Efficacy of different plant extracts and insecticide on Red flour beetle, *Tribolium castaneum*(Herbst) in Wheat, *Triticum aestivum*

ABSTRACT

The studies on the **efficacy of different plant extracts and insecticide on Red flour beetle, *Tribolium castaneum* (Herbst) in Wheat, *Triticum aestivum*** were carried out to know the impact of above plant extracts on percent mortality and percent weight loss. The research was carried out at Department of Entomology SHUATS, Prayagraj from September to December in 2022-2023.This experiment was conducted under Complete Randomized Design (CRD).The experiment was conducted on the effect of plant extracts and insecticide on the mortality of adult *Tribolium castaneum* at 5,10 and 15 days of exposure. The treatments included Neem leaf powder (5g/100g), Tulsi leaf powder (1.5g/100g), Eucalyptus leaf powder (1.5g/100g), Turmeric powder (10g/100g), Ginger rhizome powder (5g/100g), Garlic powder (5g/100g), and also included chemical as check Chlorpyriphos 48 EC (2%/100g). Among the treatments with botanicals the largest number of mortality was observed in Neem leaf powder (65.55%) followed by Eucalyptus leaf powder (55.55%) and least mortality was observed in the turmeric treatment (20%). Experiments conducted on weight loss of wheat grains at 30,60 and 90 days revealed that the maximum weight loss was occurred in turmeric treatment (1.2%) followed by ginger rhizome powder (0.85%) and minimum is recorded in neem leaf powder (0.34%).Therefore, the present laboratory studies clearly showed the efficacy of different plant extracts on red flour beetle *Tribolium castaneum*(Herbst) were almost effective when compared with chlorpyriphos (Insecticide). Hence it may be concluded that these plant extracts are eco-Friendly, cost effective and easily available. It can easily incorporated to the management of *Tribolium castaneum* in wheat.

KEYWORDS: Chlorpyriphos, Mortality, Red flour beetle, Weight loss, Wheat

1) Introduction

"Wheat is a grass widely cultivated for its seed, a cereal grain which is a worldwide staple food" **Mauseth, J. D. (2014)**. "The many species of wheat combine to form the genus *Triticum* the most widely grown is common wheat (*T. aestivum*). Wheat is grown on further land area than any other food crop,220.4 million hectares or 545 million acres"**,(FAOSTAT).** "World trade in wheat is lesser than for all other crops combined. In 2020, world production of Wheat was 761 million tonnes making it the second most produced cereal after Maize. India's Wheat production during the current crop time(July 2022- June 2023) has been estimated at a record high of 112.18 million tones(mt) – 5 percent advanced than106.84 mt last crop time. Since 1960, world production of wheat and other grain crops has tripled and is expected to grow further through the middle of the 21st century.

Global demand for wheat is adding due to the unique viscoelastic and tenacious parcels of gluten proteins, which grease the product of reused foods, whose consumption is increasing as a result of the worldwide industrialization process and the westernization of the diet". **(Shewry and Hey, 2015)**. "Wheat is an important source of carbohydrates. Encyclopedically, it's the leading source of vegetable protein in mortal food, having a protein content of about 13, which is fairly high compared to other major cereals but fairly low in protein quality for supplying essential amino acids. When eaten as the whole grain, wheat is a source of multiple nutrients and dietary fiber". **(Shewry and Hey, 2015)**. "The red flour beetle(*Tribolium castaneum*) is a species of beetle in the family Tenebrionidae, the darkling beetles. It is a worldwide pest of stored products, particularly food grains, and a model organism for ethological and food safety research" (**Grunwald *et al*., 2013**). "Both larvae and adults feed on grain dust and broken grain, but not the undamaged whole grains and spend its entire life cycle outside the grain kernels" (**Karunakaran *et al*., 2004**). "In severe infestation, the flour turns greyish and has a pungent, disagreeable odor- making it unfit for human consumption. This nonentity causes substantial loss in storehouse because of its high reproductive implicit". (**Prakash *et al*., 2008**). "The control of arthropod pests on stored products has been made by using of fumigants and residual chemical insecticides.Fumigation by phosphine is the main approach for the operative control of the insect pests" (**Chadda, 2016**). "The recent emergence of heritable high level resistance to phosphine in stored grain pests is a serious concern among major grain growing countries around the world". (**Jagadeesan *et al*., 2012) "**Botanicals have low mammalian toxicity, easy to use, biodegradable and moreover no harm to the environment. Over 120 plants and plant products can be used for the control of stored grain Insect pests". (**Ali *et al*., 2014**). "Reported that botanicals can be used as effective tool against *Tribolium castaneum* along with other IPM tactics. Application of plant-derived materials (i.e., plants powders, extracts, oils) as fumigants for the control of stored commodities insect pests and their products is potential substitute approach for the control of insect pests" (**Rehman *et al*., 2020**). "Plant based compounds, being natural and organic, may provide the starting point for such discoveries. In these regards, recent studies have identified several promising natural extracts of plant exhibiting insecticidal activities in stored grain systems" **(Tatun *et al*., 2014 and Tripathi *et al*., 2009).** "Such botanical extracts may have various modes of action and can help in pest management by repelling the pest away, may act as feeding and oviposition deterrent, and at the same time may act as insecticides" **(Mohan and Fields, 2002).** Due to increased awareness about food and environment safety, researchers all over the world are showing tremendous interest in naturally occurring insecticides derived from plants which are safer, biodegradable, easy to use and have equal potential to synthetic insecticides. In this present investigation efficacy of different botanicals and insecticide application to the red flour beetle is observed.

2) Materials and Methods:

Experimental site

This experiment was conducted in Completely Randomized Design (CRD) with three replications, seven treatments and untreated as control at Department of Entomology, Naini Agriculture Institute, Sam Higginbottom University of Agriculture, Science and Technology, Prayagraj, Uttar Pradesh during the 2022-23. The treatment details are given below along with concentrations.

Treatment details

Eight treatments were used in this research work which was easily available in the surrounding regions of prayagraj. Eight various treatments viz., Neen leaf powder, Tulsi leaf powder, Eucalyptus leaf powder, Turmeric powder, Ginger rhizome powder, Garlic powder, chlorpyriphos 48EC were chosen and were collected from the local regions of prayagraj and were stored in room temperature.

Insect culture : Rearing of test insect *Tribolium castaneum*

The cultures of *Tribolium castaneum* were obtained from local wheat godowns of Prayagraj. Plastic containers of 1.5 kg capacity were used for insect rearing. About 500gm of Wheat 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, These containers were kept at room temperature for the adult emergence of *Tribolium castaneum.*

Methodology

Preparation of plant products

After collecting the leaves from local regions of prayagraj, washed thoroughly and then air dried under shade. The dried leaves were ground to a fine powder with the help of grinding machine or pestle and mortar. The powder was passed through one mm sieve to get the fine powder of uniform particle size in all cases along with chemical, Chlorpyriphos and seeds.

Mixing of grain protectants

100gm of healthy and uninfested healthy grains will be taken in plastic jars and different botanicals will be mixed according to required quantities. Freshly emerged 10 beetles are released in the jars. Jars were covered with muslin cloth and tied with rubber bands. Observations were recorded at 5 and 10 and 15 days for Mortality. Similarly, Observations were made for Grain weight loss for 30,60 and 90 days.**(Sekar *et al.*,2021)**

Table 1. TREATMENT DETAILS: -

Treatment no.	Treatment	Dosage per 100 gm of wheat grains	Group of pesticide	Reference
T_1	Neem leaf powder	5gm	Botanical	**Rahman and Talukdar (2006), Upadhyay *et al.* (2011)**
T_2	Tulsi leaf powder	1.5gm	Botanical	**Sekhar *et al.* (2021)**
T_3	Eucalyptus leaf powder	1.5gm	Botanical	**Sekhar *et al.* (2021)**
T_4	Turmeric powder	10gm	Botanical	**Ali *et al.*(2014)**
T_5	Ginger rhizome powder	5gm	Botanical	**Epidi and Odili (2009)**
T_6	Garlic powder	5gm	Botanical	**Rahman and Talukdar (2006), Upadhyay *et al.* (2011)**
T_7	Chloropyriphos 48EC	2%	Chemical	**Zuhra *et al.* (2017)**
T_8	Control	-	-	-

Observations to be recorded:

- Mortality percent of red flour beetle *Tribolium castaneum* (Herbst)

$$\text{Percent mortality} = \frac{\text{Number of dead insects}}{\text{Total number of insects release}} \times 100$$

- Percent of weight loss of treated grain

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

Sekar *et al.*,2021

Statistical Analysis

The data averaged into respective parameter requisite will be subjected to suitable transformation. After analysis, data will be accommodated in the table as per the needs of objectives for interpretation of results. The standard procedures in agriculture statistics given by **Gomez and Gomez (1976)** were consulted throughout. The interpretation of data will be done by using the critical difference value calculated at 0.05 probability level.

3) Results and Discussion

Efficacy of different plant extracts and insecticide on Percent adult mortality of *Tribolium castaneum*

The efficacy of different botanicals on mortality of *Tribolium castaneum* was tested Freshly emerged 10 beetles are released in the plastic jars. The mortality of released adults were recorded at 5, 10 and 15 days after treatment.

The data given in the table 2 showed that the percent mortality of released adults was highest in treatments *viz.*, Neem leaf powder (65.55 percentage) followed by Eucalyptus leaf powder (55.55 percentage) ,Tulsi leaf powder (50 percentage), Garlic powder, Ginger powder , Turmeric powder recorded 41.11 percentage, 31.11 percentage and 20 percentage mortality of adults respectively. For check treatment 100 percentage mortality of adults occurred where as in untreated control 0 percentage mortality recorded.

The similar findings were recorded that "neem leaf powder was the most effective treatment, observed the mean adult mortality of (67.22) per cent Whereas, turmeric rhizome powder was the least effective in comparison to control against adult mortality (30.56 %)". **(Sekar *et al.*,2021)**

Table 2. Effect of different botanicals and insecticide on adult mortality of *Tribolium castaneum*

Treatments	Mortality after 5 days	Mortality after 10 days	Mortality after 15 days	Over all mean
Neem leaf powder	46.667 (43.07)	66.667 (54.78)	83.333 (66.14)	65.556 (54.57)
Tulsi leaf powder	33.337 (35.21)	53.333 (46.92)	63.333 (52.77)	50.000 (44.96)
Eucalyptus leaf powder	36.667 (37.22)	56.667 (48.84)	73.333 (59.00)	55.556 (48.33)
Turmeric powder	3.333 (7.24)	23.333 (28.78)	33.333 (35.21)	20.000 (24.88)
Ginger powder	16.667 (23.85)	33.333 (35.21)	43.333 (41.15)	31.111 (33.50)
Garlic powder	23.333 (28.78)	43.333 (41.15)	56.667 (48.84)	41.111 (39.62)

Chlorpyriphos 48EC	100.000 (88.34)	100.000 (88.34)	100.000 (88.34)	100.000 (88.34)
control	0.000 (1.65)	0.000 (1.65)	0.000 (1.65)	0.000 (1.65)
F test	S	S	S	S
SEm±	2.887	2.887	2.887	8.174
CD(0.05)	8.655	8.655	8.655	24.508
CV	15.385	10.619	8.824	31.175

S= Significant;
Note: Figures in the table are mean values and those in parenthesis are angular transformed values

Efficacy of different plant extracts and insecticide on Weight loss in percentage of wheat grains

The efficacy of different botanicals on percent weight loss of grains was tested Freshly emerged 10 beetles are released in the plastic jars. The weight loss of grains were recorded at 30, 60 and 90 days after treatment.

The data given in the table 3 showed that the percent weight loss of grains was highest in treatments *viz.,* Turmeric 1.2 percentage followed by Ginger 0.85 percentage, Garlic 0.76 percentage, Tulsi 0.65 percentage , Eucalyptus 0.46 percentage, Neem 0.34 percentage. Where as in control highest weight loss is observed 1.7 percentage and least weight loss is observed in check treatment 0.24 percentage.

Similar findings were recorded that the minimum weight loss recorded in Neem followed by Eucalyptus and Tulsi.(**Sekar *et al.*, 2021**).

Table 3. Effect of different botanicals and insecticide on weight loss of Wheat grains

Treatments	Weight loss after 30 days	Weight loss after 60 days	Weight loss after 90 days	Over all mean
Neem leaf powder	0.133 (2.06)	0.333 (3.30)	0.567 (4.31)	0.344 (3.21)
Tulsi leaf powder	0.267 (2.94)	0.667 (4.68)	1.033 (5.83)	0.656 (4.46)
Eucalyptus leaf powder	0.20 (2.56)	0.433 (3.76)	0.767 (5.02)	0.467 (3.77)
Turmeric powder	0.833 (5.23)	1.233 (6.37)	1.567 (7.19)	1.211 (6.25)
Ginger powder	0.433 (3.76)	0.867 (5.34)	1.267 (6.46)	0.856 (5.17)
Garlic powder	0.467 (3.91)	0.667 (4.68)	1.167 (6.19)	0.767 (4.19)
Chlorpyriphos 48EC	0.083 (1.65)	0.233 (2.76)	0.417 (3.70)	0.244 (2.68)
control	0.933 (5.54)	1.867 (7.85)	2.467 (9.03)	1.756 (7.46)
F test	S	S	S	S
SEm±	0.031	0.031	0.031	0.235
CD(0.05)	0.087	0.095	0.095	0.708
CV	11.950	6.979	4.753	51.964

S= Significant;
Note: Figures in the table are mean values and those in parenthesis are angular transformed values

4) Conclusion :

In the research, it was concluded that neem leaf powder was the most effective treatment (65.55 percentage) tailed by eucalyptus (55.55 percentage) and tulsi (50 percentage), whereas, turmeric rhizome powder (20 percentage) was the least effective in comparison to control against adult mortality owing to *T. castaneum*. Similarly the most effective treatment for weight loss of wheat grains is that neem that recorded minimum weight loss (0.34 percentage) and least effective treatment that recorded more weight loss is turmeric (1.21percentage).Other than this the chemical insecticide, Chloropyriphos used as a check showed a greater result than botanical powders. Even though chemical insecticides have an excellent track record of protecting seeds against storage pests, their negative impact on environment and human health necessitates the development of a new technique for their safe use. These issues can be solved using botanicals such as plant powders they are extremely beneficial for safeguarding seeds from stored product insects in an environmentally friendly manner.

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