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

SHAWANA KIRAN¹, MUHAMMAD JAVID IQBAL¹, SADDAM HUSSAIN², USAMA SALEEM¹*, YASMINE SHAFIQUE¹, MUHAMMAD KAMAL¹, MUHAMMAD KASHIF AZIZ³, TABSHEER AYESHA⁴ AND ANSA TARIQ³

¹Department of Zoology, Government College University Faisalabad, Pakistan
²Department of Zoology, University of Agriculture, Dera Ismail Khan, Pakistan
³Department of Zoology, Minhaj University Lahore, Pakistan
⁴Department of Zoology, Government College Women University Faisalabad, Pakistan

*Email: usamasaleem7233@gmail.com (corresponding author): ORCID ID 0000-0003-3698-7364

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 Eucalyptus 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, Eucalyptus 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 Borzouei, 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 cerealella, Cadra cautella, Stegobium panicum 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 (Borzouei 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. Eucalyptus 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 (IP²) 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. globulus 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 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 dose 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. globulus have potential to reduce the storage pest populations.

ACKNOWLEDGEMENTS

All authors are highly thankful to the concern institutes.
Table 1. Larval and adult mortality and adult emergence of *T. granarium* as affected by plant products and their effect on weight loss and germination of wheat

<table>
<thead>
<tr>
<th>Plant Products</th>
<th>% of larvae mortality</th>
<th>% of emerged adults</th>
<th>% of adults mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Dosage (mg/ mℓ)</strong></td>
<td><strong>A. indica</strong></td>
<td><strong>E. globulas</strong></td>
<td><strong>A. indica</strong></td>
</tr>
<tr>
<td>50</td>
<td>10.33 ± 2.61a</td>
<td>9.41 ± 2.82a</td>
<td>60.68 ± 5.54c</td>
</tr>
<tr>
<td>150</td>
<td>14.38 ± 3.71b</td>
<td>12.40 ± 2.62b</td>
<td>56.36 ± 4.20c</td>
</tr>
<tr>
<td>250</td>
<td>19.54 ± 2.91c</td>
<td>16.42 ± 2.87c</td>
<td>50.11 ± 4.58c</td>
</tr>
<tr>
<td>350</td>
<td>27.69 ± 2.81c</td>
<td>22.71 ± 2.52c</td>
<td>45.10 ± 5.17b</td>
</tr>
<tr>
<td>450</td>
<td>36.82 ± 2.95c</td>
<td>30.70 ± 2.90c</td>
<td>37.41 ± 3.40a</td>
</tr>
<tr>
<td>Control</td>
<td>4.99 ± 1.22ab</td>
<td>4.08 ± 2.16ab</td>
<td>71.38 ± 2.36c</td>
</tr>
</tbody>
</table>

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.

FINANCIAL SUPPORT

No financial support was provided during this study.

AUTHOR CONTRIBUTION STATEMENT

Each author contributed equally.

CONFLICT OF INTEREST

Authors have no conflict of interest.

REFERENCES


(Manuscript Received: January, 2023; Revised: March, 2023; Accepted: March, 2023; Online Published: April, 2023)

Online First in www.entosocindia.org and indianjournal.com Ref. No. e23195