GLOBAL JOURNAL OF BIO-SCIENCE AND BIOTECHNOLOGY
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EFFICACY OF CERTAIN GRAIN PROTECTANT AGAINST RUST RED FLOUR BEETLE, *TRIBOLIUM CASTANEUM* (HERBST) ON STORED RICE

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ABSTRACT
The present investigation was carried out to evaluate the relative toxicity of various plant powder *viz.,* neem seed and leaves powder, black pepper, karanj, tulsi, turmeric, onion and garlic at three doses *i.e*. 1, 3 and 5g and Untreated (control) 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 treatment tested by recording (88.66 %) mortality *T. castaneum* adult. The next effective treatment was black pepper @ 5g having (83.29 %) mortality.

KEY WORDS: Management, plant powders, rice, *Tribolium castaneum.*

INTRODUCTION

Rice (*Oryza sativa* Linnaeus) is a most important food crop of the world, which has been grown in tropical, subtropical and temperate countries, provided the staple food and a mainstay to more than 65 per cent of the world's population. More than 80 per cent of the rice is produced and consumed in Asia of which the South Asia accounts for about 30 per cent of global rice production, which is providing major source of food energy and nutrition for more than half of human population of the world. India is second largest producer and consumer of rice in the world after china. Rice is grown in *kharif* (rainy season) and generally harvesting season coincide with rain or high humidity due to unsurety of rains and uneven season in our country. Thus, harvested as well as processed rice retain high moisture content, which predisposes grain for considerable losses every year. Therefore, stored grains of rice are liable to attack by the many enemies *viz.,* insect, mites, moulds, rodents *etc.* and out of these; insects are causing enormous losses in terms of quality and quantity in transit as well as in storage. In India the storage losses have been estimated as 14 million tonnes of food grain worth of Rs. 7,000 crores every year in which, insects alone account 2.0 to 4.2 per cent for nearly 1,300 crores annually (Anonymous, 2012).

The rust red flour beetle, *Tribolium castaneum* Herbst. (Tenebrionidae: Coleoptera) is one of the major and most destructive insects pest of stored commodities (Prakash *et al.,* 1987). It is also a polyphagous and cosmopolitan in nature having Indo-Australian origin (Smith and Whitman, 1992). Although its pest status is considered as a secondary pest, requiring prior infestation by primary pest *viz.,* Rice weevil, *Sitophilus oryzae* (L), Lesser grain borer, *Rhizopertha dominica* (Fab.) etc. an internal feeder or grains may be damaged at the time of harvesting operation. *T. castaneum* is commonly known as red flour beetle, rust red flour beetle and "bran bug" which primarily attacks milled grain products, such as flour and cereals (Karunakaran *et al.,* 2004). In present studies, attempts have been made to seek the solution for preserving rice grains for consumption as well as seeds for sowing purpose; saving them from insect attacks particularly against, *T. castaneum* the most serious pest of stored rice. Mixing with some botanical plant powders within grains which can afford persistence protection against this insect attacks. Stored grains and processed commodities are always at risk of the insect invasion (Ukeh *et al.,* 2012) and due to insect attack a progressive deterioration in quality and quantity results (Nadeem *et al.,* 2012) the weight and germination capacity (Phillips and Throne, 2010).

MATERIALS & METHODS

Experiment was conducted in P. G. Research Laboratory, Department of Entomology, NMCA, NAU, Navsari during the two successive years (2011-12 & 2012-13). The nucleus culture of rust red flour beetle, *T. castaneum* was established under laboratory by collecting adults with the help of white paper strip method or by sieving with 100 mesh iron sieve from the infested rice grains stored in different storage godown as well as in rice mills in Navsari. It is used as test insect for the further study by mass multiplying and maintained under Laboratory. The mass multiplication of stock culture was maintained on rice under sanitized laboratory conditions. The milled rice grains were sterilized at 55°C temperatures in a hot air oven for four hours, to eliminate the infestation of insects. These grains were conditioned before use for about 48 hours at 30 ± 1°C and 75 ± 5 per cent relative humidity in Biological Oxygen Demand (BOD). The food was changed at monthly interval in into other sterilized and clean glass jar having fresh food and used for further study.

Procedure for the preparation of plant powders

The leaves of neem, *Azadirachta indica;* karanj, *Pongamia pinnata* and tulsi, *Occimum basilicum* which was free from any pesticides application were collected from College farm and turmeric rhizomes, *C. longa*; seeds of black pepper, *P. nigrum*; neem, *A. indica* and bulbs of onion, *A. cepa* and garlic, *A. sativum* were purchased from

local market. The plant materials were distain under tap water and cut into small pieces and dried for a week under shade. Thereafter, ground into fine powder with the help of electric mixer-grinder and directly used for study. In order to evaluate the different botanicals as a grain protectant against rust red flour beetle, *T. castaneum* 100g sterilized grains of milled rice were treated by mixing with the plant powders *viz.*, seeds of black pepper and leaves of neem, karanj, tulsi; turmeric rhizome; bulb of onion and garlic thoroughly @ 1.0, 3.0 and 5.0 g powder with 5 ml of acetone in such a way to get uniform coating an placed in transparent plastic boxes (7 x 6 cm) and kept open for two days to evaporate the acetone. Then after, the respective boxes and containers were tightly closed with the perforated lid and were stored on raised platform in the laboratory at room temperature under hygienic laboratory conditions. There was parallel control. Experiments were conducted in completely randomized design (CRD) with three repetitions.

Observation on residual toxicity was recorded after 2 and 15 days and thereafter at an interval of one month up to a period of six months. The mortality counts were recorded after 72 hours of release at each interval. Beside the dead, moribund insect was also considered as dead. The percentage mortality of adults was corrected by using formula suggested by Abbott's (1925).

$$\text{Per cent Corrected mortality} = \frac{\text{Mortality in treatment - Mortality in control}}{\text{100 – Mortality in control}} \times 100$$

The zero and cent per cent values were replaced by using formula (1/4n) x 100 and (1-1/4n) x 100 respectively. Where, n=number of adults per treatment suggested by (Bartlett, 1947).

RESULTS & DISCUSSION

The results pertaining to efficacy of different plant powder against adults of *T. castaneum* at different period of storage intervals during 2011-12, 2012-13 and overall pooled data are presented in Table-1 and it revealed that, adult mortality was significantly influenced by different plant powders under the present investigation.

TABLE 1: Efficacy of plant powders against adults of *T. castaneum* on rice grain at different period of storage (2011-2013)

Treat. No.	Treatment Details	Dose g/100 g of grain	Corrected (%) adult mortality		
			Pooled Data (2011-12)	Pooled Data (2012-13)	Overall Pooled Data (2011-13)
T_1		1g	62.52 d (78.69)*	62.86 de (79.15)	62.69 d (78.91)
T_2	Neem seed	3g	68.01 b (85.98)	68.46 ab (86.43)	68.23 ab (86.21)
T_3		5g	70.89 a (89.25)	69.78 a (88.03)	70.33 a (88.66)
T_4		1g	62.02 d (77.99)	61.55 defg (77.28)	61.78 de (77.64)
T_5	Neem Leaves	3g	58.96 ef (73.41)	59.49 fgh (74.20)	59.21 ef (73.79)
T_6		5g	68.87 b (86.98)	67.33 ab (85.04)	68.09 ab (86.02)
T_7		1g	59.85 e (74.77)	59.85 efgh (74.75)	59.85 ef (74.76)
T_8	Black pepper	3g	63.28 d (79.78)	61.99 def (77.86)	62.62 d (78.82)
T_9		5g	65.82 c (83.20)	65.98 bc (83.37)	65.90 bc (83.29)
T_{10}		1g	48.93 j (56.84)	48.55 m (56.17)	48.73 lm (56.48)
T_{11}	Karanj	3g	58.32 f (72.41)	58.78 ghi (73.08)	58.54 fg (72.73)
T_{12}		5g	65.02 c (82.16)	63.85 cd (80.54)	64.42 cd (81.35)
T_{13}		1g	44.24 l (48.67)	44.55 nop (49.22)	44.39 no (48.94)
T_{14}	Tulsi	3g	59.08 ef (73.59)	57.86 hi (71.66)	58.45 fg (72.60)
T_{15}		5g	53.21 hi (64.14)	53.82 jk (65.13)	53.51 ij (64.63)
T_{16}		1g	49.90 j (58.51)	49.61 lm (58.01)	49.76 kl (58.26)
T_{17}	Turmeric	3g	46.40 k (52.44)	47.06 mn (53.59)	46.74 mn (53.04)
T_{18}		5g	52.26 i (62.54)	51.73 kl (61.62)	52.00 jk (62.10)
T_{19}		1g	37.43 m (36.95)	38.36 q (38.53)	37.91 p (37.76)
T_{20}	Onion	3g	38.71 m (39.10)	38.40 q (38.59)	38.55 p (38.85)
T_{21}		5g	53.89 h (65.26)	54.23 jk (65.81)	54.04 hij (65.51)
T_{22}		1g	43.67 l (47.68)	42.86 op (46.28)	43.27 o (46.98)
T_{23}	Garlic	3g	54.47 h (66.22)	54.66 jk (66.52)	54.56 hi(66.37)
T_{24}		5g	56.41 g (69.39)	55.80 ij (68.38)	56.10 gh (68.88)
S. Em. ±					
Treatment (T)			0.46	1.07	0.54
(P × T)			-	-	0.82
C. D at 5%					
Treatment (T)			1.31	3.05	1.52
(P × T)			-	-	NS
C.V. (%)			1.49	3.50	2.68

* Figures in parentheses are original value while those outside are arc sine transformed values.

The pooled data of rice grain during the year 2011-12 against *T. castaneum* population clearly indicated that, all the plant product treatments were found significantly superior over rest of the treatments. However, significantly highest per cent mortality of *T. castaneum* was recorded in the treatment of neem seed powder @ 5 g/100 g (89.25 %). The next excellent treatments were found neem leaves powder @ 5 g/100 g and neem seed powder @ 3 g/100 g which recorded 86.98 and 85.98 per cent mortality, respectively. Pooled data of (2012-13) indicated that, the neem seed powder @ 5 g/100 g of grain was found significantly best treatment having (88.03 % mortality) among all the treatments tested, which was at par with the neem seed powder @ 3 g/100 g (86.43 %) and neem leaves powder @ 5 g/100 g (85.04 %) mortality of adult. The next best treatment was black pepper @ 5 g/100 g (83.37 %) mortality of *T. castaneum* adult. Moreover, significantly lowest mortality 46.28 per cent was observed in onion powder @ 1 g/100 g of grain which was least effective among all the treatments. The pooled data of two years, (2011-12 and 2012-13) are presented in Table-1 and graphically depicted in Figure-1 revealed that, the interaction effect between Period and Treatment was non-significant indicating consistent performance of various treatments over the period at different period of storage intervals against mortality of *T. castaneum*. It was clearly marked from the data that, the neem seed powder @ 5 g/100 g (88.66 %) was significantly superior treatment over rest of the treatments, which was at par with the neem seed powder @ 3 g/100 g (86.21 % mortality) and neem leaves @ 5 g/100 g recorded 86.02 per cent mortality. The next best treatment was black pepper @ 5 g/100 g (83.29 % mortality).

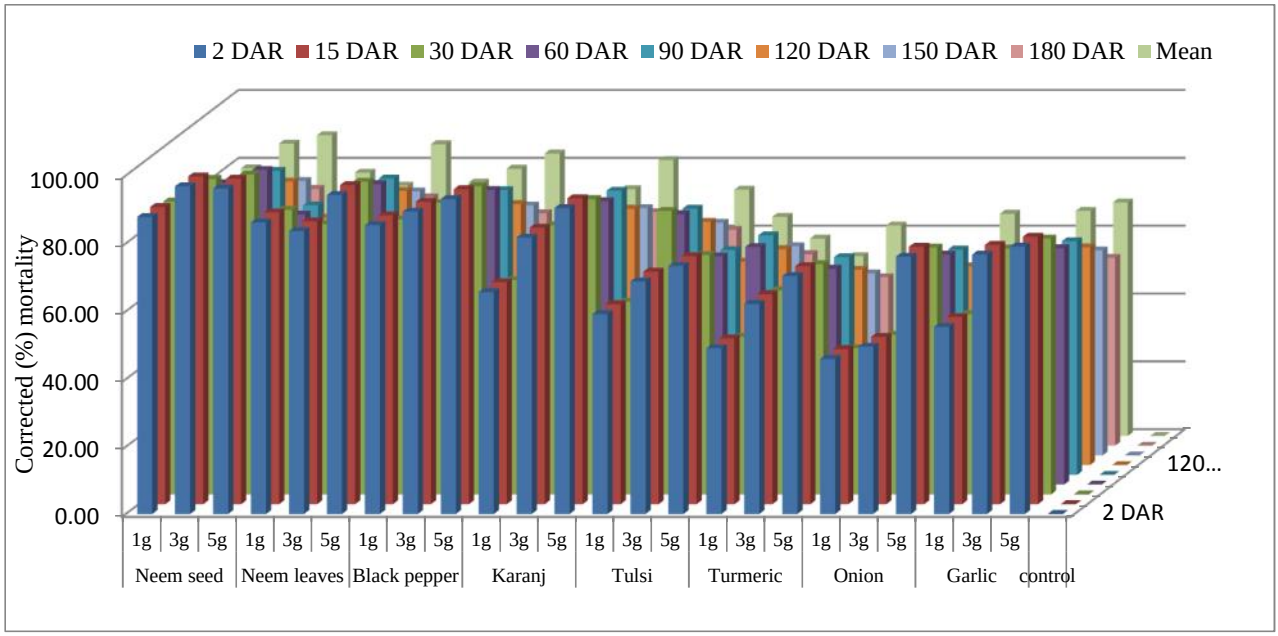

FIGURE 1: Efficacy of plant powders against, *T. castaneum* at different period of storage intervals on rice grain (Overall pooled)

However, the significantly lowest mortality was recorded in onion powder @ 1 g/100 g of grain (37.76 %). The descending chronological order of effectiveness of treatments based on per cent mortality of *T. castaneum* was, neem seed powder @ 5 g/100 g (88.66 %) > neem seed @ 3 g/100 g (86.21) > neem leaves powder @ 5 g/100 g (86.02 %) > black pepper @ 5 g/100 g (83.29 %) > karanj leaves powder @ 5 g/100 g (81.35 %) > neem seed powder @ 1 g/100 g (78.91 %) > black pepper powder @ 3 g/100 g (78.82 %) > neem leaves powder @ 1 g/100 g (77.64 %) > black pepper @ 1 g/100 g (74.76 %) > neem leaves powder @ 3 g/100 g (73.79 %) > karanj leaves powder @ 3 g/100 g (72.73 %) > tulsi powder @ 3 g/100 g (72.60 %) > garlic bulb powder @ 5 g/100 g (68.88 %) > garlic bulb powder @ 5 g/100 g (66.37 %) > onion powder @ 5 g/100 g (65.51 %) > tulsi powder @ 5 g/100 g (64.63 %) > turmeric powder @ 5 g/100 g (62.10 %) > turmeric powder @ 1 g/100 g (58.26 %) > karanj leaves powder @ 1 g/100 g (56.48 %) > turmeric powder @ 3 g/100 g (53.04 %) > tulsi powder @ 1 g/100 g (48.94 %) > garlic bulb powder @ 1 g/100 g (46.98 %) > onion powder @t 3 g/100 g (38.85 %) > onion powder @ 1 g/100 g (37.76 %). Earlier, Lohra *et al*. (2001) observed that, all plant extracts *viz.*, neem (*Azadirachta indica* A. Juss.), arandi (*Ricinus communis* L.), and karanj (*Derris indica* Lam.) (*Pongamia pinnata* L.*)*, pilu (*Salvadora oleoides* Decne.), marva (*Ocimum basilicum* L.), amaltas (*Cassia fistula* L.), bluegum (*Eucalyptus globules* Labill.), guava (*Psidium pyriferum* L.), dhatura (*Datura metel* L.), and bougainvillea (*Bougainvillea* sp.) applied to sorghum were evaluated as ovipositional deterrents against *T. castaneum* and found to be best detected by reducing the it reduced the oviposition of *T. castaneum* on sorghum seeds. Das *et al.* (2006) reported that, Nimbicidine with higher concentration 16.0 ml kg^{-1} significantly reduced the egg hatching of *T. castaneum* up to 18.60 per cent. The percentages of larval, pupal and adult survival reduced up to 20.00, 20.25 and 21.79 respectively as compared to

control against the eggs stage. Mamun *et al.* (2009) also found that, neem seed extract showed the highest toxic effect (52.50 % mortality), Whereas, Hijal leaf extract possessed the lowest toxic effect (22.24 % mortality). Among the solvents, acetone extract showed more toxic effect than other extracts. Seed extracts of respective plants were slightly more toxic than leaf extract. The effectiveness of most of the plant extracts increased proportionally with the increase in the doses and decreased with time. However, present results are completely tally with Gandhi *et al.,* (2010) reported the adult mortality against the *T. castaneum*, when the adults were introduced with different concentrations *i.e.* 0.05 to 1.0 g/10.0 g of leaf powders of Pomegranate *Punica granatum* (L.), and Curry trees, *Murraya koenigii* (L.), in wheat grains. The mortality rate increased from lower to higher concentrations under controlled laboratory conditions. The lowest concentration i. e. 0.05 g produced lowest mortality (40 %), while, it was highest (85 %) mortality at 1.0 g of *P. granatum* was recorded. In case of *M. koenigii* the percentage mortality ranged from 30 to 80 per cent. Hameed *et al.* (2012) showed that, neem leaves extract recorded the highest 45 per cent mortality at (2.5 % conc.) at 168 hrs exposure of time than kanair leaves extract by using filter paper dip method in stored wheat grain. Whereas, Iram *et al.* (2013) reported that, ethanol extract of *Citrus reticulata* (L.) peel @ 2 ml was found to be strongest repellent effect with 70.66 per cent repellency and ethanol extract of *C. reticulata* leaves @ 2 ml was the most effective reaching up to 97.66 per cent mortality at 21 day of exposure against *T. castaneum*. Perveen and Khan (2014) revealed that, n-butanol fraction (NBF) of hill toon, *Cedrela serrata* Royle was most toxic having 73, 79, 85, 93 and 99 per cent mortality, respectively at 20, 51, 102, 153 and 204 µl/cm^2 doses and also residual effect of ME, NBF and EAF at the highest dose showed cent per cent mortality. This result is in line with the present finding and thus, confirms the present findings.

CONCLUSION

The application of neem seed powder @ 5g would be effective treatment with respect to the mortality of *T. castaneum* in stored rice. The next best treatment was black pepper seed powder @ 5 g for protecting the rice grains. Rests of the treatments have also observed to provide optimal protection against *T. castaneum.*

ACKNOWLEDGEMENT

The authors are thankful to Director of Research and Dean P.G. Studies, Navsari Agricultural University, Navsari, Gujarat, India for providing the facilities during the present investigation. The help render by Principal and Dean, N.M. College of Agriculture, N.A.U., Navsari is also duly acknowledged.

REFERENCES

Abbott, W. S. (1925) A method of computing the effectiveness of insecticides, *J. Eco. Ent*, **18**: 265-267. [Fide: http:// www. bcin.ca/Interface/openbcin.cgi?submit=submit & Chinkey =99430].

Anonymous (2012) (Fide: http://agritech.tnau.ac. in/ crop protection/ crop_prot_crop_insect %20 storage importance. html).

Bartlett, M. S. (1947) The use of "transformation" *Biometrics.* **3**: Pp. 39–52., Pp. 39-52.

Das, D. R., Parween, S. and Faruki, S. I. (2006) Efficacy of commercial neem-based insecticide, Nimbicidine® against eggs of the red flour beetle *Tribolium castaneum* (Herbst). *Univ. J. zool. Rajshahi Univ*., **25**: Pp. 51-55.

Gandhi, N., Pillai, S. and Patel, P. (2010) Efficacy of pulverized *Punica granatum* (Lythraceae) and *Murraya koenigii* (Rutaceae) leaves against stored grain pest *Tribolium castaneum* (Coleoptera: Tenebrionidae). *Int. J. Agric. Biol.*, **12** (4): 616–620.

Hameed, A., Freed, S., Hussain, A., Iqbal, M., Hussain, M., Naeem, M., Sajjad, A., Hussain, H., Sadiq, M. and Tipu, L. A. (2012)Toxicological effects of neem (*Azadirachta indica*), Kanair (*Nerium oleander*) and spinosad (Tracer 240SC) on the red flour beetle (*Tribolium castaneum*) (Herbst.). *Afr. J. Agric. Res.* 7(4): 555-560.

Iram, N., Arshad, M. and Akhter, N. (2013) Evaluation of Botanical and Synthetic Insecticide for the Control of *Tribolium castaneum* (Herbst.) (Coleoptera: Tenebrionidae). *BioAssay* 8:3 (Fide: http://www. bioassay. org.br/ ojs/index. php/bioassay/article/view/117).

Karunakaran, C., Jayas, D.S. and White, N.D.G. (2004) Identification of wheat kernels damaged by the red flour beetle using X-ray images. *Biosystems Engineering., 87*(3): 267-274. (Fide: http://www.padil.gov.au/pbt)

Lohra, Y., Singhvi, P. M. and Pamwar, M. (2001) Effect of certain plant extracts on oviposition of rust-red flour beetle, *Tribolium castaneum* Herbst: infesting stored Jowar. *J. Appl. Zool. Res.* **12**(1): 67-70.

Mamun, M.S.A., Shahjahan, M. and Ahmad, M. (2009) Laboratory evaluation of some indigenous plant extracts as toxicants against red flour beetle, *Tribolium castaneum* Herbst *J. Bangladesh Agril. Univ.* **7**(1): 1-5.

Perveen, F. and Khan, A. (2014) Toxicity and effects of the hill toon, *Cedrela serrata* methanolic leaves extract and its fractions against 5th instar of the red flour beetle, *Tribolium castaneum. Int. J. Agric. Res. Rev.* **2**(1) pp: 18-26.

Prakash, A., Rao, J., Mathur, K. C. and Pasalu, I. C. (1987) *Rice storage and insect pest management*, B. R. Publishing Corporation, New Delhi. Pp. 377.

Smith, E. H. and Whitman, R. C. (1992) *Field Guide to Structural Pests*. National Pest Management Association, Dunn Loring, V A. (Fide: http://edis.ifas.ufl.edu/in566).

Ukeh, D. A. and Udo, I. A. (2008) Analysis of insect populations in stored crops in Cross River State Nigeria. Global Journal of Pure and Applied Sciences, **14**(1): 31-36 (Fide:http://www.home.att. net~africantech/ GJPAS/ GJPAS. htm).