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ENTOMOLOGY

Botanical Management of Rust Red Flour Beetle, *Tribolium castaneum* (Herbst) on Stored Wheat

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ABSTRACT

The current study on Botanical Management of Rust Red flour Beetle, *Tribolium castaneum* (Herbst) on stored wheat during 2020-2021 in the Entomology Department revealed that *neem* leaf powder was the most effective treatment, observed the mean adult mortality of 67.22 per cent and also records the minimum weight loss after 60 days of storage. The eucalyptus and *tulsi* can be used as next best treatment in controlling the adult emergence. Whereas, turmeric rhizome powder was the least effective in comparison to control against adult mortality (30.56 %), grain weight loss and adult emergence owing to *T. castaneum*. Other than this the chemical insecticide, fenvalerate used as a check showed a greater result than botanical powders with mean adult mortality of *T. castaneum* was 72.78 percent.

HIGHLIGHTS

- Rust red flour beetle is a principal storage pest of wheat.
- Chemical insecticide causes the negative impact to the environment.
- Botanicals are safeguarding the seeds with the eco-friendly manner.

Keywords: botanicals, fenvalerate, management, rust red flour beetle

Tribolium castaneum (Herbst) is considered as a major pest of stored grain. The principal stored grain pest of wheat is red flour beetle *Tribolium castaneum* (Herbst) that is a cosmopolitan and most serious pest. The red flour beetle may be present in large numbers in infested grain. Typically, these beetles can be found not only inside infested grain products, but in cracks and crevices where grain may have spilled. They are attracted to grain with high moisture content and can cause a grey tint to the grain they are infesting. The beetles give off a distasteful odour, and their presence encourages mould growth in grain. The larvae destroy 12.5-14.60 per cent of the individual seeds and during their development some 88 grains are attacked by per larva. It leads to considerable loss in quantity of grains and reduce its viability.. Control of these relies heavily on the use of synthetic insecticides and fumigants. Pimentel *et al*. (2007) reported that the phosphine resistance is shown by *Tribolium castaneum* (Herbst), *Rhizopertha dominica* (F), *Oryzophilus surinamensis* (L). In view of all these problems, several insecticides have either been banned or restricted in their use. Hence, botanical management might be good option for stored pest. We need to go for safe alternatives like plant powders. Botanicals have low mammalian toxicity,

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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 *T. castaneum* along with other IPM tactics.

MATERIALS AND METHODS

Some botanical powders were evaluated for their bio efficacy against *Tribolium castaneum* on stored wheat, using the leaf powder and rhizome powder of some plants. There were 8 treatments with four leaf powder and two rhizome powders along with treatment Fenvalerate as a checkand a control without any treatment.

Preparation of botanical powder

The leaves of neem, *Azadirachta indica*; eucalyptus, *Eucalyptus globus*; *tulsi*, *Ocimum sanctum*; and guava, *Psidium guajava* free from any other pesticide application was collected from college farm and turmeric rhizomes, *Curcuma longa*; ginger rhizomes, *Zingiber officinalis* were purchased from local market. After collection of leaves and rhizomes, these were washed thoroughly under tap water and cut into small pieces and then dried under shade for a week. The dried materials were ground to a fine powder with the help of electric grinder or mortar and pestle. The powder was then sieved and preserved under dry and shade conditions for experimentation.

100 gm of healthy and uninfested healthy grains of local wheat variety was broken and taken in plastic bottles, and then each bottle was mixed with botanical powders at the rate of 1.5 gm /100 gm seed. The experimentation was conducted by using Completely Randomised Design replicated three times. Fenvalerate 0.4 D at the rate of 0.30 gm/ 100 gm of seeds was treated as a check. One untreated control was maintained without mixing the botanical powder. Freshly emerged 10 pairs of adult beetles were released in each plastic bottle. Bottle was covered with muslin cloth and tied with rubber bands. Observations on adult mortality was recorded at 5,10 and 15 days and grain weight loss at 30 and 60 days after the treatment were made. The adult emergence of the pest was also was recorded at 15, 45 and 90 days after treatment.

Per cent adult mortality

The adult mortality of *T. castaneum* was recorded for each treatment after 5, 10 and 15 days of exposure by using the following formula:

Percent adult morality =

$$\frac{\text{Number of adults died}}{\text{Total Number of adults released (20)}} \times 100$$

Per cent weight loss of grains

Weight loss of grains were calculated after 30 and 60 DAT by subtracting the value of infested grain weight from the original weight. The percent weight loss was calculated by using the following formula:

Percent weight loss =

$$\frac{\text{Initial weight} - \text{Final weight}}{\text{Initial weight}} \times 100$$

Where,

Initial weight = weight of original wheat grains

Final weight = weight of infested wheat grains

Per cent adult emergence

Weight loss was calculated after removing dead ones and insect grass, the containers were kept separately for adult emergence (population build up). The adult emergence was calculated after 15, 45 and 90 DAT by using the following formula:

Percent adult emergence =

$$\frac{\text{Number of adults emerged from hatched eggs}}{\text{Total number of eggs hatched (100)}} \times 100$$

RESULTS AND DISCUSSION

After the analysis of the data the results obtained on different treatments of botanical powders are depicted in the table 1 revealed that there was significant difference among various treatments. The treatment of *neem* leaf powder @ 1.5 gm/100 gm of grains recorded highest adult mortality of 53.33 per cent in stored wheat and another two next best treatments with similar kind of action showed by two unlike plant leaf powders of eucalyptus and *tulsi* with the same value of 43.33 per cent. It was then followed by guava leaf powder (41.67%),

Table 1: Efficacy of some botanical powders on adult mortality of *Tribolium castaneum*

Sl. No.	Botanical powders name	Dosage (gm/100g grains)	Per cent adult mortality of *T. castaneum*			
			5 DAT	10 DAT	15 DAT	Pooled mean
1	*Neem*	1.5 gm	53.33 (46.91)	61.67 (51.76)	86.67 (68.86)	67.22 (55.84)
2	Eucalyptus	1.5 gm	43.33 (41.16)	56.67 (48.83)	76.67 (65.95)	58.89 (50.38)
3	Ginger	1.5 gm	36.67 (37.25)	48.33 (44.04)	68.33 (55.77)	51.11 (45.69)
4	Turmeric	1.5 gm	21.67 (27.71)	28.33 (32.14)	41.67 (40.20)	30.56 (33.35)
5	*Tulsi*	1.5 gm	43.33 (41.16)	51.67 (45.96)	68.33 (55.77)	54.44 (47.63)
6	*Guava*	1.5 gm	41.57 (40.20)	43.33 (41.16)	56.67 (48.84)	47.22 (43.40)
7	Fenvalerate	0.30 gm	58.33 (49.80)	76.67 (61.22)	83.33 (65.95)	72.78 (58.99)
8	Untreated control		0 (0.00)	0.00 (0.00)	6.67 (14.76)	2.22 (4.92)
	SE(m)±		0.93	1.15	1.48	2.53
	CD at 5%		2.79	3.47	4.44	7.16

DAT- days after treatment; Figures in the parentheses are angular transformed values; Data represented are mean of three replications.

ginger rhizome powder (36.67 %). Ahmed *et al*. (2019) and suggested that *A. sativum* (garlic) and *Z. officinale* (ginger) were more effective resulting into 15 times higher adult mortality when mixed with rice grains. The treatment of eucalyptus, *tulsi* and *guava* leaf powder are par with each other. Gupta (2005) studied the efficacy of *tulsi* (*O. sanctum*) leaf powder on the growth and development of *T. granarium* and found that immature and adult stages of *T. granarium* showed a total mortality when reared on refined wheat flour containing one and two per cent *tulsi* leaf powder. The least adult mortality was recorded in turmeric rhizome powder (21.67 %). While no adult mortality was noticed in uncontrol treatment and also one chemical treatment was used as a check fenvalerate @ 0.30 g observed the adult mortality of *T. catsaneum* 58.33 per cent. Islam and Talukder (2005) work on malathion and carbaryl towards the red flour beetle a major stored pest, were evaluated.

After 10 days of storage, *neem* leaf powder (61.67 per cent), which was superior compared to other treatments. Next best was eucalyptus leaf powder (56.67 %), then followed by *tulsi* leaf powder (51.67 %) and ginger rhizome powder (48.33 %) par with each other and guava leaf powder (28.33 %). Oyegoke *et al*. (2012) observed that the repellent properties of *O. sanctum* against *T. castaneum* in the laboratory, mortality increased with increase in concentration, with highest mortality (63.5%) observed with 0.5 g/10 g of *O. Sanctum*. Turmeric leaf powder had shown the least death rate of all the treatments, at 28.33 per cent. Sunil (2003) showed that turmeric powder is not a good protectant as it caused 57 per cent grain damage and 17 per cent weight loss in sorghum against *S. oryzae*. However in check, fenvalerate showed the adult mortality rate more than botanical powders which was at 76.67 per cent.

Here once again after 15 DAT *neem* leaf powder was the best treatment, with an 86.67 % adult mortality rate of *Tribolium castaneum*. Whereas, turmeric rhizome powder shows the least effective treatment (41.67 %) compare to all other treatments. After *neem* followed by eucalyptus showed the better results with an (76.67 %) and then followed by *tulsi* leaf powder and ginger rhizome powder with an equal value of (68.33 %), guava leaf powder (56.67 %). So, after 15 days of storage fenvalerate with an adult mortality of 83.33 per cent which was less than neem leaf powder (86.67 %) with significant difference between them. Guru *et al*. (2018) reported the similar results of adult mortality of F2 generations with the deltamethrin at 1% used against rice weevil, *Sitophilus oryzae* (L.) and red flour beetle, *Tribolium castaneum* (Herbst) under laboratory conditions. Sathish and Patgiri (2017) carried out an experiment in the laboratory to evaluate the efficacy of *O. sanctum* leaves extracts as grain protectants against *T. castaneum*. with highest mortality (70.00%) was recorded in *tulsi* acetone extract.

Evaluation of grain weight loss

The table 2 and graph 2 provide information on grain weight loss after 30 days of storage ranged from 0.13 to 0.89 per cent. The untreated control

Table 2: Effect of some botanical powders on per cent weight loss of grains and adult emergence of *T. castaneum*

Sl. No.	Botanical powders name	Dose (gm/100g grains	Per cent weight loss of grains			Per cent adult emergence of *T. castaneum*	
			[1]30 DAT	[1]60 DAT	[1]15 DAT	[2]45 DAT	[3]90 DAT
1	Neem	1.5gm	0.31 (0.80)	0.67 (1.09)	0.00 (0.71)	7.34 (2.80)	20.67 (27.03)
2	Eucalyptus	1.5gm	0.18 (0.83)	0.78 (1.13)	0.00 (0.71)	10.00 (3.24)	26.00 (30.57)
3	Ginger	1.5gm	0.40 (0.95)	0.87 (1.18)	0.00 (0.71)	15.67 (4.03)	34.33 (35.87)
4	Turmeric	1.5gm	0.79 (1.14)	1.07 (1.26)	0.00 (0.71)	12.00 (3.54)	42.67 (40.78)
5	Tulsi	1.5gm	0.28 (0.89)	0.80 (1.15)	0.00 (0.71)	8.00 (2.92)	26.00 (30.65)
6	Guava	1.5gm	0.68 (1.09)	0.86 (1.17)	0.00 (0.71)	13.34 (3.72)	28.67 (32.37)
7	Fenvalerate	0.30 gm	0.09 (0.77)	0.55 (1.03)	0.00 (0.71)	5.00 (2.34)	11.00 (19.36)
8	Untreated control	—	0.89 (1.18)	1.86 (1.54)	0.00 (0.71)	22.67 (4.81)	57.67 (49.41)
	SE(m)±	—	0.01	0.03	—	0.09	0.92
	CD at 5%	—	0.03	0.09	—	0.28	2.77

DAT- days after treatment; [1,2]Figures in the parentheses are square root transformed values; [3]Figures in the parentheses are angular transformed values; Data represented are mean of three replications.

(without any treatment) lost the maximum amount of grain weight (0.89 %), whereas, the grains treated with *neem* leaf powder lost the minimum amount of grain weight with a value of (0.13 %). Ahmed *et al*. (2019) reported that *Azadirachta indica* when admixture with wheat checked the population growth and 4 to 5 times reduction in grain weight loss. Khan and Marwat (2003) assessed the powders made from leaves, seeds and bark of *Azadirachta indica* and *Nerium oleander* for their deterrent effects against *Rhizopertha dominica* and got its repellency up to 96 %, from *neem* leaves and seeds. After that the other botanical powders occupy the next places followed by turmeric (0.79 %), guava (0.68%), ginger (0.40 %), *tulsi* (0.28 %) and eucalyptus (0.18 %). In the check treatment with Fenvalerate the grain weight loss (0.09 %) was recorded lowest compared to botanical powders. In the above grain weight loss, there was a significantly difference in the effect of botanical powders of turmeric, ginger, *tulsi*.

After 60 days of storage, the minimum weight loss was seen in the case of botanical *neem* leaf powder was (0.67 %) and chemical treatment of fenvalerate was 0.55 per cent. As usual the maximum weight loss was recorded in the untreated control (1.86%). It was then tailed by turmeric rhizome powder (1.07 %), ginger rhizome powder (0.87 %), guava leaf powder (0.86 %), *tulsi* leaf powder (0.80 %) and eucalyptus leaf powder (0.78 %). Rahman *et al*. (2003) leaf of eucalyptus showed a less weight loss of seed. Sunil Kumar (2003) evaluated the turmeric powder and said that 17 % weight loss was seen in sorghum against *S. oryzae*. The treatments of ginger (0.87) and guava (0.86); *tulsi* (0.80) and eucalyptus (0.78) had no significant difference each other.

Evaluation of adult emergence

The data gathered with respect to adult emergence of *T. castaneum* in different inert materials at 15, 45 and 90 days after storage are described in table 2 and graph 3. Adult emergence was not identified in any on the treatments after 15 days of storage. There was no significant difference among all the treatments after 45 days of storage. The lowest adult emergence was obtained in the treatment of *neem* leaf powder (7.34 %), followed by *tulsi* leaf powder (8 %), eucalyptus leaf powder (10 %). Hameed *et al*. (2012) reported the *neem* and neem-based products against different insect pests of field crops and stored grains. *Neem* was found to be comparatively better than kanair. Highest adult emergence was recorded in the untreated control (22.67 %). The remaining were ginger rhizome powder (15.67 %), guava (13.34 %), turmeric (12 %). The chemical treatment fenvalerate used as a check records the least percentage of adult emergence of *T. castaneum* was 5 per cent.

At the end of 90 days, all the botanical powders proved to be significantly effective on adult emergence of *Tribolium castaneum* over the untreated control (57.67 %). However, the highest adult emergence (42.67 %) was marked in the turmeric leaf powder, followed by ginger rhizome powder (34.33 %) and guava leaf powder 28.67 per cent.

Fenvalerate used as a check records the lowest adult emergence with a value of 11 per cent, followed by *neem* leaf powder 20.67 per cent. Patil *et al*. (2015) evaluated that the relative toxicity of various plant powder viz., *neem* seed and leaves powder, tulsi and turmeric against the rust red flour beetle, *T. castaneum* adults in laboratory conditions by treating rice grains. The results revealed that *neem* seed powder @ 5 g was found to be significantly effective among all the treatments tested by recording (88.66%) *T. castaneum* adult mortality. Yadav and Tiwari (2017) taken chopped neem leaves and ajwain seed powder with minimum adult emergence of 12 % and 11.67 per cent. Remaining two botanical powders of *tulsi* and eucalyptus recorded the same value of (26 %). Tooba *et al*. (2005) stated that the repellent and toxicity of some medicinal plants Immune to insect attack. The potential of leaves of five plants (*Eucalyptus* sp., *Bouginvillea glabra*, *A. indica*, *Saraca indica* and *R. communis*) were selected as grain protectants against insect infestation. Forty-five days storage of wheat grain samples were tested with 5% (by weight) of above-mentioned selected test leaves which showed 76-78% repellence against *Tribolium castaneum* insect compared with the control samples of wheat grain without test leaves.

CONCLUSION

In the research, it was concluded that *neem* leaf powder was the most effective treatment tailed by eucalyptus and *tulsi*, whereas, turmeric rhizome powder was the least effective in comparison to control against adult mortality, grain weight loss and adult emergence owing to *T. castaneum*. Other than this the chemical insecticide, fenvalerate 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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