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TESTING THE EFFECT OF HERBAL POWDERS ON GRAIN PARAMETERS IN STORED WHEAT IN THE PRESENCE OF *SITOPHILUS ORYZAE* UNDER FREE CHOICE

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ABSTRACT

Efficacy of plant powders was tested against *Sitophilus oryzae* on the basis of grain damage and weight loss of wheat, in the laboratory of Department of Agricultural Entomology, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal. The ancient practice of using plant-based compounds as seed protectants has recently attracted a lot of interest. Under free choice conditions, six sets were considered where each set containing the 6 different botanicals of 5% concentration. Each powder was mixed with 25g of wheat grains. Data was recorded after 30 days of release of weevils and results revealed that, in SET-1, Annona leaf powder was found effective against *S. oryzae* with lower mean percentage of grain damage (0.72%) while mean percentage of weight loss was lower in tobacco leaf powder (0.31%). In SET-2, the effectiveness of Mentha leaf powder proved higher than other botanicals as mean percentage of grain damage and weight loss (0.97% and 0.39%) was lower as compared to other treatments. In a similar way, based on the grain damage and weight loss parameters, the effectiveness of curry leaves (0.96%and 0.38%) in SET-3, turmeric and guava leaves(0.71% and 0.33%) in SET-4, guava leaves (0.54% and 0.30%) in SET-5 and mentha leaves (0.42% and 0.28%) in SET-6 as grain protectants was higher than the other botanicals. As a result, these botanicals may be one of the most effective alternatives to chemical insecticides for the management of weevils.

Keywords: Wheat, Grain damage, Weight loss, free choice, *Sitophilus*

Introduction

Wheat is most significant staple food for humans, which is cultivated on more land than any other commercial crop. It accounts for 20% of all food calories consumed worldwide and is a very valuable source of carbohydrates (Breiman and Graur 1995; Anonymous 2018). The world's second-largest producer of wheat is India. In 2016–17, it harvested a record of 97.44 mt of wheat grain on an area of 30.72 mha (Anonymous, 2017). In the food production chain, storage is crucial, and studies have shown that higher losses are found in this process (Majumder *et al.*, 2016). Insects, rodents, microorganisms, improper storage, etc. cause about 10% of post-harvest losses in all food grains. Approximately 14 mt of food grains worth Rs. 7000 crores are lost in storage each year in India. An estimated Rs. 1300 crores of these losses are attributable to insects alone (Anonymous, 2015). Insect infestations in stored grains have a negative impact on processing quality and nutritional content. According to Talukder (2006), Rajendran and Sriranjini (2008), insect pests can damage storage grains and their products by 20–30% in tropical areas and 5–10% in temperate areas. Coleopterans make up 70% of the insects that infest grains that have been stored, and the genera *Sitophilus* and *Tribolium* are the most destructive species of storage insects (Khan and Selman 1988). The rice weevil, *Sitophilus oryzae* (L.), is one of the most destructive pests of cereal grains and their products. (Yan *et al*., 2014; Rita Devi *et al*., 2017). It is a major pest that feeds on whole grain kernels. Significant loss in grain weight, secondary pest infestation, and contamination due to growth of fungus are all results of adult feeding and larval activity inside kernels (Athanassiou *et al*., 2017). Grain production in many developing nations mainly depends on Small-scale farmers and postharvest processing mills (Bendinelli *et al*., 2020). When grains are stored, synthetic insecticides are used to control rice weevil pest. Chemical insecticides and fumigants were frequently used to treat insect storage pests, but this practice led to serious issues like the emergence of insect species that are resistant to insecticides (Zettler and Cuperus, 1990; Ribeiro *et al*., 2003; Lorini *et al*., 2007; Mehta and Kumar, 2020) and also recent laboratory studies indicated that many cultivars have developed some resistance to *S. oryzae* (Swamynarayana *et al*., 2014).Although inexpensive and feasible, fumigation has many drawbacks when compared to other methods of pest control. Insect populations are becoming more and more resistant to phosphine-based insecticides (Mau *et al*., 2012; Venkidusamy *et al*., 2017). Rice weevil has developed resistance to artificial pesticides (Benhalima *et al*., 2004). Thus, it is essential to develop environmental friendly methods that can replace chemical insecticides. Aromatic plant derivatives have the potential to be used as biopesticides. The effectiveness of specific plants against a wide range of insects that harm stored grain has been proven in numerous studies (Kellouche 2005). However, new insecticides will need to follow all requirements. They need to be pest-specific, safe for mammals, biodegradable, less likely to develop pest resistance, and reasonably priced (Isman, 2006). Recent reports on the use of certain native plant products as grain protectants against the *S. oryzae* and other stored grains insect-pests are promising (Bhanderi *et al*., 2015; Bala, 2015). In order to identify and possibly recommend the most effective plant extracts against *S. oryzae* in the stored wheat grains, the current study was started.

Materials and Methods

The experiment was carried out in the laboratory of Department of Agricultural Entomology, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, Birbhum, West Bengal, India from September-December, 2021.

Collection of grains

The healthy wheat grains were procured from the market. The seeds were examined further, and any foreign particles were eliminated from the batch. They were disinfected in hot air oven at 60°C for 4 hr and stored in plastic jars under laboratory conditions.

Maintenance of stock culture

Wheat grains that were infected were gathered from nearby sources. The test insect *S. oryzae* emerged from the grains after being kept in the lab. The insects were transferred to the appropriate grains after emergence. The test insect stock culture was maintained subsequently.

Grain protectants

Leaves of neem (T1), custard apple (T2), dried chillies (T3), tobacco (T4), basil (T5), eucalyptus (T6), mentha (T7), bay leaf (T8), curry leaf (T9), citrus (T10), guava (T11) and turmeric (T12) were sun dried and stored.

Procedure

At 27 ± 2°C and 75 ± 5% RH, 25 g of wheat grains were stored in a circular box with seven separate compartments leaving center compartment empty. The six compartments containing wheat grains were treated with different botanicals @5% concentration i.e. 1.25g botanical powder mixed with 25g seeds. Each box is considered as a set with three replications. In each replication of a set, 12 pairs of adult weevils were released in empty compartment and were allowed to walk freely around in any of the compartments. The experiment was conducted in a completely randomized block design with each set replicated three times. Data related to grain damage and weight loss was recorded after 30 days of initial release of weevils, where grains (damaged and undamaged) from every replication of each set were counted and, weighed using electronic weighing machine. The given formulas (Adams and Schulten 1978) were used to quantify grain damage (%) and weight loss (%).

$$\%\ \text{Weight Loss} = \frac{(\text{UND}) - (\text{DNU})}{\text{U}(\text{ND} + \text{NU})} \times 100 \qquad ...(1)$$

Where,

U -Weight of un-infested grains (g)

NU -Number of un-infested grains (n)

D -Weight of infested grains (g)
ND -Number of infested grains (n)

$$\% \text{ Grain damage} = \frac{\text{Number of damaged grains}}{\text{Total No. of grains used}} \times 100$$

Statistical analysis

The data from the various treatments was statistically analyzed using Completely Randomized Design (CRD) using OPSTAT. The significance of treatment was tested using a critical difference (C.D.) at a 5% level of significance for the comparison of treatments, with the marginal means of each treatment taken into account.

Results and Discussion

Tables 1-6 depicted the extent of mean percentage of grain damage and mean percentage of weight loss of stored wheat grains caused by *S. oryzae* after 30 days of release. The stored wheat grain was treated with 5% conc. of different plant powders (w/w) in each set.

In SET-1 (Table 1), the lowest mean percentage of grain damage was recorded in *Annona* leaf powder (0.72%), but the least mean percentage of weight loss was in tobacco leaf powder (0.31%), whereas higher mean percentage of grain damage and weight loss were recorded in eucalyptus leaf powder (1.07% and 0.60%, respectively). According to Haryadi and Yuniarti (2003), leaf powder of *A. squamosa* at 4.5% concentration significantly reduced the progeny of *S. zeamais*.

In SET-2 (Table 2), the lowest mean percentage of grain damage and weight loss were recorded in mentha leaf powder (0.97% & 0.39%, respectively), whereas higher mean percentage of grain damage and weight loss were recorded in both guava leaf powder (1.45% and 0.63%) and turmeric leaf powder (1.45% and 0.63%). *Mentha spicata* leaf powder at 2% concentration in wheat caused 100% mortality of *S. oryzae* after 94 hours and provided protection for 4 weeks (Chakrabarty and Ghose 1988).

In SET-3 (Table 3), the lowest mean percentage of grain damage and weight loss were recorded in curry leaf powder (0.96% and 0.38%, respectively), whereas higher mean percentage of grain damage and weight loss were recorded in bay leaf powder (1.26% and 0.60%). Pathak *et al.* (1997) observed the toxic effects and ovicidal properties of Curry leaf oil @ 340 ppm against *C. chinensis* and suggested that the plant product can be used for small-level protection of legumes against the bruchid.

In SET-4 (Table 4), the lowest mean percentage of grain damage was recorded in turmeric leaf powder (0.71%), but the least mean percentage weight loss was recorded in guava leaf powder (0.33%), whereas higher mean percentage grain damage was recorded in citrus leaf powder (1.04%), but higher mean percentage of weight loss was recorded in eucalypts leaf powder (0.54%). Similar findings were also recorded by Panikar and Vijayalakshmi (1998) who reported grain protectant effectivity of turmeric leaf powder against *S. oryzae*.

In SET-5 (Table 5), the lowest mean percentage of grain damage and weight loss were recorded in guava leaf powder (0.54% and 0.30%, respectively), whereas higher mean percentage grain damage and weight loss were recorded in turmeric leaf powder (1.32% and 0.65%). Sharaby (1988) reported that adult weevils of *S. oryzae* were highly susceptible to contact action with dried leaf powder of *P. guajava* with an LD_{50} value of 2.2g/100 rice grains.

In SET-6 (Table 6), the lowest mean percentage of grain damage and weight loss were recorded in mentha leaf powder (0.42% and 0.28%, respectively), whereas, higher mean percentage of grain damage was recorded in both eucalyptus (0.79%) and basil (0.79%). The highest mean percentage of weight loss was recorded in eucalyptus leaf powder (0.44%). *Mentha spicata* leaf powder at 2% concentration when mixed with wheat caused 100% mortality of *S. oryzae* after 94 hours and provided protection for 4 weeks (Chakrabarty and Ghose 1988).

On the basis of mean percentage of grain damage and weight loss parameters of wheat grains, the leaf powders of Annona, tobacco, mentha, curry leaf, turmeric, and guava was found to be better grain protectants. These plant powders can be used as grain protectants for the environmental friendly management of the rice weevil in wheat, demonstrated the better results against *S. oryzae* among the twelve plant powders tested.

Table 1: Mean grain damage % and weight loss % of wheat grains caused by *S. oryzae* in choice test (SET-1)

Treatments	Mean grain damage (%)	Mean weight loss (%)
T1: Neem leaves	0.77 (0.85)	0.44 (0.64)
T2: Custard apple leaves	0.72 (0.84)	0.35 (0.59)
T3: Red chilli	0.83 (0.89)	0.38 (0.61)
T4: Tobacco leaves	0.78 (0.87)	0.31 (0.55)
T5: Basil leaves	0.89 (0.94)	0.46 (0.67)
T6: Eucalyptus leaves	1.07 (1.02)	0.60 (0.76)
SEm (±)	0.097	0.068
C.D. (*P*= 0.05)	NS	NS
C.V. (%)	18.62	18.59

Figures in the parentheses are square root transformed values

Table 2: Mean grain damage % and weight loss % of wheat grains caused by *S. oryzae* in choice test (SET-2)

Treatments	Mean grain damage (%)	Mean weight loss (%)
T7: Mentha leaves	0.97 (0.96)	0.39 (0.61)
T8: Bay leaves	1.14 (1.06)	0.46 (0.67)
T9: Curry leaves	1.15 (1.06)	0.51 (0.71)
T10: Citrus leaves	1.28 (1.07)	0.60 (0.73)
T11: Guava leaves	1.45 (1.19)	0.63 (0.78)
T12: Turmeric leaves	1.45 (1.20)	0.63 (0.79)
SEm (±)	0.121	0.08
C.D. (*P*= 0.05)	NS	NS
C.V. (%)	19.22	19.36

Figures in the parentheses are square root transformed values

Table 3 : Mean grain damage % and weight loss % of wheat grains caused by *S. oryzae* in choice test (SET-3)

Treatments	Mean grain damage (%)	Mean weight loss (%)
T1: Neem leaves	1.23 (1.09)	0.51 (0.68)
T2: Custard apple leaves	1.04 (1.02)	0.40 (0.62)
T3: Red chilli	1.09 (1.04)	0.58 (0.75)
T7: Mentha leaves	1.02 (0.96)	0.50 (0.67)
T8: Bay leaves	1.26 (1.08)	0.60 (0.75)
T9: Curry leaves	0.96 (0.97)	0.38 (0.60)
SEm (±)	0.132	0.105
C.D. (*P*= 0.05)	NS	NS
C.V. (%)	22.22	26.79

Figures in the parentheses are square root transformed values

Table 4 : Mean grain damage % and weight loss % of wheat grains caused by *S. oryzae* in choice test (SET-4)

Treatments	Mean grain damage (%)	Mean weight loss (%)
T4: Tobacco leaves	0.92 (0.95)	0.40 (0.63)
T5: Basil leaves	0.85 (0.92)	0.34 (0.58)
T6: Eucalyptus leaves	1.27 (1.11)	0.54 (0.69)
T10: Citrus leaves	1.04 (0.97)	0. (0.67)
T11: Guava leaves	0.97(0.97)	0.33 (0.57)
T12: Turmeric leaves	0.71 (0.83)	0.37 (0.58)
SEm (±)	0.115	0.098
C.D. (*P*= 0.05)	NS	NS
C.V. (%)	20.77	27.34

Figures in the parentheses are square root transformed values

Table 5 : Mean grain damage % and weight loss % of wheat grains caused by *S. oryzae* in choice test (SET-5)

Treatments	Mean grain damage (%)	Mean weight loss (%)
T1: Neem leaves	0.74 (0.83)	0.46 (0.66)
T2: Custard apple leaves	0.80 (0.87)	0.55 (0.72)
T3: Red chilli	0.73 (0.84)	0.38 (0.61)
T10: Citrus leaves	0.96 (0.97)	0.62 (0.78)
T11: Guava leaves	0.54 (0.72)	0.30 (0.54)
T12: Turmeric leaves	1.32 (1.14)	0.65 (0.79)
SEm (±)	0.093	0.071
C.D. (*P*= 0.05)	NS	NS
C.V. (%)	17.90	18.01

Figures in the parentheses are square root transformed values

Table 6 : Mean grain damage % and weight loss % of wheat grains caused by *S. oryzae* in choice test (SET-6)

Treatments	Mean grain damage (%)	Mean weight loss (%)
T4: Tobacco leaves	0.60 (0.77)	0.32 (0.56)
T5: Basil leaves	0.79 (0.87)	0.36 (0.59)
T6: Eucalyptus leaves	0.79 (0.86)	0.44 (0.65)
T7: Mentha leaves	0.42 (0.64)	0.28 (0.52)
T8: Bay leaves	0.59 (0.76)	0.31 (0.55)
T9: Curry leaves	0.55 (0.73)	0.30 (0.54)
SEm (±)	0.081	0.051
C.D. (*P*= 0.05)	NS	NS
C.V. (%)	18.24	15.52

Figures in the parentheses are square root transformed values

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