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Eco-friendly Approach for the Management of Rust Red Flour Beetle, *Tribolium castaneum* (Herbst) on Wheat Grains

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ABSTRACT

Background: Wheat is the major cereal crop occupying an eminent place in economy of our country. About 10-15% wheat is lost annually due to ravages of stored grains pests during storage. The principal stored grain pest of wheat is red flour beetle *Tribolium castaneum* (Herbst) which is a cosmopolitan and most serious pest.

Methods: The present investigation was carried out in the Entomology Laboratory during 2020-2021, College of Agriculture, Central Agricultural University, Imphal to investigate eco-friendly management of rust red flour beetle, *Tribolium castaneum* on wheat grains by using different inert materials *viz*., paddy straw, paddy husk ash, cow dung ash, coal ash, sand dust, saw dust, boric acid and one untreated control with the dose of 1.5 gm/100 gm of wheat grains.

Result: The results showed that the boric acid exhibited 100 per cent adult mortality of *T. castaneum* within 5 days after treatment. Afterwards the next best treatment was cow dung ash, coal ash shows the very effective in treatment in the adult emergence and grain weight loss. Whereas, saw dust shows the least effective treatment in the controlling adult emergence.

Key words: Eco-friendly management, Inert materials, *Tribolium castaneum.*

INTRODUCTION

Wheat (*Triticum aestivum* Linn.) is known as the “KING OF CEREALS”. It is mostly consumed in the north and north - west parts of the country. Wheat is the major cereal crop occupying an eminent place in economy of our country. Production of wheat during 2019-20 is estimated with a record of 107.18 million tonnes. In India, majority of small and marginal farmers store small quantities of wheat grains in their house for consumption and seed purpose. About 10-15% wheat is lost annually due to ravages of stored grains pests during storage.

T. castaneum (Herbst) is considered as a major pest of stored grain (Howe, 1965). This beetle is found in granaries of wheat, cereals, mixed cake, dried flowers and pet food, seeds, chocolate, meal, spices, nuts *etc*., In some tropical countries these losses are as high as 30% (Lohar, 2001). The red flour beetle may be present in large numbers in infested grains.

Control of these relies heavily on the use of synthetic insecticides and fumigants. But their widespread use has led to some serious problem including development of insect strains resistant to insecticides (Zettler and Cuperus, 1990) toxic residues on stored grains, toxicity to consumers and increasing costs of claim, environmental contamination, harmfulness to non-target organisms etc. In view of all these problems, several insecticides have either been banned or restricted in their use. For example, the use of organophosphate was decreased, because of increasing resistance incidence in stored-product insects against these chemicals (Fang *et al*., 2002).

Therefore, Environmentally Friendly Management is the good option for stored pest. We need to go for safe alternatives like inert materials, which are chemically inactive, no toxicity and local availability. Inert dusts absorb the waxy layer of insects, leading to dehydration and death. So, in view of above information the objective was to identify an eco-friendly management of rust red flour beetle, *T. castaneum* on wheat grains.

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MATERIALS AND METHODS

Some inert materials were evaluated for their efficacy against *T. castaneum* on wheat grains during the period of December 2020 to April 2021 in research lab of Entomology Department, Central Agricultural University, Imphal, Manipur. With the ambient conditions used as maximum and minimum temperature was 35°C and 30°C, respectively. The maximum and minimum relative humidity were 70 and 65 per cent, respectively during the course of inquiries. There were 8 treatments *viz.*, paddy straw, paddy husk ash, cow dung ash, coal ash, saw dust, sand dust, boric acid and untreated control with three replications.

Sources of inert materials

Paddy straw was collected from our college field and Paddy husk ash was obtained from nearby rice mill. Cow dung pallets were collected from the college farm and it was burnt to get the ash. Coal ash was obtained from kitchen. Saw dust was also collected from the carpentry workshop. Sand dust was available in campus. Boric acid was obtained from the Department of Soil Science, CAU, Imphal.

Details of the experiment

100 gm of healthy and disinfest broken grains of local wheat variety was kept in plastic bottles. Each bottle was mixed with inert materials at the rate of 1.5 gm/100 gm seed. Treatments were replicated for three times and design used to be CRD (completely randomized design). One untreated control was maintained without mixing the inert material. Freshly emerged 10 pairs of adult beetles was released in each plastic bottle. Bottle was covered with muslin cloth and tied with rubber bands.

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:

$$\text{Per cent adult mortality} = \frac{\text{Number of adults died}}{\text{Total number of adults released (20)}} \times 100$$

Per cent weight loss of grains

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

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

Where,
Initial weight = Weight of original wheat grains
Final weight = Weight of infested wheat grains

Per cent adult emergence

After weight loss were calculated in the containers removing the insect decease ones and frass 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:

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

RESULTS AND DISCUSSION

Per cent adult mortality

After evaluation of some inert materials the results depicted in the Table 1 shows that the 100 per cent adult mortality of *T. castaneum* was recorded at 5 DAT in case of grains treated with boric acid (100%). Thakur *et al*. (2014) reported that among different inert materials evaluated for their efficacy against the *T. castaneum*, after 7 days of storage cent per cent mortality of adult was recorded in boric acid was highest. The next best alternatives are cow dung ash, coal ash with adult mortality of 91.67% and 86.67% after 15 days of storage. Pawar (1980) evaluated that 1.25 cm layer of cow dung ash at the top was effective in protecting seeds from *C. chinensis* in tanks and barrel. Further, mixing with 30 per cent wood ash was also effective against *S. oryzae* and *S. cerealella* in maize. Paddy husk ash resulted as intermediate effect at 5 DAT (55%), 10 DAT (73.33%) and 15 DAT (78.33%). Krishnamurthy and Rao (1950) reported that rice husk ash has been tested as an insecticide, mixed with stored grains and have been used by farmers in Japan and India. Paddy straw (48.33%) and sand dust (53.33%)

Table 1: Efficacy of some inert materials on adult mortality of *T. castaneum*.

Inert materials name	Dosage (gm/100 g grains)	Per cent adult mortality			
		5 DAT	10 DAT	15 DAT	Pooled mean
Paddy straw	1.5 gm	41.67(40.20)	48.33(44.04)	56.67(48.84)	48.89(44.36)
Paddy husk ash	1.5 gm	55.00(47.87)	73.33(58.93)	78.33(62.29)	68.89(56.36)
Cow dung ash	1.5 gm	63.33(52.74)	83.33(70.11)	91.67(73.40)	81.11(65.42)
Coal ash	1.5 gm	71.67(57.86)	76.67(61.14)	86.67(68.66)	78.33(62.56)
Saw dust	1.5 gm	25.00(29.93)	38.33(38.24)	43.33(41.16)	35.56(36.44)
Sand dust	1.5 gm	46.67(43.09)	53.33(46.91)	61.67(51.76)	53.89(47.25)
Boric acid	1.5 gm	100(90.00)	100(90.00)	100(90.00)	100(90.00)
Untreated control		0(0.00)	5.00(12.92)	11.67(19.89)	5.56(10.94)
SE(m)±		0.56	0.55	0.69	1.89
CD at 5%		1.69	1.66	2.09	5.36

DAT- Days after treatment.

Figures in the parentheses are angular transformed values.

Data represented are mean of three replications.

was the next shows the similar kind of adult mortality at 10 days after treatment. Saw dust was the least effective treatment, with an adult mortality rate of 38.33 per cent. Kumar (2012) recorded the adult mortality of *T. castaneum* through inert materials, after 30 days of storage cow dung ash was found best treatment. While saw dust was least effective treatment Although, there was 5 per cent adult mortality was recorded in uncontrol. In the case of boric acid, the rest of the periods show zero per cent adult mortality because its already showing 100 per cent in the first 5 days. Over all pooled mean were also calculated.

Evaluation of grain weight loss

The Table 2 provide information on grain weight loss after 30 and 60 days of storage. The most effective treatment in inert material was boric acid @1.5 g/100 g grains with zero per cent weight loss. Then it was followed by cow dung ash (0.15%), coal ash (0.25%), paddy husk ash (0.44%) and sand dust (0.65%) of grain weight loss. Tabu *et al*. (2012) reported that efficacy of some inert materials against Adzuki bean beetle, recorded that low seed weight loss without affecting seed germination in stored chickpea. Sivasrinivasu (2001) assessed the cent per cent mortality of rice weevil at 28 days after storage in sorghum treated with 30 per cent ash and observed no weight loss for 90 days of storage period. The maximum weight loss was seen in the untreated control (0.92%). The least effective treatment was saw dust (0.79%) and then followed by paddy straw with a value of (0.71%). The data collected on grain weight loss after two months of storage were ranged from 2.09 to 0.22 per cent, the minimum weight loss was seen in the treatment of boric acid (0.22%). The remaining treatments *viz*., saw dust (1.77%), paddy straw (1.57%), sand dust (0.88%) paddy husk ash (0.78%), coal ash (0.75%) and cow dung ash (0.54%). According to Golob *et al*. (1982) restricted infestation of stored insects in maize grains admixed with wood ash, tobacco dust, saw dust and sand. So far, again the uncontrol of without any treatment to the grains lost maximum weight of (2.09%).

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.

Adult emergence was not noticed in any of the treatments after 15 days of storage, because of the average life cycle of *T. castaneum* in the laboratory conditions was 22-26 days. There was no statistically significant difference in the adult emergence of *T. castaneum* between the inert material treatments after 45 days of storage. The minimum adult emergence was noticed after 45 days of storage in a treatment of boric acid treatment (3.67%) as against 25.34% in untreated control. The remaining treatments are follows saw dust (15.34%), paddy straw (13%), sand dust (12%), paddy husk ash (11.34%), coal ash (9.62%) and cow dung ash (7.34%). Meena *et al*. (2014) reported the adult emergence of *C. cephalonica* on wood ash (33.33%) control 90 per cent. Tabu *et al*. (2012) said that wood ash and sand reduced the F1 progeny emergence. Lakhani and Patel (1985) evaluated that ash at 5 per cent was the most effective and cheapest material in reducing the damage by *E. cautella* to the bajra by about 9 per cent and in keeping eggs hatching and adult emergence low. Here the inert material treatment of saw dust reported the highest adult emergence of *T. castaneum* was 40.67 per cent, followed by the next treatments are paddy straw (31.67%) and paddy husk ash (25.33%). Yadav and Tiwari (2017) reported that minimum adult emergence in ash powder, sand and cow dung ash was 2.00, 2.33 and 8.33 per cent. By way of usual the untreated control noticed the maximum number of adult emergences 76 per cent after 90 DAT and the least number of adult emergences was observed in the treatment of boric acid (12.67%). The remaining treatments *viz*., cow dung ash (17%), coal ash (21.33%) and sand dust 22.33 per cent

Table 2: Effect of inert materials on per cent weight loss of grains and adult emergence of *T. castaneum*.

Inert materials	Dose	Per cent weight loss of grains		Per cent adult emergence		
name	(gm/100 g grains)	[1]30 DAT	[1]60 DAT	15 DAT	[1]45 DAT	[2]90 DAT
Paddy straw	1.5 gm	0.71(1.11)	1.57(1.44)	0.00(0.00)	13.00(3.68)	31.67(34.23)
Paddy husk ash	1.5 gm	0.44(0.97)	0.78(1.13)	0.00(0.00)	11.34(3.44)	25.33(30.22)
Cow dung ash	1.5 gm	0.15(0.81)	0.54(1.02)	0.00(0.00)	7.34(2.80)	17.00(24.31)
Coal ash	1.5 gm	0.25(0.87)	0.75(1.12)	0.00(0.00)	9.67(3.19)	21.33(27.49)
Saw dust	1.5 gm	0.79(1.14)	1.77(1.51)	0.00(0.00)	15.34(3.98)	40.67(39.62)
Sand dust	1.5 gm	0.61(1.06)	0.88(1.18)	0.00(0.00)	12.00(3.54)	22.33(28.18)
Boric acid	1.5 gm	0.00(0.71)	0.22(0.85)	0.00(0.00)	3.67(2.03)	12.67(20.80)
Untreated control	-	0.92(1.20)	2.09(1.61)	0.00(0.00)	25.34(5.09)	76.00(60.70)
SE(m)±	-	0.01	0.02	-	0.09	0.57
CD at 5%	-	0.04	0.07	-	0.29	1.70

DAT- Days after treatment.

[1]Figures in the parentheses are square root transformed values.

[2]Figures in the parentheses are angular transformed values.

Data represented are mean of three replications.

respectively. Apuli and Villet (1996) verified wood ash against *C. maculatus* in cowpea. The damage to seeds ranged from 63 per cent in the ash free control to 1.3 per cent in seeds treated with 30 per cent ash. The number of progenies similarly ranged from 148 in the untreated control to 2.5 in 30 per cent ash treatment. In the treatment of coal ash and sand dust there was statistically significant difference between them. After 90 days of storage, the order of adult emergence was: untreated control > saw dust > paddy straw > paddy husk ash > sand dust ≥ coal ash > cow dung ash > boric acid.

CONCLUSION

Present study revealed that boric acid @ 1.5 gm/kg grain was the best to protect the wheat grains from a major storage insect *T. castaneum*. Other alternatives could be cow dung ash, coal ash and paddy husk ash. These eco-friendly approaches have good potential in future.

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