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2 **Efficacy of some essential oil for the management of Rice Weevil (*Sitophilus***
3 ***oryzae*) on stored wheat**
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9 **. ABSTRACT**
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The experiment was conducted in Completely Block Design (CRD) at the laboratory of the Department of Entomology, Naini Agriculture Institute Sam Higginbottom University of Agriculture, Science and Technology, Prayagraj, Uttar Pradesh with three replications seven treatments and untreated control against Rice Weevil *Sitophilus oryzae* (L.) i.e.T1 (Neem Oil), T2 (Clove Oil), T3 (Lavender Oil), T4 (Karanj Oil), T5 (Eucalyptus oil), T6 (Lemongrass Oil), and T7 (Tea tree Oil) and T0 (control). The experiment was conduct on the efficacy of different essential oil for the management of rice weevil, *Sitophilus oryzae* and adult mortality at 24, 48 and 72 hrs of exposure. The treatments included Neem Oil (0.5ml/lit), Clove Oil (0.5ml/lit), Lavender Oil (0.4ml/lit), Karanja Oil (0.4ml/lit), Eucalyptus Oil (0.5ml/lit), Lemon grass Oil (0.5ml/lit) and Tea tree Oil (0.5ml/lit). Among the treatments the largest number of mortality was observed in neem oil (83.33%), followed by karanj oil (77.77%), and least mortality was observed in the lavender oil (31.11%), rest of the treatments were found intermediate as followed by clove oil (67.77%), followed by eucalyptus oil (57.77%), followed by lemon grass oil (54.44%) and tea tree oil (51.10%). Percent weight loss of treated wheat grains at intervals of 30, 60 and 90 days after treatment. The results revealed that neem oil (7.32%), followed by karanj oil (11.99%). Least weight loss was recorded in lavender oil (41.06%). Whereas rest of treatments were found intermediate. And the highest germination was found in neem oil treated wheat seeds. The present study clearly revealed that these naturally occurring indigenous plant products could be used to manage the storage insect pests in wheat.

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12 *Keywords: Sitophilus , Storage , neem , Eucalyptus*

1. INTRODUCTION

Wheat is one of the most important and widely cultivated staple food crops among the cereals and is contributing about 30% to the food basket of the country. It is agronomically and nutritionally most important cereal essential for the food security, poverty alleviation and improved livelihoods. Wheat is one of the most important and widely cultivated staple food crops among the cereals and is contributing about 30% to the food basket of the country. It is agronomically and nutritionally most important cereal essential for the food security, poverty alleviation and improved livelihoods. The world acreage under wheat crop accounts 223.11 million hectare with production of 737.83 million metric tons with an average productivity of 3.39 tons/ha (USDA report, 2022).

Uttar Pradesh ranks first in area (36.6%) and production (39.3 %) of wheat in the country. Out of 100 leading wheat producing districts (each with more than lakh tons of production), 43 belong to Uttar Pradesh and of them 19 to the western part of the state in particularly wheat productivity is far lower than Punjab and Haryana. This is because of late sowing of wheat due to long duration rice varieties and late harvest of sugarcane, poor seed replacement rate, lack of quality seed at right time and place, lack of in-puts (fertilizers, irrigation water) due to limited resources and small holding size and poor mechanization, etc.

After China, India is leading producer of wheat in the world. In India, wheat comes second in number after rice among cereals and cultivated in an area 30 million hectare with the production of 97.44 metric tons recorded in 2016-17 (Kumar et.al)

Botanical insecticides have long been treated as attractive alternatives to synthetic chemical insecticides (Isman, 2006). Different types of plant preparation such as powders, solvent, essential oils and whole plants are being investigated for their insecticidal activity including their action as fumigants, repellents, antifeedants, anti ovipositors, insect growth regulators (Weaver and Subramanyam, 2000).

The rice weevil, *Sitophilus oryzae* is a serious pest of products in India that cause severe damage in both quantity and quality of stored cereals so grains are non-viable as well as not suitable for human consumption (Chauhan et al., 2005; Sahaf et al., 2008).

Rice weevil has got economic importance. It is the most destructive insect pest originated from India and now it has a cosmopolitan. Rice weevil is a serious grain pest which attack on rice, wheat, sorghum, maize, barley, pulses, dried beans and cereal products. Larvae and adults are internal feeders affecting quality and quantity of grains. This species has a relatively short developmental period and high populations can easily be built up. Thus, unless control measures are taken, heavy infestations may take place. Additionally, the kernel damage caused by *S. oryzae* larvae enables other species, the external feeders, which are not capable of infesting sound grain, so increase the damage rapidly.

The adult weevil female lays 4 eggs per day and up to 300 over their life time and may live for four to five months. The grub stage is more injurious than adult, it makes small hole into the grain, enters inside and feeds on the starchy content of the grain leaving only shell intact. It has been found that rice weevil infestation alone resulted in sorghum grain damage upto 83.5 per cent over a period of six months

Effective management of *S. oryzae* is mainly depending upon the use of conventional liquid and gaseous insecticides (White and Leesch, 1995).

The growing awareness of environmental hazards caused by synthetic insecticides has led to search for safe and environment friendly alternatives. In this regard, a number of studies are being carried to find out the plant origin chemicals for their insecticidal properties against wide-range of insect pest including stored grain insect pests

2. MATERIAL AND METHODS

Studies on *Sitophilus oryzae* were conducted at Entomology department SHUATS, Prayagraj during 2022-2023. Materials used and the techniques employed during the course of investigation for conducting experiment are presented below.

Rearing of test insect *S. oryzae*: The cultures of *S. oryzae* were obtained from the local markets of Prayagraj. Plastic containers of 1.5 kg capacity were used for insect rearing. About 500 gm of grains were kept in each container and about 600 adults of insects were released separately. They were allowed to lay eggs for 3 to 5 days and removed after 7 days, when the egg laying was over. These containers were kept at room temperature for the adult emergence of *S. oryzae*.

Other materials:

Petri plates, plastic jars, muslin cloth, butter paper, marker and rubber bands.

Preparation of plant products:

All the treatments used were collected from the local markets.

Observation to be recorded

Evaluation based on mortality

The cereal grains (100g) were kept in plastic jar of 500gm capacity and test materials were mixed at respective doses thoroughly and properly by manual agetation until the materials are evenly distributed among the grains and ensure homogenous mixture, which was considered as one replication. Three replications were used in each case. Ten pairs of *Sitophilus oryzae* adults were released in each plastic container at an interval of 24, 42 and 72 hours after treatment. The plastic jars were covered with muslin cloth and tied with rubber bands. The percent adult mortality was calculated based on the number of dead insects. The percentage mortality of the adults was calculated by using formula and then subjected to ANOVA.

$$\text{Percent adult mortality} = \frac{\text{Number of dead insects}}{\text{Number of insects released}} \times 100$$

Evaluation based on weight loss in free choice test

100g of wheat grains were taken and placed in a container at equi distance from the center. Approximately 50 pairs of 12 days old adult rice weevils are released in the center through giving free choice to the adults of orientation and then the containers were covered with muslin cloth. Same procedure was repeated for three replications. and the readings were counted at 30, 60 and 90 days after release. And the readings were calculated by using the formula mentioned below

$$\text{Percent weight loss} = \frac{\text{Initial weight of seeds} - \text{Final weight of seed}}{\text{Initial weight of seeds}} \times 100$$

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94 **Evaluation based on germination**

95 To find out the effect of treatments on seeds germination test was conducted at 90 Days after
96 treatment. Germination of the seeds was tested by paper towel method by maintaining three replications of
97 each treatment. 50 seeds were selected randomly and kept on moist paper for 7 days and germination
98 Percentage was calculated by using formula

99

$$\text{Percentage of seed germination} = \frac{\text{Number of germinated seeds}}{\text{Total number of seeds}} \times 100$$

100 **Statistical analysis**

101 Data will be subjected to Complete Randomized Design (CRD) after suitable transformations.
102 The per cent data will be subjected to angular transformation before statistical analysis. Similarly, the data
103 based on mean number of insects will undergo square root transformation with X+0.5 adding factor.

104
105 **Results**

106 **Percent adult mortality**

107 The data pertaining to overall mean mortality of rice weevil at intervals of 24, 48 and 72 hours after
108 treatment are mentioned in below table. The results revealed that T₁ neem oil was found effective and have
109 highest mortality of 83.33% over the rest of the treatments. The minimum mortality was observed in T₃
110 lavender oil with 31.10 % mortality. Rest of the treatments were found intermediate as T₄ karanj oil
111 (77.77%) followed by T₂ clove oil (67.77%) followed by T₅ eucalyptus oil (57.77%) followed by T₆ lemon
112 grass oil (54.44%) and T₇ tea tree oil (51.10%). whereas no mortality was observed in T₀ untreated
113 control.

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Table 1: Mortality of rice weevil as influenced by different essential oils in stored wheat.

TREATED OIL	DOSE IN (ml/kg)	mortality %			Overall mean
		24 Hours after treatment	48 Hours after treatment	72 Hours after treatment	
Neem oil	5ml/kg	76.66	80	93.33	83.33
Clove oil	5ml/kg	63.33	66.66	73.33	67.77
Lavender oil	4ml/kg	26.66	30	36.66	31.1
Karanj oil	4ml/kg	73.33	76.66	83.33	77.77
Eucalyptus oil	5ml/kg	53.33	56.66	63.33	57.77
Lemon grass oil	5ml/kg	50	53.33	60	54.44
Tea tree oil	5ml/kg	46.66	50	56.66	51.1
Untreated control		0	0	0	0
S.E.(d)		2.041	1.8	1.66	1.8
C.D		10.6	9.348	8.655	9.349
C.V		12.561	10.453	8.571	10.207

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weight loss of treated grain under free choice test

131 The data pertaining to overall mean percent weight loss of rice weevil at intervals of 30, 60 and
132 90 days after treatment are mentioned in below table. The results revealed that T₁ neem oil (7.32%)
133 followed by T₄ karanj oil (11.99%). least weight loss was recorded in T₃ lavender oil (41.06%). whereas
134 rest of the treatments were found intermediate as T₂ clove oil (16.79%) followed by T₅ eucalyptus oil

(22.77%) followed by T₆ lemon grass oil (26.73%) and T₇ tea tree oil (31.14%). Whereas in T₀ untreated control it was observed that 47.32% of weight loss was recorded.

Table 2: weight loss of treated seed grains under free choice test

TREATED OIL	DOSE IN (ml/kg)	mortality%			
		24 Hours after treatment	60DAT	90DAT	24 Hours after treatment
Neem oil	5ml/kg	4.21	7.96	9.8	7.32
Clove oil	5ml/kg	12.41	17.85	20.13	16.79
Lavender oil	4ml/kg	36.05	42.4	44.75	41.06
Karanj oil	4ml/kg	7.66	13.36	15	11.99
Eucalyptus oil	5ml/kg	18.60	24.06	25.66	22.77
Lemon grass oil	5ml/kg	22.28	28.13	29.8	26.73
Tea tree oil	5ml/kg	27.13	31.91	34.38	31.14
Untreated control		41.36	48.46	52.15	47.32
S.E.(d)		0.268	0.221	0.23	1.353
C.D		1.393	1.15	1.197	7.028
C.V		3.794	2.481	2.388	15.831

Effect on germination percentage of wheat grains

Results revealed that highest germination percentage was recorded in T₁ neem oil (93.33%) followed by T₄ karanj oil (86.66%). Least germination was recorded in T₃ lavender oil (46.66%), Remaining treatments found intermediate as T₂ clove oil (73.33%) followed by T₅ eucalyptus oil (66.66%) followed by T₆ lemon grass oil (63.33%) and T₇ tea tree oil (53.33%). whereas T₀ untreated control has 23.33% was observed.

Table 3: Effect on germination percent on wheat grains

Treated Oil	Dose (ml /kg)	germination%
Neem oil	5ml/ kg	93.33
Clove oil	5ml/ kg	73.33
Lavender oil	4ml/ kg	46.66
Karanj oil	4ml/ kg	86.66
Eucalyptus oil	5ml/ kg	66.66
Lemon grass oil	5ml/ kg	63.33
Tea tree oil	5ml/ kg	53.33
Untreated control		23.33
S.E.(d)		1.92
C.D		9.99
C.V		9.11

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152 4. DISCUSSION

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154 *Efficacy of different essential oils on adult mortality of rice weevil, Sitophilus oryzae Linn. on stored wheat.*

155 All the treatments were found to be significantly superior to control in enhancing adult mortality. From the
156 results maximum mortality was recorded in T₁ neem oil and results are similar to **poudel et al. (2023)**. among
157 all the treatments the next best treatment is T₄ karanj oil and the results are similar to **gayatree et al. (2022)**. the
158 next best treatment T₂ clove and results are supported by **bhattaraj et al. (2023)** followed by T₅ eucalyptus oil
159 as supported by **yang et al. (2020)** followed by T₆ lemongrass oil as supported by **poudel et al. (2023)** followed
160 by T₇ tea tree oil as supported by **yang et al. (2020)**. lavender oil showed least effect and results are similar to
161 **germinara et al. (2017)**.

162 *Efficacy of different essential oils on weight loss of treated grain under free choice test.*

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164 results maximum mortality was recorded in T₁ neem oil and results are similar to **poudel et al. (2023)**.
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Effect on germination percentage of wheat grains.

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Conclusion

In the research, it was the percent mortality was highest in treated grains with treatment T₁ neem oil followed by T₄ karanj oil. The least mortality was observed in T₃ lavender oil. Efficacy of different essential oils on weight loss of treated grain under free choice test the percent weight loss was highest in treated grains with treatment T₁ neem oil followed by T₄ karanj oil. The least mortality was observed in T₃ lavender oil. Effect on germination percentage of wheat grains The germination percentage was highest in treated grains with treatment T₁ neem oil followed by T₄ karanj oil. The least mortality was observed in T₃ lavender oil.

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