Original Research Article

Traditionally used Botanicals:The potential source of *Triboliumcastaneum*(Herbst) management

Abstract

To solve the problem of *Triboliumcastaneum*Herbst in wheat storage a study was conducted in Jorhat-13, Assam Agricultural University's Department of Entomology, in 2018.Wheat is widely used as a staple food in the world including India. But storage condition conditionsof wheat grains are infected by several coleopteran pests. *Triboliumcastaneum*Herbst is a ubiquitous and pestiferous pest among all. Adult and larva larvaeboth are harmful for towheat storage which often demolishes stored grains.The present study attempted to manageDry powders of *A. indica*, *C. roseus*, *C. heptaphylla*, *D. stramonium*, *E. tereticornis*, *M. struthiopteris*, and *V. negundo* were used against *T. castaneum* to get rid of problematic local medicinal plants.The highest LD_{50} value was found in *A. indica* (1.49%) followed by *D.stramonium* (1.52%) and *E. tereticornis* (2.02%) and the lowest LD_{50} in *Matteucciastruthiopteris* (11.72%). In the repellency test, the highest rate of repellency was observed in *A. indica* (82.21%) followed by *D. stramonium* (72.59%), *E. tereticornis* (70.36%), and the lowest in *Matteucciastruthiopteris*(32.58%). Based on LD_{50} and mean repellency, the top three botanicals (*A. indica, D. stramonium, E. tereticornis*) were selected for further worke.g.,mortality and weight loss. Mortality A mortalitystudy recorded 100% mortality after 35 days of treatment in the case of *A. indica*, *D. stramonium*, *E. tereticornis*. During the trial in 2018, *A. indica* (5.76%) had the lowest grain weight loss, followed by *D. stramonium* (12.05%) and *E. tereticornis* (12.05). The highest grain weight loss was observed in control with 62.33 per cent. Give your one line conclusion on these research.

Key word- Wheat, *Triboliumcastaneum*, Botanicals, LD_{50} and Repellency.

Introduction

Wheat is one of themost important cereal grains, used widely as staple food in many countries for high nutritive values. The population is expected to grow to 9.1 billion people by the year 2050, and about 70% extra food production will be required to feed those (Godfray*et al.*, 2010).But the major constrains constraintsof storagewheat is the insect infestation and more than 600 different species of beetles, 70 species of moths, 355 species of mites, 40 species of rodents, and 150 species of fungi (Nattudurai*et al.*, 2017) attack wheat. Among them, *Triboliumcastaneum*Herbst (Coleoptera:Tenebrionidae) is a ubiquitous and pestiferous storage pest which often demolish stored grains specially wheat causes 328mg weight loss due to infestation of adults and larvae (Rathore, 2022).Due to infestation of this insect flour turns grayish and mouldy with pungent odour (Good, 1936; Roorda *et al.*, 1982; Hagstrum and Subramanyam, 2006).

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Finding more effective and healthy substitutes has become required due to synthetic insecticide toxicity and resistance issues.Presently, plant extracts are the most commonly tested alternative products (Papachristos and Stamopoulus 2002; Umoetok and Gerard 2003; Ferrero *et al.*, 2006; Chopa*et al.*, 2006; Wang *et al.*, 2006).Botanicals contain manyalkaloids and other secondary metabolites which have insecticidal and anti-feedant properties against several storage ~~pest~~ pests(Khalequzzaman and Sultana, 2006; Anita *etal*., 2012; Ramya*etal*., 2008; Islam and Talukder, 2005);Kumral*et al.*,(2009) also described about theacaricidal, repellent, and oviposition deterrent activities of various botanicals.

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To overcome the problems of synthetic pesticides, there is an urgent ~~needs~~ need~~of~~ foran eco-friendly, economically viable alternative pest control method~~which~~ thatis affordable for poor farming communities, safe for ~~workers~~ worker'shealth, and has higher returns (Sighamony*et al*., 1990; Cobbinah and Appiah-Kwarteng, 1989; Niber, 1994; Jembere*et al*., 1995; Lajide*et al*., 1998;). Talukder(2006), listed 43 plant species as insect repellents, 21 plants as insect feeding deterrents, 47 plants as insect toxicants, 37 plants as grain protectants, 27 plants as insect reproduction inhibitors, and 7 plants as insect growth and development inhibitors.Among the medicinal plants, several domestic plant species ~~has~~ havebeen reported to be repellent and toxic to*T. castaneum*(Mareggiani*et al*., 2000; Nikkon*et al*., 2009; Suthisut*et al*., 2011).Therefore, ~~in~~ the present studysevenlocally available and ~~farmer's~~ farmerused plants dry powders were tested against *Triboliumcastaneum*(Herbst)in the Department of ~~entomology~~Entomology, AAU Jorhat-13 ~~during~~ in2018.

MATERIALS AND METHODS

To find out thedry ~~powders~~ powderefficacy of seven botanicals *viz. Azadirachtaindica*, *Catharanthusroseus*, *Clausenaheptaphylla*, *Datura stramonium*, *Eucalyptus tereticornis*, *Matteucciastruthiopteris*, and *Vitexnegundo* against *Triboliumcastaneum*(Herbst).An experimentwas carried out in 2018, in the Toxicology Laboratory of the Department of Entomology at AAU Jorhat-13.

Adults stage of *Triboliumcastaneum*(Herbst)were collected from ~~Post Harvest~~Post-Harvest Laboratory, Department of Agricultural Engineering, Jorhat-13 for mass rearing (Abbasipour*et al*., 2011). The fresh wheat seed (HD- 3086) was provided for feeding in eight different plastic containers (2 No's 29cm×12cm, 2 No's 32cm×13.50, 2 No's 25cm×12cm, 2 No's 22cm×11cm). The insect culture was maintained in toxicology laboratory, Department of Entomology, AAU Jorhat- 13, on room temperature 27- 30^{0}C.

Leaves were collected and washed with tap water and kept in shade for air- drying. After complete drying, electric blender was used to make and fine powder and obtained by sieving through kitchen strainer (Agha *et al.*, 2017).For each plant leaf powder was used as 0.25, 0.50, 0.75, 1.00, 1.25, 1.75 and 2.50 gm / 25g seed were thoroughly mixed which correspondence to 1, 2, 3, 4, 5, 7 and 10 per cent (wt./wt.), (Ojo and Ogunleye, 2013).The treated seeds were stored in plastic containers (7 cm ×6 cm) at room temperature with three replications and 20 adults for

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each treatment.After 24, 48, and 72 hours of therapy, the mortality was calculated. If there was mortality in control, Abbott's formula (1925) was used to rectify it. To get the LD50 value (wt/wt), probit analysis was used on the mortality data that was obtained.

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For repellency test, 9 cm diameter ~~petri~~ Petri dish was divided into three parts, treated, untreated and without grain part (Karakas, 2016). In treated part of the plate filled with 0.3gm of dry powder from each plant were mixed with 3gm of wheat seed (10% wt/wt) (Dhaniya and Dayanandan, 2016).

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Test chamber with one side treated and the other untreated. Each ~~petri~~ Petri dishmiddle area received ten insects, which were then released while being protected by a cover plate. ~~Then, up u~~Until the sixth hour, the number of insects on each chamber was counted hourly. The formula below was used to get the percent repellency.

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PR (%) = (Nc-50) x 2

Where: PR= % repulsion,

Nc= Percentage of weevils present in the control half.

According to Mc Donald et al. 1970, the grades of repellency (% repellency rate) were categorized. One ANOVA with the JMP SAS and IBM SPSS 20 packages was used to examine differences between distinct means.

Repellency rate (%) Class

> 0.01	-	0.1	0
0.1	-	20	I
20.1	-	40	II
40.1	-	60	III
60.1	-	80	IV
80.1	-	100	V

The four most effective botanicals were chosen from the LD50 testing. 10 ~~gm~~ gdry powder of these botanicals was mixed with 100g~~m~~ (10% w/w) seeds (Ojo and Ogunleye, 2013). The treated seeds were subsequently released along with 20 individuals (male and female, in a 1:1 ratio) to observe *T. castaneum* mortality. At 1, 3, 7, 14, 21, 28, 35, and 45 days, the number of dead insects was counted in order to assess mortality. Counting was stop after 45 days to avoid the overlapping generation (Devi *et al.*, 2014:). If mortality was found in control subjected to percentage of corrected mortality by Abbott's (1925).

The following formula was used to determine the weight loss of grains.
% WL= (IW-FW) X 100 / IW

Where, WL: Weight loss index.
IW: Initial weight and FW is the final weight.

Results and discussion

Dry powders' effectiveness in combating Triboliumcastaneum

The assessment of the comparative toxicity and LD_{50} of seven plant leaf powders were saw in 2018. Relative lethality has been expressed as a percentage and LD_{50} has been expressed as a percentage with weight/weight g.In 2018, result of experiment of laboratory efficacy and relative toxicity were described below. After 24 hours of exposure, *A. indica, C. roseus, C. heptaphylla, D. stramonium, E. tereticornis, M. struthiopteris,* and *V. negundo* had LD50 values of 2.09, 8.15, 9.05, 2.97, 2.81, 19.40, and 11.72 percent (wt/wt) against *T. castaneum,* respectively.After 48 hr of exposure it was 1.71, 3.82, 3.48, 2.01, 2.49, 14.64, 3.94 per cent and after 72 hr 1.49, 2.71, 4.44, 1.52, 2.02, 4.45, 2.80 per cent respectively (Fig.1).

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The toxicity orderof diverseplant powders against *Triboliumcastaneum*(Herbst) was *A. indica*>*E. tereticornis*>*D. stramonium*>*C. roseus*> *C. heptaphylla*> *V. negundo*> *M. struthiopteris* when *A. indica*was considered as standard for the exposure period of 24 hr. After 48 hr and 72 hr of exposure, the order of toxicity was *A. indica*>*D. stramonium*> *E. tereticornis*>*C. heptaphylla*> *C. roseus*>*V. negundo*> *M. struthiopteris* and *A. indica*>*D. stramonium*>*E. tereticornis*>*C. roseus*> *V. negundo*> *C. heptaphylla*>*M. struthiopteris,* respectively (Fig. 1).

In the present investigation, *A. indica*was considered as standard to evaluate the relative toxicity of selected botanicals.After exposure for 24, 48, and 72 hours, respectively~~, .the~~ The respective toxicities of *C. roseus, C. heptaphylla, D. stramonium, E. tereticornis, M. struthiopteris,* and *V. negundo* were ~~all~~ found to be significantly less toxic than *A. indica* (Fig. 1).In bioassay study, it was perceived that the per cent mortality of *Triboliumcastaneum*(Herbst) due to the botanicals action was raised gradually with increase in concentrations as well as exposure period.

During the experiment, it was discovered that the relative toxicity and LD_{50} of the plants *Azadirachtaindica, Catharanthusroseus, Clausenaheptaphylla, Datura stramonium, Eucalyptus tereticornis, Matteucciastruthiopteris,* and*Vitexnegundo* varied significantly. Comparing these botanicals to other botanicals, *A. indica, D. stramonium,* and *E. tereticornis* produced the best results. *A. indica* leaf powder was found to have the maximum toxicity against *T. castaneum* (Herbst) based on LD_{50} and relative toxicity, which was consistent with findings by Mamun*et al.* in 2009 and Rehman*et al.* in 2019. Different authors described the toxicity of *A. indica* against numerous storage pests.They reported that the presence of triterpenoid /secondary metabolites azadirachtin, salanin, meliantriol (Mbailao*et al*. 2006, Ileke and Oni 2011) were responsible for antifeedant, ovicidal,

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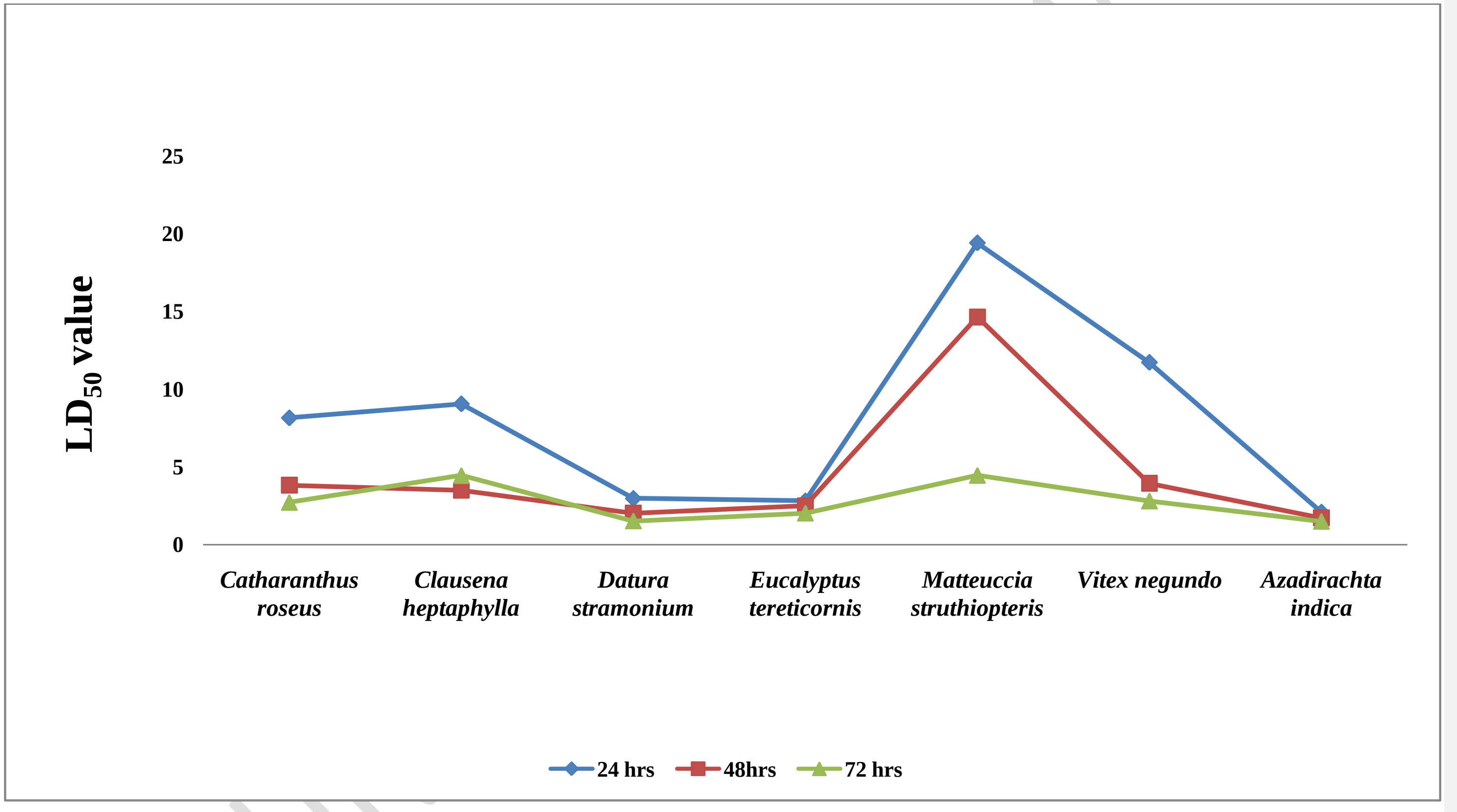
Figure 1. LD$_{50}$ and Relative toxicity of different plant powder against *Triboliumcastaneum*(Herbst) after 24, 48 and 72 hours of treatment (2018)



The data were found to be significantly heterogeneous at = 0.05

Y = Probit kill, X = log dose

Mortality based on 4 replications each with 20 individuals larvicidal, insect growth regulatory, and repellent activity (Chaudhary *et al.*, 2017) of *A. indica*. *Eucalyptus tereticornis*leaf powder was found effective against *T. castaneum*(Herbst) based on LD_{50} experiment. Earlier workers also observed that the eucalyptus was effective against *T. castaneum*(Siddique *et al.*, 2017) and*Trogodermagranarium* (Agha *et al.*,2017).Jawalkar*et al.*,2016; Al Bachchu; Jahan*et al.*, 2019 also used *D. Stramonium*and*A. indica*against storage pests and found similar ~~result~~results.

Repellency~~of~~ testingagainst *Triboliumcastaneum*

The repellency rate was observed highest in *A. indica*(86.66%), which was significantly different from other treatments, followed by *D. Stramonium*(73.33%), *E. tereticornis*(73.33%), and *C. heptaphylla*(66.66%), which were statistically similar with each other. *C. roseus*(46.66%) showed a comparatively less repellency rate, while *V. negundo* (33.33%), *M. struthiopteris*(26.66%) gave significantly less repellency rate in comparison to other treatments. After 2 h~~r~~ onward the repellency rate gradually increased and was found highest in the case of *D. struthiopteris*(80.00%) after 72 hr of treatment. After 72 hours of treatment, there was no discernible difference in the repellency of *A. indica* (80.00%), *C. roseus* (33.33%), *C.heptaphylla* (60.00%), and *E. tereticornis* (73.33%). After 72 hours, *M. Struthiopteris* (40.00%) and *V. negundo* (40.00%) likewise recorded lower repellency rates (Fig. 2).

After observation of 1, 2, 3, 4, 5, 6, 24, 48, and 72 h~~r~~ the mean repellency rate was found in *A. indica*(82.21%) which was under the repellency class V (based on the scale given by Mc Donald *et al.*,1970) followed by *D. stramonium*(72.59%), *E. tereticornis*(70.36%), *C. heptaphylla*(64.07%) and *V. negundo*(53.33%) (class IV),while *C. roseus*(47.67%) was found under (class III). The less mean repellency was observed in case of *M. struthiopteris*(32.58%) under repellency (class II).There was no repellency observed in control treatment. (Fig. 2)After *D. stramonium*, *A. indica*, leaf powder shown greater repellency against *T. castaneum* (Herbst) in treated wheat grains. The significant toxicity of *D. stramonium* against storage pest was also noted in earlier works by various researchers (Abbasipour*et al.*, 2011, and Jawalkar*et al.*, 2016). Another study by Manzoor et al. (2011) found that *D. stramonium* had the highest level of repellency toward *Callosobruchuschinensis*.

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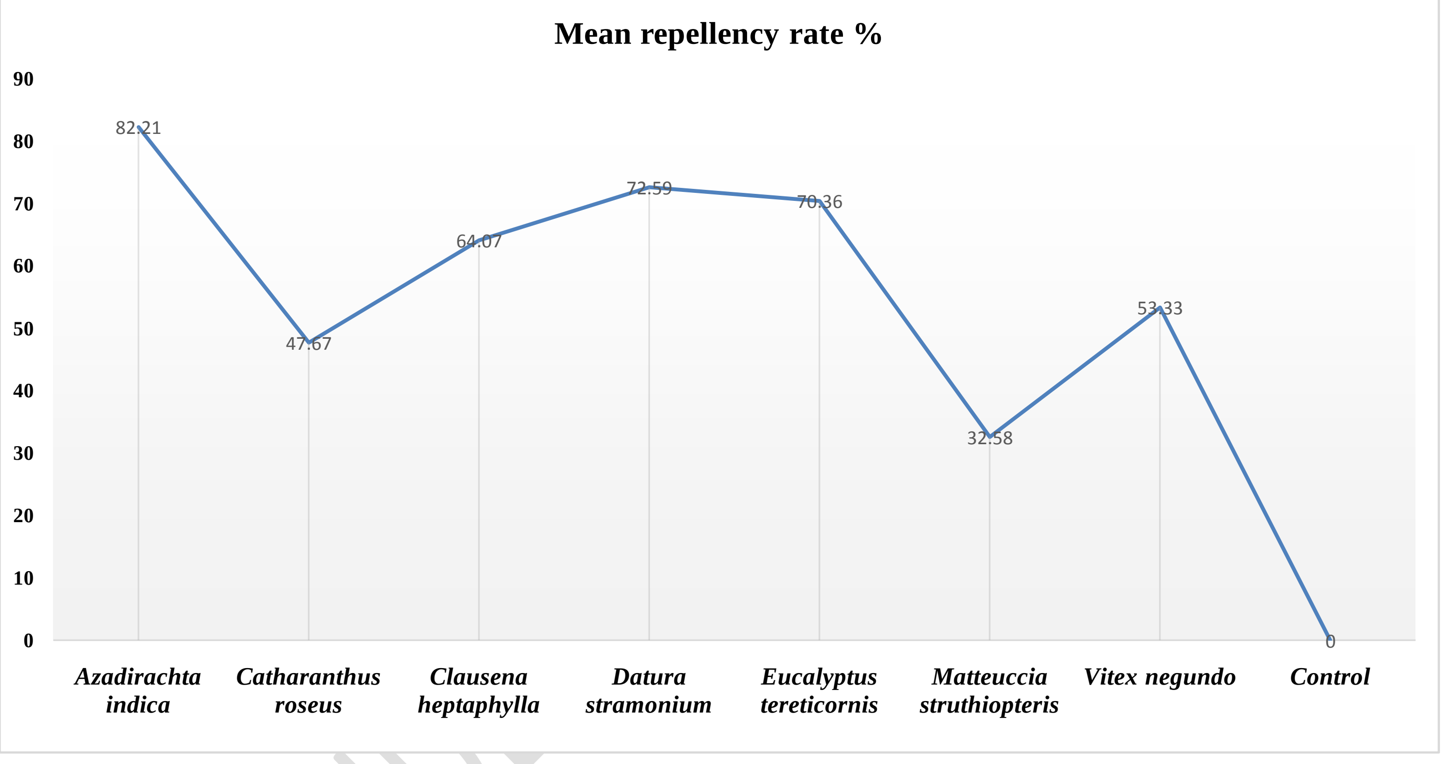
Hanif *et al.*, (2016) also reported the highest rate of repellency advocated by *A. indica*and *D. stramonium* (77.66%, 81.48% and 76.43%) against *T. castaneum*, *Rhyzoperthadominica*and *Trogodermagranarium*.Many workers reported that *D. stramonium*has both poisonous and medicinal properties (Soni*et al*, 2012; Mukhtar *et al.*, 2019). All parts of *D. stramonium* are toxic to mammals. (Mukhtar *et al.*, 2019). In Ayurvedic, *D. stramonium*is described (Kirtikar and Basu, 1999; Soni*et al.*, 2012) as remedial medicine for various human ailments.*Eucalyptus tereticornis*leaf powder found effective against *T. castaneum*(Herbst) based on repellency. Naseem and Khan (2011) showed that higher concentration (60%) of *E. camaldulensis*recorded 75.83% repellency of *T. castaneum*after 3~~three~~ h~~rs~~ of treatment.

Figure 2. In 2018, the effect of several plant leaf powders at repelling *Triboliumcastaneum* (Herbst).



Figures with in parentheses are transformed values

Data are based on 3 replications each with 10 individuals

Zero and cent per cent values were subjected to the formula ¼ n before angular transformation (after Steel and Torrie, 1960), where n= number of insects

Mortality of *Triboliumcastaneum*

The results in the year 2018 revealed that *A. indica*dry leaf powder had given maximum (32.50%) mortality of *T. castaneum*followed by *D. stramonium* (31.25%) and *E. tereticornis*(28.75%), which were statistically similar to each other and significantly different from the control one day after treatment, while no mortality was found in control. Similarly, at 3, 7, and 14 days after treatment also, *A. indica*showed the highest mortality (42.50, 52.50 and 62.50%, respectively) ~~then~~ than*D. stramonium* (40.00, 50.00 and 60.00%, respectively) and *E. tereticornis* (35.00, 40.00 and 55.00%, respectively). They were registered comparatively less mortality than *A. indica*. At 21 and 28 days after treatment, it was observed that all the ~~treatments~~ treatment'smortality increased gradually and was found 100% at 35 days after treatment. *A. indica*showed significantly highest mortality (80.00% and 92.50%, respectively), followed by *D. stramonium* (77.50% and 90.00%, respectively) and *E. tereticornis*(75.00% and 87.50%, respectively)which were statistically atpar. No mortality was observed in the case of control (Fig. 3).Effect of botanicals on stored grain pests ~~were~~ wasalso observed in previous studies by Kumar *et al.* (2008) and Perera and Karunaratne (2012). *D. stramonium* leaf powder also demonstrated increased mortality in treated wheat grains when compared to *A. indica* when compared to *T. castaneum* (Herbst). Previous works of many workers also reported the high toxicity of *D. stramonium*againststorage pests (Jawalkar*et al.*, 2016 and Abbasipour*et al.*, 2011).Another study by Manzoor*et al.* (2011) found that *Triboliumcastaneum* was where *D. stramonium* caused the greatest amount of mortality.Based on mortality, *Eucalyptus tereticornis* leaf powder was proven to be efficient against *T. castaneum* (Herbst). Earlier workers also observed that eucalyptus was effective against *T. castaneum*(Siddique *et al.*, 2017) and*Trogodermagranarium* (Agha *et al.*,2017). *E. globulus*registered 100 ~~per cent~~percent mortality (Rupp *et al.*, 2006) and 71 ~~per cent~~percent (Chagas *et al.*, 2002) feeding inhibition activity *of S. oryzae.*

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Weight loss of wheat grains

All of the released insects died after 35 days in 2018 when wheat grains were treated with *A. indica*, *D. stramonium*, and *E. tereticornis* to observe the mortality of *T. castaneum*.

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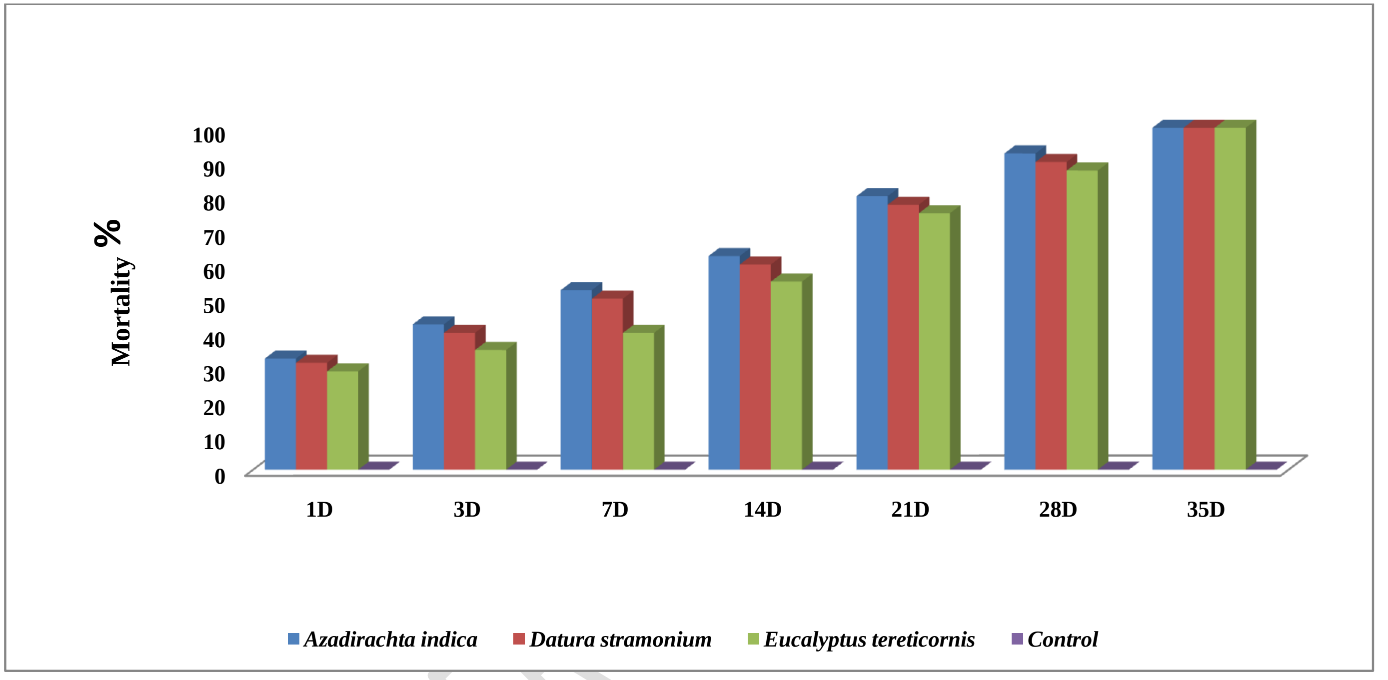
So, 35 days later, the weight reduction of the grains was determined. The lowest grain weight loss was seen in *A. indica* (5.76%), followed by *D. stramonium* (12. 05%) and *E. tereticornis* (12. 05) throughout the experiment in 2018. *T. castaneum* discharged plant dry powder treated containers.

The control group experienced a significant grain weight decrease in 2018 (62.33%), which was significantly higher than that of the other botanicals treatments (Fig. 4). Most of the secondary metabolites are highly effective against insect pests, ecofriendly, easily extractable and biodegradable, with low or no mammalian toxicity. (Tisserand and Balacs 1995; Isman 2000;

Amer and Mehlhorn 2006a, b; Shaaya and Rafaeli 2007; Abdel- Ghaffar and Semmler 2007; Bagvan*et al.*, 2008 and Lucia *et al.*, 2012).

Figure 3. Mortality of *Triboliumcastaneum*(Herbst) after using different plants powder in 2018



D= Day after spraying

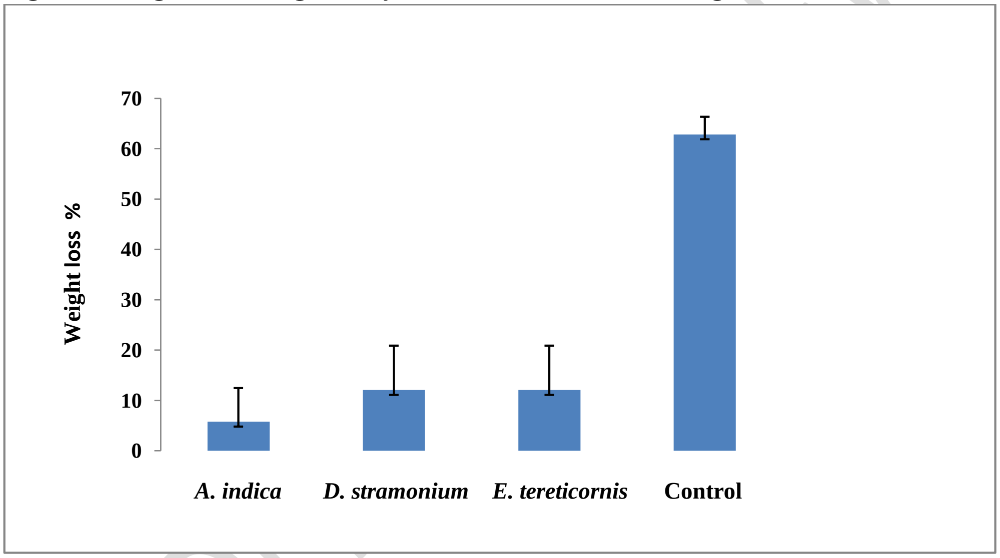
Figures are average corrected mortalities of 4 replications with 20 insects

Figures with in parentheses are transformed values

Zero and cent per cent values were subjected to the formula ¼ n before angular transformation (after Steel and Torrie, 1960), where n= number of insects

Most of the plant terpenoids showed repaid knockdown effect indicating neurotoxic mode of action (Enan 2001 and Isman 2006).Effect of botanicals on stored grain pests were also observed in previous studies by Kumar *et al*. (2008) and Perera and Karunaratne (2012). *D. stramonium* leaf powder also demonstrated with higher weight loss results in treated wheat grains when compared to *A. indica*against *T. castaneum*(Herbst). Based on a weight loss experiment, *Eucalyptus tereticornis* leaf powder was proven to be efficient against *T. castaneum* (Herbst).The earlier weight loss studies(Haq *et al.*, 2005; Khanzada*et al.*,2017)are also showing similarity with present study.

Figure 4. Weight loss brought on by *T. castaneum* in wheat during 2018



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