International Journal of Multidisciplinary Research and Development
www.allsubjectjournal.com
Online ISSN: 2349-4182, Print ISSN: 2349-5979
Received: 25-12-2021, Accepted: 10-01-2022, Published: 27-01-2022
Volume 9, Issue 1, 2022, Page No. 33-36

Herbarium management of rust red flour beetle, *Tribolium castaneum* (Herbst) on stored pearl millet (*Pennisetum glaucum*)

Garima Modi, Yogita Chhangani
[1] Research Scholar, Jai Narain Vyas University, Jodhpur, Rajasthan, India
[2] Associate Professor, Department of Zoology, Lachoo Memorial College of Science and Technology, Jodhpur, Rajasthan, India

Abstract
The quantitative and qualitative damage to stored grains and grain product from the insect pests may amount to 20-30% in the tropical zone and 5-10% in the temperate zone. Food grain production in India has reached 250 million tonnes in which nearly 20-25% food grains are damaged by stored grain insect pests. Our country is, therefore, loosing on an average of 9.33 per cent stored grains. Putting tonnes of synthetic pesticides in the environment and killing all the organism alike is certainly not a right approach of solving pest problems. Since ancient time pests have been damaging and causing heavy losses to stored grains both quantitatively and qualitatively. Escalating costs due to depleting natural reserves coupled with ever increasing doses to overcome resistance problem, synthetic insecticides are becoming an unprofitable important input in crop production. Synthetic insecticides have been used extensively in grain facilities to control stored product insect pests. To replace the use of synthetic fumigants in the stored product pest management, an attempt was made to identify the suitable alternative herbarium. Pearl millet (*Pennisetum glaucum*) is an important nutri-cereal for human as well as a forage/fodder crop for livestock. It is a rich source of nutrients as compared to the major cultivated cereal crops. However, major factors which limit its utilization are the presence of anti-nutritional factors (tannins and polyphenols) which lower availability of minerals and poor keeping quality because of higher lipase activity. The current studies revealed that leaf powder of neem was the most effective treatment in Pearl millet. Botanicals can be used as effective tool against *T. castaneum* along with other IPM tactics.

Keywords: *Herbarium, management,* rust red flour beetle, pearl millets, synthetic insecticides

Introduction
Stored product of agricultural and animal origin are attacked by over 600 species of beetle gadflys, seventy species of moths and regarding 355 species of mites inflicting quantitative and qualitative losses and bug contamination in food commodities is a crucial internal control downside of concern for food industries. *T. castaneum* could be a common and most damaging pest of hold on products and is cosmopolitan in distribution. The insect cause serious injury to any or all styles of stored products appreciate flour cereals, meals, beans, spices, pasta, cake, mix, dried pet food, dried flowers, chocolate, nut seed, and even dried depository specimen. This gadfly is usually found in granaries, mills, warehouse, and store. Presently completely different styles of preventive and curative management measures are practiced to induce protection from this pest. In several countries, efforts are being created to reduce the employment of harmful pesticides through the use endemic plant product, implementation of IPM approaches, use of bio-degradable products and applying insect growth regulators to safeguard hold on grains. In many areas of the globe regionally out there plant materials are wide accustomed protect stored product against injury by insect infestation. Biology product is environmentally safe, less hazardous, economic and simply available. Botanicals like Bonkalmi, Bazna, Bishkatali, Datura, Durba, Eucalyptus, Ghora-neem, Hijal, Karanja, Mahogoni, Marigold, Neem, Nishinda, Pithraj, and lots of others could also be grownup by farmers with minimum expense and extracted by endemic methods. These botanical materials may be used as another to chemical pesticides. This may be terribly useful in minimizing the undesirable aspect impacts of artificial pesticides. The current experiment was undertaken with herbarium plant leaf powder to research the effect of this product on the mortality of the insect. The Red darkling beetle is drawn to bajra grain with high wet content may} cause a gray tint to the grain they're infesting. The beetles offer 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. It results in respectable loss in amount of grains and cut back its viability. Management of those depends heavily on the employment of artificial pesticides and fumigants. Insight of these problems, many insecticides have either been prohibited or restricted in their use. Hence, biology management might be smart choice for hold on pest. We'd like to travel for safe alternatives like plant powders.

Materials and Methods

Study area

The experiments were carried out at the Department of Zoology and Environmental Sciences, Lachoo Memorial College, Jodhpur, under ambient conditions (32 ± 0.64 ° C and 68 ± 3% relative humidity). The bioefficacy of some herbal powders was assessed against Tribolium castaneum in stored Bajra, use the leaf powder along with the treatment.

Preparation of botanical powder

Neem leaves, *Azadirachta indica;* eucalyptus, *Eucalyptus globus*; Tulsi, *Ocimum sanctum*; and guava, *Psidium guajava*, free from any other pesticide use, was collected in the back yard of the college. After the leaves were collected, they were thoroughly washed with tap water and cut into small pieces, and then dried in the shade for one week. Powder with the help of an electric grinder or mortar and pestle. The powder was sieved and stored in dry and shady conditions for experiments. 100 g of healthy and healthy uninfected local Bajra variety grains were split and placed in plastic bottles, and then each bottle was mixed with botanical powder in an amount of 1.5 g / 100 g of seeds. The experiments were performed with a fully randomized design that was replicated three times. An untreated control was kept without mixing the powder. Ten pairs of newly hatched adult beetles were released into each plastic bottle. The bottle was covered with muslin cloth and tied with elastic bands. Observation of adult mortality at 5, 10 and 15 days and weight loss of the grains at 30 and 60 days after the treatment was performed was recorded. The emergence of adults of the pest was also 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:

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

Per cent weight loss of grains

Weight loss of grains was 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:

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

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:

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

Results and Discussion

After the analysis of the data the results obtained on different treatments of botanical powders is 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 bajra 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%). 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 %), and then followed by *tulsi* leaf powder (51.67 %) and guava leaf powder (28.33 %).

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

S.no.	Botanical Powders name	Dosage (gm/100g grains)	% Adult mortality of *T.castaneum*			
			5 DAT	10 DAT	15 DAT	Pooled Mean
1	Neem	1.5 gm	53.33 (46.71)	61.67 (50.76)	86.67 (68.83)	67.22 (55.82)
2	Eucalyptus	1.5 gm	43.43 (41.12)	57.01 (48.12)	77.96 (65.91)	58.89 (50.32)
3	Ginger	1.5 gm	36.75 (37.21)	48.33 (44.10)	69.22 (53.44)	51.22 (45.67)
4	Turmeric	1.5 gm	21.12 (26.71)	29.01 (32.12)	41.67 (40.21)	30.52 (33.32)
5	Tulsi	1.5 gm	44.92 (41.12)	52.32 (45.18)	69.22 (55.76)	54.11(47.61)
6	Guava	1.5 gm	41.57 (40.11)	43.33 (41.12)	56.91 (48.32)	48.22 (43.41)
7	Untreated control		0.00 (0.00)	0.00 (0.00)	6.67 (14.72)	2.21 (4.91)

DAT- days after treatment; Data represented are mean of three replications.

Evaluation of grain weight loss

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

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

S. No.	Botanical Powders name	Dosage (gm/100g grains)	% Weight loss of grains			% Adult emergence of *T.castaneum*	
			30 DAT	60 DAT	15 DAT	45 DAT	90 DAT
1	Neem	1.5 gm	0.31 (0.80)	0.67 (1.09)	0.00 (0.71)	7.32 (2.80)	20.67 (27.02)
2	Eucalyptus	1.5 gm	018 (0.83)	0.76 (1.12)	0.00 (0.71)	10.11 (3.22)	26.11 (30.56)
3	Ginger	1.5 gm	0.40 (0.95)	0.87 (1.17)	0.00 (0.71)	15.62 (4.03)	34.32 (35.86)
4	Turmeric	1.5 gm	0.79 (1.11)	1.02 (1.23)	0.00 (0.71)	12.01 (3.52)	42. 62 (40.76)
5	Tulsi	1.5 gm	0.28 (0.87)	0.80 (1.15)	0.00 (0.71)	8.01 (2.92)	26.01 (30.65)
6	Guava	1.5 gm	0.68 (1.10)	0.85 (1.17)	0.00 (0.71)	13.32 (3.72)	28.66 (32.37)
7	Untreated control	-	0.89 (1.16)	1.86 (1.54)	0.00 (0.71)	22.67 (4.21)	56.66 (49.41)

DAT- days treatment; data represented are mean of three replications

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). As usual the maximum weight loss was recorded in the untreated control (1.86%). It was then tailed by turmeric rhizome powder (1.07 %), guava leaf powder (0.86 %), *tulsi* leaf powder (0.80 %) and eucalyptus leaf powder (0.78 %).

Evaluation of adult emergence

The data collected on emergence of T. castaneum adult animals in various inert materials at 15, 45 and 90 days after storage are described in Table 2. No adult emergence was observed in any of the treatments after 15 days of storage. There was no significant difference between any of the treatments after 45 days of storage. The lowest adult emergence was achieved with treatment with neem leaf powder (7.34%), followed by tulsi leaf powder (8%), eucalyptus leaf powder (10%). it turned out to be comparatively better than Kanair. The greatest incidence of adults was registered in the untreated control (22.67%). After 90 days, all vegetable powders were found to be significantly effective in the occurrence of Tribolium castaneum adult animals compared to the untreated control (57.67%). The emergence (42.67%) was pronounced with turmeric leaf powder, followed by ginger rhizome powder (34.33%) and guava leaf powder 28.67%. Leaves with 76.78% resistance to Tribolium castaneum compared to Bajra grain control samples 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 powder was the least effective in comparison to control against adult mortality, grain weight loss and adult emergence owing to *T. castaneum*. 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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