Xi'an Shiyou Daxue Xuebao (Ziran Kexue Ban)/
Journal of Xi'an Shiyou University, Natural Sciences Edition
ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 11 | 2023
DOI: 10.5281/zenodo.10224256

EFFECT OF DIFFERENT PLANT POWDER DOSAGES AGAINST *RHYZOPERTHA DOMINICA* (COLEOPTERA: BOSTRICHIDAE) AND *TROGODERMA GRANARIUM* (COLEOPTERA: DERMESTIDAE) IN STORED WHEAT GRAINS

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Abstract

The leaves and branches of two plants species *Citrullus colocynthis* and *Salvadora oleoides* were obtained to acquire powder. The mixed powder was applied individually at 5g and 10g concentration against *Rhyzopertha dominica* and *Trogoderma granarium*. Studies were carried out from August-2021 to March-2022 under controlled laboratory conditions. The observations were made on the concern parameters such as, Mortality rate, Weight loss and Supplement damage of the grain. Results revealed that non-significantly maximum mortality of both pests were recorded 57.0% and 58.0% at 10g dosage of *C. colocynthis* powder in the month of December-2021. While the minimum mortality 1.0% and 2.0% was observed at 5g dosage of *S. oleoides* plant powder during August -2021. Maximum weight loss and Insect damage to grain were found on 5g of *S. oleoides* powder 17.0%, 31.3% and 15.0%, 29.2% to *R. dominica* and *T. granarium*. On the contrary low weight loss and insect damage 7.1%, 22.1% and 9.1%, 24.3% were recorded at 5g powder dosage of *C. colocynthis*. Present findings would be helpful for the effectiveness of these tested plants as grain protectants versus stored grain pests especially in the advancement of pest management strategies.

Keywords: Lesser grain borer, Khapra beetle, Plants Powder Extract, Grain Wheat, Mortality.

INTRODUCTION

Wheat (*Triticum aestivum*) by production and consumption is the uttermost significant cereal crop worldwide (Ileke, 2011). In Pakistan, an estimated 65 to 75 percent of the wheat production is kept in storage on farms (Zulfikar *et al*., 2020). In order to combat malnutrition, wheat grain with the highest protein content is the most significant cereal crop traded globally (Ileke, 2011), especially in Pakistan. Even though wheat is important to Asia's and Pakistan's overall food security, various insect pests pose a threat to its improper storage. The stored wheat faces enormous losses due to these insect infestations. Up to 70% of storage loss in developing countries was attributed to insect infestation (Strbac, 2002; Kavita, 2004). These insect pests damage cereal grains in both quantitatively and qualitatively (Fornal *et al*., 2007). The most commonly found insect pests in warehoused wheat grains are, *Rhyzopertha dominica* Fabricius (Bostrichidae: Coleoptera) is very injurious pest that infests all kinds of stored grains. This insect feeds on grain endosperm and spends the majority of its life cycle (larvae, pupae, and adult)

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inside kernels. (Rees, 2004; Edde 2012) and *Trogoderma granarium* Everts (Coleoptera: Dermestidae) is regarded as the world's most dangerous insect pest of stored products (Lowe *et al.,* 2000; Gharib, 2004).

Therefore, it is important to decline such losses by protecting stored grains from pests. Many scientists have developed different insect pest control techniques in past decades to combat these destructive insect pests worldwide, particularly in Pakistan where every year enormous amounts of synthetic pesticides are used to combat insect pests. These pesticides are not only harmful to people, but they also disturb the ecosystem due to the carelessness use of those pesticides (Khan and Marwat, 2004).

In order to control pests in stored edible things, an alternative effective technique is required to over the harmful impacts of chemical insecticides. Therefore, to combat insect infestation, small-scale farmers in Eastern Africa usually employ some traditional techniques (Hassanali *et al*., 1990; Poswall and Akpa, 1991). In African traditional methods, where Plant materials have played a significant role when they were intermixed with stored wheat kernels (Chougourou *et al*., 2015). Botanical pesticides are often far safer than commonly used synthetic pesticides (Bell *et al*.,1990). Typically, they don't have any harmful effects on the ecosystem. The method of usage and the nature of botanical materials fluctuate from place to place and seem to be influenced in part by the kind and potency of suitable flora that can be found in various places. However, a relatively modest figure of botanical plants are well-known to have insecticidal properties against stored insect pests. Further, more effective alternative methods are needed to develop for the protection of stored foodstuffs. This study thus sought to assess the effectiveness of two plants powdered leaves and branches against *R. dominica* and *T. granarium* damage of stocked wheat kernels.

MATERIALS AND METHODS

Research area:

The experiment was carried out in the Advanced Entomology Laboratory, Department of Zoology, University of Sindh, Jamshoro. The research was conducted from August 2021 to March 2022.

Source and Preparation of Test Plants Powdered extracts:

Two Plant materials, *Citrullus colocynthis* and Salvadora *oleoides* of the leaves and branches were obtained from the Kacho area of District Dadu. Leaves and branches of test plants were washed in water then sundried for 2 to 3 weeks to ensure moisture-free Powders. The Powder was gained by smashing each dried selected plant's parts separately in an Electric blender and was sieved through a size of 0.2 mm mesh. Equal grams of leaves and branches Powder of each tested plant were mixed individually and were stored separately in plastic jars with tight lids under laboratory conditions prior to use.

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Source of wheat grains:

TD-1 wheat variety was collected from the town Sita Road, District Dadu. The grain supposed to have been Infested, Damaged, and or availability of debris was cleaned from the whole wheat kernels was disinfested at 50°C by use of Oven for six-hour to kill whole life cycle of pests within the kernels. This wheat variety was later used for experimental purposes.

Source of Insects:

Two type of stored grain pests *Rhyzopertha dominica*, and *Trogoderma granarium* were obtained from the various localities of the concerned District and used for Research work.

Treatments and Experimental Design:

Two different dosages of 5g and 10g of Plant Powder were mixed separately with 140g of selected wheat variety in 500g capacity plastic jars for a 20 minute by using a Mixture/Shaker machine (Heidolph REAX, 2000). Thirty Non-Uniform larvae of Khapra beetle and Lesser grain borer of adults were released into each Jar as well as that of the Control (without Powder use) as triplicate. With the help of double rubber bands, jars were enclosed with muslin cloths and maintained at the 27°C±2% and 71%±6% R.H in the Laboratory. For the eight months, every month-wise reading was taken in which 50g of treated and untreated TD-1 kernels from each plastic were collected and assessed for the parameters like Mortality rate, Weight loss, and Insect Damaged Grains.

Data Collection:

(A) After treatment, from each jar number of dead beetles were calculated monthly wise and the Abbott formula was used to correct the mortality %. (Abbott, 1925):

$$\text{No: 1, } M_c = \frac{M_o - M_c}{100 - M_c} \times 100$$

M_o: Observed mortality rate of treated adults (%)

M_e: Mortality rate of control (%)

M_c: Corrected mortality rate (%)

(B) In each treatment, damaged and undamaged number of wheat kernels was counted and due to attack of insect pests weight loss was counted through the use of formula “Count and Weigh method” (Adams and Schulten, 1978):

$$\text{No: 2, Percent Weight loss} = \frac{(W\mu \times Nd) - (Wd \times N\mu)}{Wu \times (Nd + Nu)} \times 100$$

Wμ: Weight of undamaged grains

Nμ: Number of undamaged grains

Wd: Weight of damaged grains

Nd: Number of damaged grains

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(C) The grains with characteristic insect emergent hole was calculated (Oparaeke & Daria, 2005), using the following formula:

$$\text{No: 3, Percent Insect damaged grain} = \frac{\text{Number of bored grains}}{\text{Total number of grains in sample}} \times 100$$

Statistical analysis

The data were tabulated using the ANOVA (analysis of variance) and LSD (Fishers Least Significant Difference) tests in Statistix ® version 8.1 for all analyses.

RESULTS

The results were obtained for the mortality of *R. dominica* and *T. granarium* at different dosages of two different plant parts powdered (*Citrullus colocynthis* and *Salvadora oleoides*). The result revealed that from December -2021 to February- 2022, mortility of *R. dominica* was found most abundantly in grain samples treated with tested plants at 10g dosages when compared to the control. The *C. colocynthis* plant powder was found most effective against *R. dominica* followed by *T. granarium*. However, lower mortality was obtained in 5g dosage of plant powders against selected pests (Table 1-4). The percentages of mortality increased with the raise in powder dose.

The finding indicated that mean percentages of weight loss and insect damaged grains induced by lesser grain borer and Khapra beetle on the treated and untreated wheat kernels as shown in (Table 1 to 4). The record showed the greatest of both parameters from August to October-2021 due to two different dosages of tested plants. Whereas, the percentage of weight loss and insect damaged grain decreases with the increase in plant powder concentration. The control values are non-significantly higher than that of uncontrolled values. The maximum mortality of both wheat pests were recorded from December-2021 to January-2022, but the remaining two parameters were recorded from August to October 2021. Lower mortality was noticed in similar months (August to October-2021) but the weight loss and insect damaged grain decreased from December-2021 to February-2022, whereas the moderate range of selected parameters were recorded in November- 2021 and March-2022 (Figure 1 to 4).

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Table 1: Monthly (Mean±SD) effect of *R. dominica* reared on TD-1 wheat variety treated with varying amount (5g & 10g) of *C. colocynthis* Plant Powders

Month and Year	5g			10g		
	Mortality Rate (%)	Weight Loss (%)	Insect Damaged Grains (%)	Mortality Rate (%)	Weight Loss (%)	Insect Damaged Grains (%)
August,2021	20.0^{e}±3.6	7.1^{b} ±0.34	22.1^{b} ±2.8	34.0^{c} ±9.53	6.3^{b} ±1.05	16.5^{b} ±2.59
September,2021	23.0^{de} ±5.56	5.0^{bc} ±2.55	21.1^{b} ±2.84	36.0^{c} ±9.53	4.3^{c} ±0.62	16.0^{bc} ±1.0
October,2021	25.0^{cde} ±5.56	4.56^{bc} ±1.67	19.2^{bc} ±1.12	38.0^{bc} ±9.84	4.13^{c} ±1.0	15.5^{bc} ±1.44
November,2021	26.0^{cde} ±6.0	3.56^{bc} ±2.03	18.1^{bcd} ±2.0	40.0^{bc} ±0.0	4.0^{c} ±1.0	13.0^{bcd} ±1.05
December,2021	41.0^{a} ±1.73	2.16^{c} ±0.96	12.1^{e} ±2.25	58.0^{a} ±7.21	1.23^{d} ±0.68	7.03^{d} ±2.0
January,2022	36.0^{ab} ±1.0	1.8^{c} ±0.26	13.3^{de} ±2.35	54.0^{a} ±7.93	1.01^{d} ±0.01	8.36^{cd} ±0.71
Feburay,2022	32.0^{bc} ±4.35	2.0^{c} ±1.0	15.1^{cde} ±1.85	50.0^{ab} ±8.54	1.46^{d} ±0.47	10.4^{bcd} ±2.19
March,2022	30.0^{bcd} ±10.0	5.1^{bc} ±0.7	16.1^{cde} ±3.73	46.0^{abc} ±6.0	3.43^{c} ±1.45	12.3^{bcd} ±1.52
Control	8.0^{f} ±3.46	23.0^{a} ±6.24	33.6^{a} ±4.5	10.0^{d} ±0.0	20.0^{a} ±2.0	32.0^{a} ±12.5

Mean±SD within columns with the common letter(s) are not significantly differ at (LSD test, P< 0.05)

Table 2: Monthly (Mean±SD) effect of *R. dominica* reared on TD-1 wheat variety treated with varying amount (5g & 10g) of *S. oleoides* Plant Powders

Month And Year	5g			10g		
	Mortality Rate (%)	Weight Loss (%)	Insect Damaged Grains (%)	Mortality Rate (%)	Weight Loss (%)	Insect Damaged Grains (%)
August,2021	1.0^{e} ±0.5	17.0^{b} ±1.0	31.3^{ab} ±6.06	19.0^{e} ±5.0	12.1^{b} ±1.85	26.1^{b} ±1.15
September,2021	3.0^{e} ±0.75	15.0^{bc} ±0.0	30.4^{ab} ±5.71	21.0^{de} ±3.46	11.0^{bc} ±1.8	25.1^{bc} ±0.95
October,2021	6.0^{de} ±5.29	14.1^{bc} ±1.82	28.3^{ab} ±5.0	23.0^{de} ±2.64	9.3^{bcd} ±2.12	23.9^{bcd} ±1.31
November,2021	7.0^{cde} ±4.0	12.8^{bcd} ±0.9	27.1^{b} ±5.28	24.0^{cde} ±2.64	7.16^{de} ±1.68	22.3^{bcde} ±1.6
December,2021	19.0^{a} ±6.24	5.86^{e} ±1.2	20.2^{b} ±10.5	39.0^{a} ±7.81	3.76^{ef} ±1.48	15.3^{e} ±3.82
January,2022	15.0^{ab} ±5.56	5.1^{e} ±0.85	22.1^{b} ±7.97	35.0^{ab} ±9.53	3.6^{f} ±1.34	16.6^{de} ±1.95
Feburay,2022	14.0^{abc} ±0.0	9.0^{de} ±1.0	23.7^{b} ±4.6	32.0^{abc} ±3.6	6.3^{def} ±2.2	18.1^{cde} ±0.95
March,2022	9.0^{bcd} ±8.18	11.2^{cd} ±1.31	25.3^{b} ±3.67	29.0^{bcd} ±1.0	8.16^{cd} ±1.7	20.4^{bcde} ±1.36
Control	1.16^{e} ±0.28	32.0^{a} ±7.21	40.6^{a} ±13.6	3.0^{f} ±1.0	28.0^{a} ±3.46	38.6^{a} ±11.9

Mean±SD within columns with the common letter(s) are not significantly differ at (LSD test, P< 0.05)

Table 3: Monthly (Mean±SD) effect of *T. granarium* reared on TD-1 wheat variety treated with varying amount (5g & 10g) of *C. colocynthis* Plant Powders

Month And Year	5g			10g		
	Mortality Rate (%)	Weight Loss (%)	Insect Damaged Grains (%)	Mortality Rate (%)	Weight Loss (%)	Insect Damaged Grains (%)
August,2021	19.0^{e} ±3.6	9.1^{b}±0.34	24.3^{b} ±3.05	33.0^{c} ±9.53	8.63^{b} ±0.8	18.7^{b} ±2.79
September,2021	22.0^{de} ±5.56	7.9^{b} ±1.0	23.1^{bc} ±2.84	35.0^{c} ±9.53	6.63^{b} ±0.83	18.0^{b} ±3.46
October,2021	24.0^{cde} ±5.56	6.63^{bcd} ±1.0	21.4^{bcd} ±1.85	37.0^{bc} ±9.84	6.33^{b} ±0.57	17.7^{b} ±2.57
November,2021	25.0^{cde} ±6.0	5.76^{bcde} ±1.1	20.1^{bcde} ±2.0	39.3^{bc} ±0.57	6.1^{b} ±1.1	15.1^{bc} ±2.1
December,2021	40.0^{a} ±1.73	2.8^{de} ±0.85	14.1^{f} ±2.25	57.0^{a} ±7.21	1.4^{c} ±0.52	9.09^{c} ±0.94
January,2022	35.0^{ab} ±1.0	2.2^{e} ±0.72	15.6^{ef} ±2.0	53.0^{a} ±7.93	1.03^{c} ±0.05	10.75^{bc} ±1.43
Feburay,2022	31.0^{bc} ±4.35	3.33^{cde} ±0.7	17.2^{def} ±1.05	49.0^{ab} ±8.54	2.1^{c} ±1.17	12.6^{bc} ±2.14
March,2022	29.0^{bcd} ±10.0	7.13^{bc} ±1.02	18.3^{cdef} ±0.81	45.0^{abc} ±6.0	5.86^{b} ±1.0	14.06^{bc} ±2.1
Control	6.0^{f} ±3.46	25.3^{a} ±6.42	35.6^{a} ±5.85	8.0^{d} ±3.46	22.3^{a} ±4.5	35.0^{a} ±13.2

Mean±SD within columns with the common letter(s) are not significantly differ at (LSD test, P< 0.05)

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Table 4: Monthly (Mean±SD) effect of *T. granarium* reared on TD-1 wheat variety treated with varying amount (5g & 10g) of *S. oleoides* Plant Powders

Month And Year	5g			10g		
	Mortality Rate (%)	Weight Loss (%)	Insect Damaged Grains (%)	Mortality Rate (%)	Weight Loss (%)	Insect Damaged Grains (%)
August,2021	2.0^{e} ±0.0	15.0^{b} ±1.0	29.2^{ab} ±6.23	20.0^{e} ±5.0	10.0^{b} ±1.73	24.0^{b} ±1.73
September,2021	4.0^{de} ±1.0	13.0^{bc} ±2.0	27.1^{bc} ±6.07	22.0^{de} ±3.46	7.0^{bc} ±1.0	23.1^{b} ±2.53
October,2021	7.0^{de} ±5.29	12.0^{bc} ±1.73	25.0^{bc} ±5.56	24.0^{de} ±2.64	7.1^{bc} ±0.9	21.0^{bc} ±4.15
November,2021	8.0^{cde} ±4.0	10.4^{cd} ±1.11	24.0^{bc} ±5.56	25.0^{cde} ±2.64	5.1^{cd} ±0.1	20.0^{bcd} ±1.0
December,2021	20.0^{a} ±6.24	4.83^{e}±1.05	17.0^{c} ±4.35	40.0^{a} ±7.81	1.8^{d} ±0.8	13.0^{d} ±2.74
January,2022	16.0^{ab} ±5.56	4.2^{e} ±0.95	19.0^{bc} ±4.35	36.0^{ab} ±9.53	1.5^{d} ±1.0	14.0^{cd} ±0.7
Feburay,2022	15.0^{abc} ±0.0	7.0^{e} ±1.0	20.0^{bc} ±4.35	33.0^{abc} ±3.6	4.1^{cd} ±1.0	16.0^{cd} ±2.0
March,2022	10.0^{bcd} ±8.18	7.1^{de} ±1.01	22.0^{bc} ±4.58	30.0^{bcd} ±1.0	6.1^{bc} ±1.0	18.0^{bcd} ±1.0
Control	2.0^{e} ±0.5	30.3^{a} ±4.5	38.0^{a} ±11.5	4.0^{f} ±2.0	26.0^{a} ±6.92	36.0^{a} ±10.5

Mean±SD within columns with the common letter(s) are not significantly differ at (LSD test, P< 0.05)

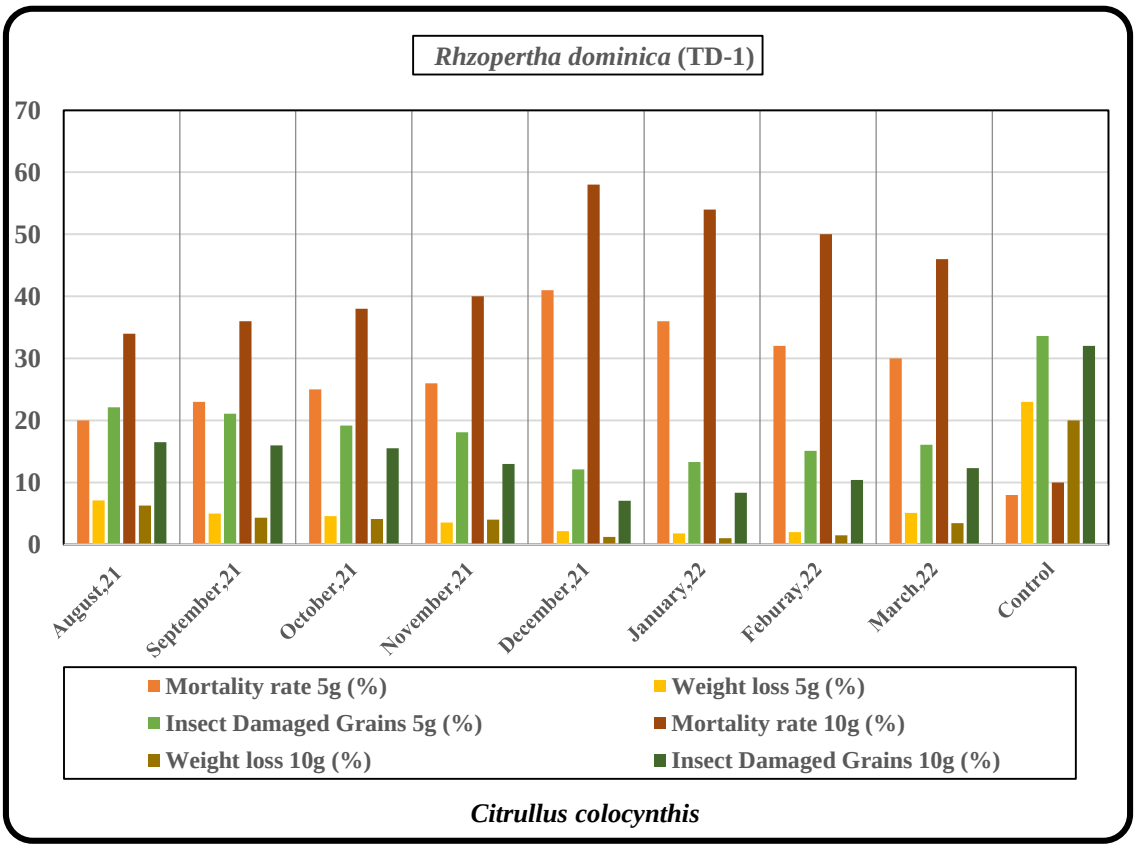

Fig 1: Monthly (Mean) effect of *R.dominica* reared on TD-1 wheat variety treated with varying amount (5g & 10g) of *C. colocynthis* Plant Powders

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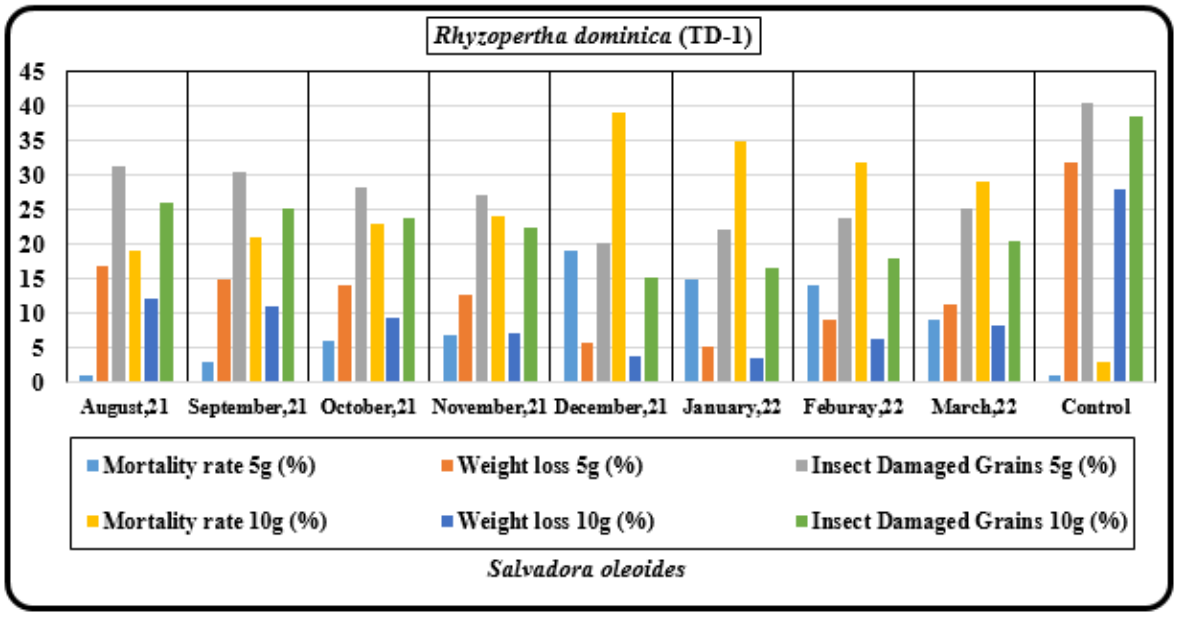

Fig 2: Monthly (Mean) effect of *R. dominica* reared on TD-1 wheat variety treated with varying amount (5g & 10g) of *S. oleoides* Plant Powders

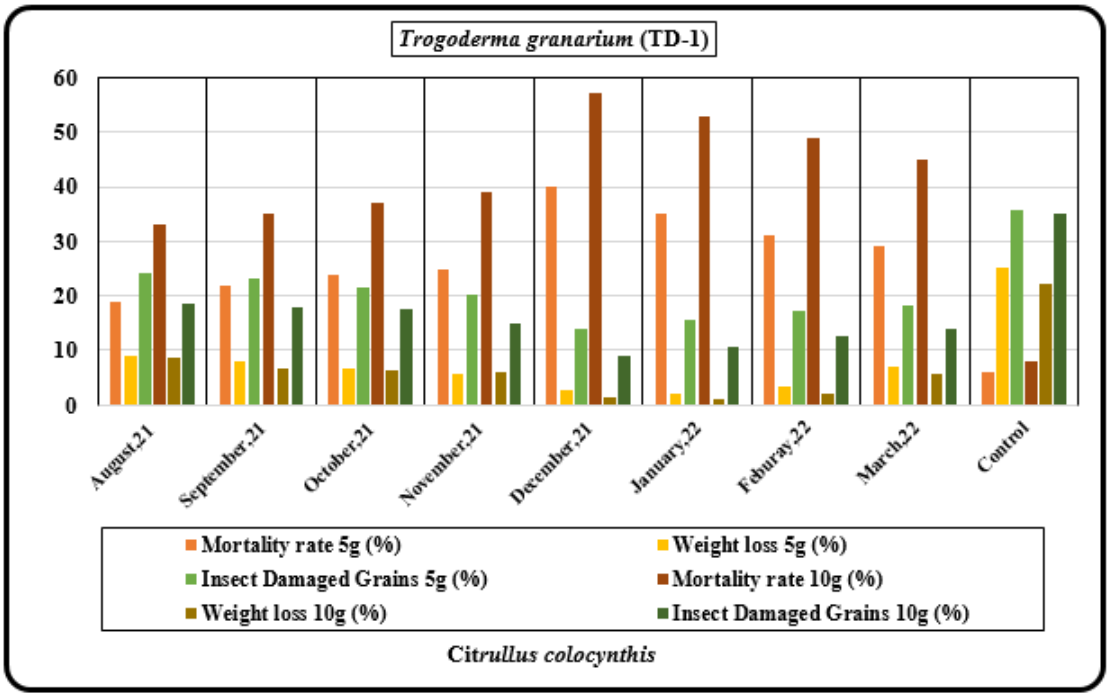

Fig 3: Monthly (Mean) effect of *T.granarium* reared on TD-1 wheat variety treated with varying amount (5g & 10g) of *Citrullus colocynthis* Plant Powders

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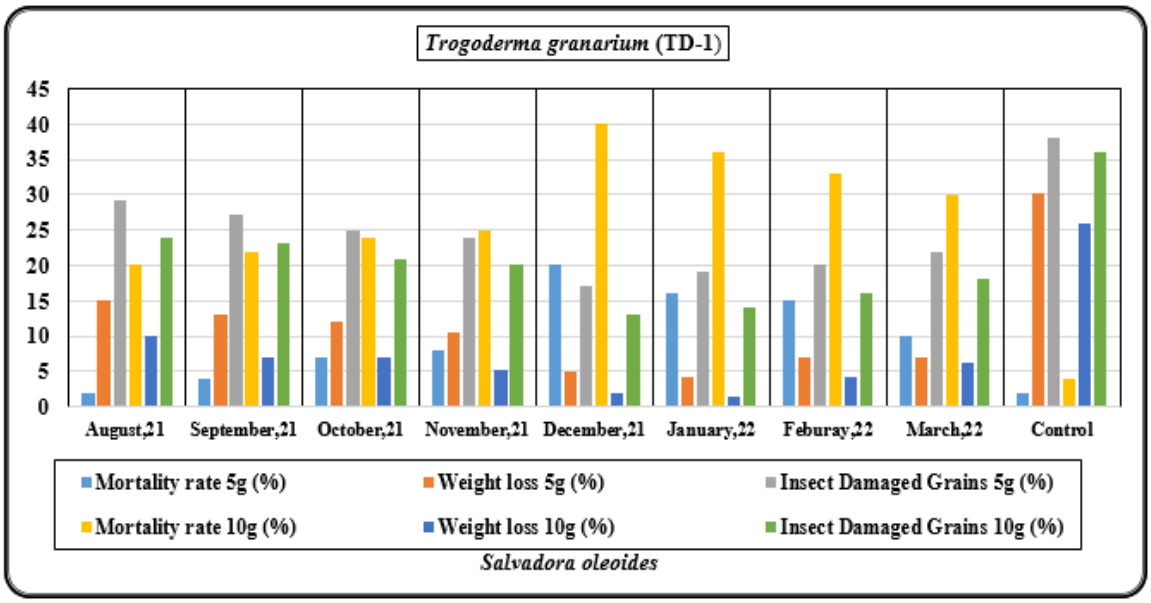

Fig 4: Monthly (Mean) effect of *T.granarium* reared on TD-1 wheat variety treated with varying amount (5g & 10g) of *Salvadora oleoides* Plant Powders

DISCUSSION

The current investigation aimed to determine the percentage of two different *R. dominica* and *T.granarium* pests mortality that resulted from exposure to two different powdered dosages from the two examine plants. Our research has revealed that greatest percentage mortality of selected test pests was caused by 10 g of the powdered extracts from *C. colocynthis* and *S. oleoides* in the month of December-2021. This result is consistent with that of Alvi *et al*. (2018), who found that *Rhazya stricta* leaf and seed extracts substantially have greater mortality rates in *R. dominica* and *T. granarium* under labortical conditioning. Similar findings were shown by Negbenebor, *et al*. (2021), who indicated the highest mortality percentage induced by *R. dominica* was observed at more than 50% caused by 8.0 g/20 g of extracted powder from the *H.suaveolens, A. boonei* and *T. vogelii*. More so, Asawalam and Onu (2014) demonstrated that, when compared to the control, adult mortality rates for *T. granarium* after application of the botanical powder were much higher (80 to 98%). Also, Chougourou *et al*. (2015) found significantly higher mortality figures for *C. maculatus* at all doses of plant powders in comparison of control. Similar figures concerning control in comparison to the dosage of plants extracted in treated wheat grain were observed in present studies.

In this study we observed cumulative weight loss induced by *R. dominica* and *T.granarium* on the treated and untreated wheat kernels. The lowest percentage weight loss was observed in wheat grain @ higher 10g of two selected plants powdered dosage against *R.dominica* and *T.granarium* in the month of August-2021. Similar records were observed by Chougourou *et al*. (2015), who determined that *C. ambrosioides* yielded the lowest

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percentage of weight reduction, @ 7.5 percent. The kersting's groundnut showed the greatest decrease (91.65 percent) rate when treated with powdered of *C. ambrosiodes* against *R.dominica* reported by Chougourou *et al*. (2015). The toxic efficacy of the plant extracts on the test insect provides an indication to the relative value of powdered extracts in protecting wheat grain from the damage caused by the infestation of *R.dominica* (Negbenebor, *et al*., 2021). Furthermore, percentage weight loss was observed as significantly greater in the control treatment when compared to the treated wheat grains induced by tested insect pests. The same finding was noted by Asawalam and Onu (2014).

In the final studies, we examined insect damaged grain induced by chosen wheat grain pests on the treated and untreated kernels. The lowest percentage of grain damage was viewed in wheat grain @ lower 5g of two selected *C. colocynthis* and *S. oleoides* plants powdered dosage against tested pests, *R.dominica* and *T.granarium* in the month of August-2021, and was non-significantly different from the untreated control. The results of this study agreed with Asawalam and Onu (2014), who found that the mean number of perforated kernels in the various treatments was significantly different from the mean number of untreated kernels. *A. indica* and *J. curcas* leaf powders administered for three months after infestation also prevented grain weight loss and damage; this may be because the plant parts utilised had anti-feeding qualities, as noted by several authors Singh and Singh (2005), Kudachi (2008) and Asmanizar and Idris (2012). Therefore, these findings add to the existing data regarding the effectiveness of botanical extracts as bio-pesticides of stored edible things. In addition, the research of this study suggested that powder form extracts from the leaves and branches of *C. colocynthis* and *S. oleoides* possessed insecticidal capabilities against the lesser grain borer, Khapra beetle, and also have the potential to prevent the insect from infesting stored wheat.

CONCLUSION

The Citrullus colocynthis and *Salvadora oleoides* powders proved effective in controlling *Rhyzopertha dominica* and *Trogoderma granarium.*

The different dosages of powder of both plant species have harmless effects in protecting wheat grains.

Citrullus colocynthis powdered extract became the best grain protectant against lesser grain borer than the Khapra beetle.

TD-1 variety of wheat was observed as susceptible to *Rhyzopertha dominica* and resistant to *Trogoderma granarium* in the view of weight loss and damaged grain.

It is recommended that powder form of tested plants at any concentration could be beneficial to the control of damage caused by the insect pests in storage products.

ISSN: 1673-064X
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DOI: 10.5281/zenodo.10224256

Acknowledgment

This research work is a part of Ph.D studies of Shamsher Ali and the Scholar is highly thankful to his supervisor Professor Dr.Naheed Baloch for providing laboratory space and equipment support during the assistance of the related experimental study.

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ISSN: 1673-064X
E-Publication: Online Open Access
Vol: 66 Issue 11 | 2023
DOI: 10.5281/zenodo.10224256

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