19± 3.71a	41.11± 1.33d
Control	4.99± 1.22ab	77.34± 5.73e	3.66± 2.83a
E. globulas			
50	9.41± 2.82a	89.44± 3.53d	10.76± 1.27a
150	12.40± 2.62b	81.10± 3.91cd	12.12± 2.33b
250	16.42± 2.87c	68.55± 5.28c	17.01± 3.15c
350	22.71± 2.52c	67.44± 3.31b	23.09± 3.54cd
450	30.70± 2.90c	49.19± 3.71a	37.11± 2.27d
Control	4.08± 2.16ab	70.43± 4.81e	5.00± 3.61a
	% of damaged seeds	% weight loss in gram (a)	% of seed germined nation
A. indica			
50	60.68± 5.54c	2.54± 0.13b	85.74± 6.82a
150	56.36± 4.20c	2.12± 0.33b	88.81± 4.57a
250	50.11± 4.58c	1.14± 0.30a	94.64± 2.30a
350	45.10± 5.17b	0.89± 0.32a	95.42± 3.28a
450	37.41± 3.40a	0.35± 0.50a	97.55± 1.43a
Control	71.38± 2.36c	2.74± 0.10b	82.01± 2.70a
E. globulas			
50	54.70± 6.43c	2.54± 0.18b	83.60± 5.91a
150	50.40± 5.34c	1.23± 0.26b	87.65± 5.63a
250	47.23± 3.62c	1.19± 0.29a	91.54± 3.20a
350	41.20± 4.21b	1.11± 0.30a	93.33± 4.31a
450	36.53± 2.51a	1.09± 0.34a	95.48± 2.54a
Control	73.44± 3.45c	2.90± 0.10b	81.02± 3.68a

Tukey's test showed that means followed by the similar small letter in the similar column are not significant ($p< 0.05$) different to each other.

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AUTHOR CONTRIBUTION STATEMENT

Each author contributed equally.

CONFLICT OF INTEREST

Authors have no conflict of interest.

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