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The comparative study of the inhibition potential of four plant powders against the Khapra beetle (*Trogoderma granarium)*

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ABSTRACT
This research work aimed to evaluate the adult inhibition potential of powders of four different plants. The bulb of *Allium sativum,* leaves of *Moringa oleifera*, rhizome of *Curcuma longa* and *Zingiber officinale*were used against the test insect *Trogoderma granarium* infesting groundnut seeds. All fourplant powders were applied at threerates of application, i.e. 0.5%, 1% and 2% in 10 gms of groundnut seeds (w/w). The replicates were made for each concentration. The rhizome powder of *C.longa* showed a maximum inhibition per cent 60.40% while the powders of *A.sativum* ,*M.oleifera* and *Z. officinale* showed 50.52%, 44.95% and 56.26% of inhibition percent respectively, at 2% concentration. All powders gave effective results in causing adult inhibition in all three concentrations (0.5%, 1% and 2%) as compared to the control.

INTRODUCTION
India is a diverse country. It is rich in heritage and culture with diversity in religions, languages, festivals and food. It is the 7th largest country in the world, but it occupies first position in terms of population.The major problem with this huge number of individuals is fulfilling the demand for food, which is also increasing with the rise in population. Tofulfil this growing need, the country still depends on peasants. They have to deal with many foes in and off field to bring these pulses, cereals, millets, rice and grains to our plate, tomeet our nutritional requirements. The most common method employed to control thesepests is through chemical insecticide, but their use is limited due to resistance in pests, toxin residues in food grains (Soman *et al., 2024*) and environmental problems (Mohamed et.al 2020) and health hazard **(**Thompson (1966), Agarwal *et al.,* (2010))**.** The chemical residues make the grains unfit for human consumption and cause many health hazards. Due to all of these reasons, several synthetic pesticides have been either banned or their use is restricted. Thus, there is a requirement for a safer alternative to these synthetic pesticides, which have antifeedant, repellent and insecticidal potential and with no or least hazardous impact on the environment. Botanicals emerge as a solution to all these requirements as they are biodegradable, eco-friendly and have insecticidal properties. Many researchers proved the potential of plant materials against different stages of the life cycle of grain pests [Bloszyk *et al.,* (1995), Asawalam and Igwe (2012)]. These have many benefits in comparison with chemical insecticides as these are biodegradable, pest-specific, don't cause any harm to non-

targeted species, environmental friendly and safe for humans. These plant materials can be used in the form of acetone extracts (Ahmad *et al.,* 2013), ethanolic extracts (Mahmoud *et al.,* 2015), ethyl acetate extracts (Habib and Karim, 2016), and aqueous extracts (Vijayalakshmi *et al.,* 2021) to control stored grain insect pests. The powders of various plant parts are also found to be an effective natural method for managing pests like *Tribolium castaneum* (Anita *et al.,* 2012), *Sitophilus zeamais* (Tiwari *et al.,* 2018), *Sitophilus oryzae* (Mehta *et al.,* 2020) and *Rhizoperthadominica* (Hassan *et al.,* 2022)]. Various plant oils such as *Ocimum suave*oil(Bekele *et al.,*1996), Almond oil, Camphor oil, Mustard Oil, Tea tree oil, Coconut oil (Kataria and Kulkarni,2017), Neem oil, Castor oil, Karanj oil, (Masolkar *et al.,* 2018),*Cymbopogon* species oil (Devi *et al.,* 2020), Eucalyptus oil, Orange oil and Cinnamon oil(Patil *et al.,* 2021) can be used as biopesticides Whether in powder, extract, or oil, botanicals have proven effective against stored grain pests in each application. So, this research aims to minimize the use of chemicals to control insect pests.

In this study, dried bulb powder of *Allium sativum*, dried leaf powder of *Moringa officinale*, dried rhizome powder of *Curcuma longa* and *Zingiber officinale* were evaluated to assess their inhibition potential in different concentrations against *Trogoderma granarium* infesting groundnut seeds. All the plants have medicinal importance (anti-inflammatory, anti-diabetic, prevent heart diseases and cancer) along with insecticidal properties. Additionally, it also has many health benefits when consumed coated over seeds.

MATERIALS AND METHODOLOGY

Study Area

This research work was carried out at the Entomology Lab, Dept. of Zoology, Jai Narain Vyas University, Jodhpur, Rajasthan.

Botanical

The fresh botanicals, i.e. leaves of drumstick (*Moringa oleifera),* bulb of garlic (*Allium sativum),* rhizome of turmeric and ginger *(Curcuma longa* and *Zingiber officinale)*were collected from local areas and the market. These plant materialswere then air dried and ground into fine powder, after which it was sieved. These plant powders were kept in air-tightcontainers for future use.

Test Grain

The seeds of groundnut were purchased from the local market. These were then cleaned to remove debris and infested grains. After this disinfestation was done by keeping these in the ovenfor 5 hours at 50ºC so that all the stages of insect pests ofstored grain were killed if present.

Test Insect

For the present study, *Trogoderma granarium* was used as the test insect. The culture of *T. granarium*was maintained at the entomology lab at 30±2ºC temperature. The jars were covered with muslin cloth and a rubber band to allow proper aeration. The culture was established onthe seeds ofthe groundnut.

METHODOLOGY

The powder of all four plants wastaken in three concentrations, i.e. 0.5%, 1.0% and 2.0%and mixed with 10 grams of uninfected groundnut seeds. The vials were agitated manually for proper coating over seeds. Three replicatesfor each concentration were made, and for the control, no powder was mixed. Then, in each vial, five pairs of newly emerged test insects were introduced. The mouth ofthe vials was also covered by muslin cloth using a rubber band to avoid the escape of the test insect. These vials were then kept in an incubator at 30±2ºC.There werea total of 13units inthe experiment, including a control.

Assessment of Inhibition Rate Percent:

In all units, the adults of *T.granarium*, even dead or alive, were removed after 7 days. Then the newly emerged insects were counted regularly till emergence stops.

Inhibition Rate Percent:

The inhibition rate per cent was calculated by counting the newly emerged adults in treated and non-treated vials. The inhibition rate per cent was calculated according to Tapondjou *et al.,* 2002

$$\% \text{ IR}=\frac{Cn-Tn}{\text{Cn}}\times 100$$

Where;

Cn is the number of newly emerged insects in the untreated (control) vials.

Tn is the number of newly emerged insects in treatments.

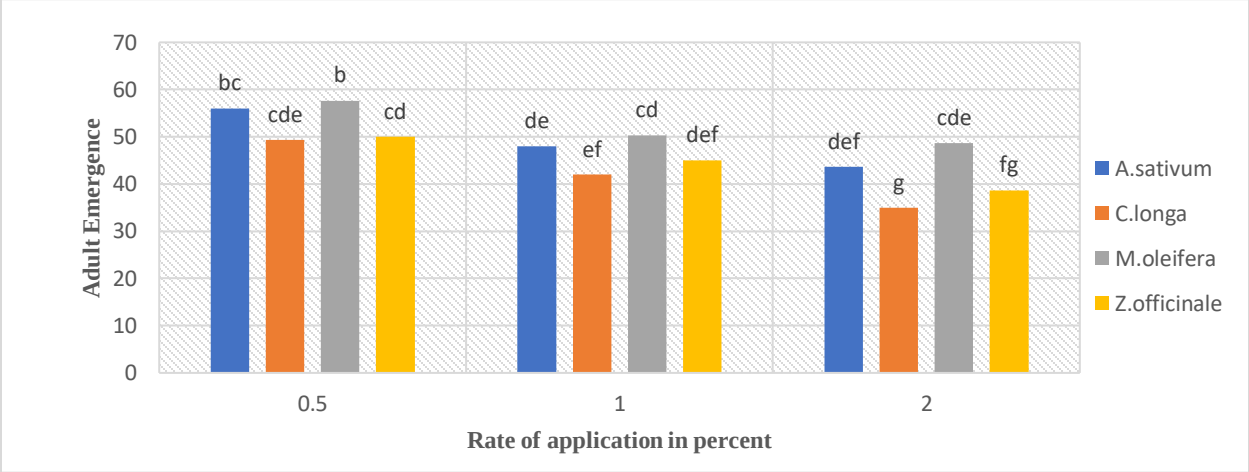

Figure-1.The alphabets put over the bars indicate that the same letter is not significantly different from each other

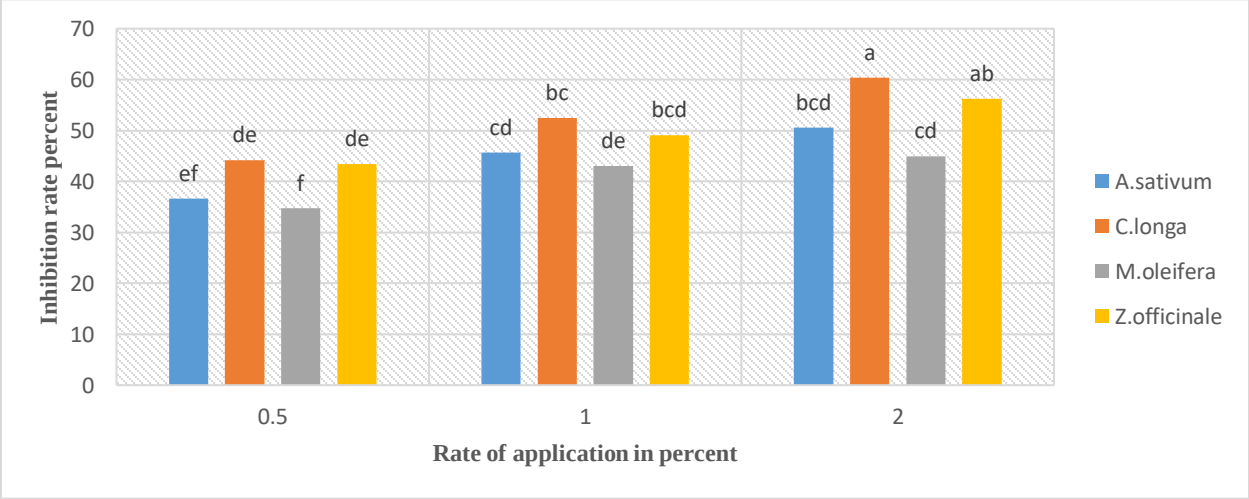

Figure-2.The alphabets put over the bars indicate thatthe same letter is not significantly different from each other

RESULT

The efficacy of plant powders was tested against *T.granarium*, and the results revealed that all the plant powders were found effectivein controllingthe test insect. The effectiveness of treatment increases with the increase in concentration.

Figure 1 showed that at the 0.5% application,the lowest mean emergence of adult was observed in *C.longa* with 49.33,which was then followed by *Z.officinale* (50.00), *A.sativum* (56.00). The highest mean emergence 57.67, was observed in *M.oleifera*. Similar results were observed with 1% and 2% application of plant powder. Here, also highest mean adult emergence was observed with *M.oleifera* (50.33 and 48.67, respectively) and the lowest mean emergence was observed in *C.longa* (42.00 and 35.00, respectively). All the treatments were found effective in comparison with the control, where the mean adult emergence recorded was 88.33.

Figure 2 shows the inhibition rate per cent. At 0.5 % of application of plant powder, the highest inhibition, 44.16% was observed in *C.longa* and the lowest, 36.58% in *M.oleifera*. The other two treatments were also effective with 44.95% and 34.70% inhibition rate percent in *Z.officinale* and *A.sativum*, respectively. At 1% rate of application, the inhibition rate per cent increases with 52.46%, 49.10%, 45.66% and 42.99% in *C.longa*, *Z.officinale*, *A.sativum* and

M.oleifera, respectively. The treatment of 2% application also gave similar results with the highest inhibition% in *C.longa*, i.e 60.40%. All the treatments, irrespective of concentration found effective in controlling test insects.

DISCUSSION.

The results of the present findings revealed that the powder of rhizome of *Curcuma longa* showed the highest efficiency in inhibiting the adult emergence of *T.granarium* among the four powders. Ashouri et.al 2010 also reported the effectiveness of powder of turmeric and cinnamon to control *Sitophilus granarius* and *Rhyzopertha dominica* in stored wheat. The parameters studied were adult emergence and mortality; both powders were found effective in comparison to the untreated control. Asawalam *et. al.* (2012) reported the effectiveness of powder of turmeric to control rice weevil *Sitophilus oryzae* in stored rice. The parameters studied were adult emergence and weight loss percentage, which were decreased by Curcuma powder compared to the untreated control.The results are also supported by [Mario et.al (2021), Mario *et al.*, (2023)] who reported the efficacy of Curcuma powder in inhibiting the F1 progeny emergence in *Callosobruchus chinensis.*

Ileke and Oni (2011) tested the drumstick powder and concluded its potential to decrease the progeny emergence in *Sitophilus zeamais* in wheat grains. The inhibition effect was also reported by Kemabonta*et.al* (2013) against Sitophilus oryzae in stored wheat. They used powders of seeds from Azadirachta indica, Anacardium occidentale, and Moringa oleifera, and the inhibition rates with these were 99.5%, 96.5%, and 77.2%, respectively. Musa (2013) also tested the effectiveness of powder of *Moringa oleifera* (leaf) and *Allium sativum* (clove) against Tribolium granarium in ground nuts. The treatment was applied for 5 days at 2%, 4% and 6% concentration. He reported the efficiency of both powders in decreasing the emergence. The results of the present research are consistent with the results of the study of [Rivers and Udo (2024)]. In thisstudy effect of *Moringa oleifera* leaf powder against *Sitophilus zeamais* in maize and *Callosobruchus maculatus* in cowpea was studied. The powder was applied at three concentrations (5, 10, and 15 g/100 g of seeds). They reported the efficacy of drumstick powder in inhibiting the emergence of progeny in test insects.

The efficiency of garlic powder along with fennel, red pepper and cumin to decrease the adult emergence of *Sitophilus oryzae* and *Callosobruchus maculatus* was reported by Zayed and Hasan (2013). Onu et.al (2015) reported the efficacy of garlic powder and neem powder in decreasing the progeny emergence against *Sitophilus oryzae, Sitophilus zeamais*and *Callosobruchus maculatus.*The results are supported by previous findings of Jahan *et.al.* (2020) that garlic tablet powder decreases the adult emergence in pulse beetle infesting chick pea seeds. The powder was applied in three concentrations, 0.5, 1.0 and 1.5g/kg, which gave 41.00%, 32.33% and 21.33% adult emergence, respectively, as compared to the control (51.33%). The powder of garlic and ginger was applied at a 50g/kg concentration with maize to evaluate the emergence of F1 progeny of *Sitophilus oryzae*. Both the powders decrease the emergence of F1 progeny in comparison with the control.[Barre and Jenber (2022)] Similar results were obtained by Bukar et.al (2022) that very few (less than 5%) F1 progeny of *Rhyzopertha dominica* in stored cowpea were recorded in the least application (250mg/kg) of garlic and ginger powder, and no F1 progeny were recorded in the highest application of powder i.e. 1000mg/kg.

Many other scientists also reported the potential of different plant powders in inhibiting the progeny emergence. (Sitoe et.al. 2020; Rashad *et.al.* 2021; Negbenebor *et. al.* 2021).

CONCLUSION

The findings of the present research revealed the potential of plant powders. The powders of all four plants (*Allium sativum*, *Curcuma longa*, *Moringa oleifera* and *Zingiber officinale*) gave promising results in reducing the adult emergence of test insect *T.granarium* in groundnut seeds during storage These plant products can be used in the place of chemicals as these plants are easily available, non-toxic, biodegradable, eco-friendly and the formulation of these powders is easy and light on the pocket so can be used by farmers, homemakers to protect their pantry. Future research in a similar study area can be undertaken to develop plant formulations and evaluatetheir efficacy at the field level.

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