The Nucleus **49**, No. 1 (2012) 65-69

The Nucleus
A Quarterly Scientific Journal of Pakistan
Atomic Energy Commission
NCLEAM, ISSN 0029-5698

APPRAISAL OF DIFFERENT PLANT PRODUCTS AGAINST *TROGODERMA GRANARIUM* EVERTS TO PROTECT STORED WHEAT- A LABORATORY COMPARISON

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(Received March 09, 2011 and accepted in revised form January 27, 2012)

Laboratory study was initiated to analyze various locally available botanical materials such as *Chenopodium album* L. (White goosefoot), *Cichorum intybus* L. (Chicory) and *Meliolotus parviflora* L. (Honey clover) applied at the rate of 2 percent into wheat grain for the control of *Trogoderma granarium* Everts (Coleoptera: Dermestidae). After data computation on the basis of fixed parameters, it was observed that all natural protectants used had shown potentiality in controlling *T. granarium* as these proved very effective compared to no pesticide application treatment. It is worthwhile to mention that among various products tested, *C. intybus* powder showed the best results to control pest, approached by *C. album* and *M. parviflora* treatments as compared to untreated kernels. The results of this findings show that natural protectants used in the study could be useful and desirable tools in stored wheat pest management plan.

Keywords: Bioinsecticide, Antifeeding, *Trogoderma granarium,* Plant Protectants, Wheat.

1. Introduction

The grains are mostly stored in improvised structures such as raised platforms, ventilated racks, open baskets and sacks [1]. During storage, the wheat grains are damaged by storage pests, the most common being khapra beetle, *Trogoderma granarium* Everts (Coleoptera: Dermestidae) [2]. It is one of the most important pests of stored grains and cereal products in many warm and arid climates [3]. It has been recognized as one of the 100 worst invasive species worldwide [4]. The beetle caused severe damage to the wheat grain and deteriorates its quality [5]. In addition, this pest appeared relatively tolerant to insecticides and many fumigants especially at larval stage [6]. It can cause huge losses in stored grains through voracious feeding, heating of grains, the larvae's ability to withstand starvation for upto 3 years and to live on food with very low moisture content [7]. On the basis of criteria taken for measuring relative tolerance of wheat grains against this insect, the maximum and minimum intensities of percent infestation and weight losses parameters varied from 8.0-26.0%, and 3.0-7.33%, respectively, in Pakistan [8]. Due to its refuge seeking behavior, the existence of a special type of recurrent dormancy in the larval stage and to survive long periods of deprivation, it is extremely difficult to eradicate this insect from premises or transport facilities [9].

Synthetic pesticides have been used for many years to control storage pests. Although much success has been realized, yet chemical pesticides have several limitations like occurrence of environmental and health hazards [10]. About, 866 different plant species had been described capable to produce chemicals useful against insects, from which 256 biologically active chemical components have been identified [11]. Now, the use of safe and low environmentally toxic botanical pesticides is emerging as one of the prime means to protect stored grains. Owing to their natural origin, biodegradable and biological products, they do not leave toxic residues or by-products to contaminate the environment [12]. For this reason, it is necessary to scrutinize the effectiveness of locally accessible plant protectants against *T. granarium,* which are safe to man and undisruptive to surroundings. These local plant protectants are not only cheaper, but they are freely accessible and for that reason the majority of the farmers in countryside areas may be able to employ them in

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controlling the storage pests. The objective of this research was thus to find out the efficiency of available plant products to control *T. granarium* in stored wheat grains.

2. Materials and Methods

2. 1. Experimental Resources

The parent adults of *T. granarium* were cultured, fed with wheat flour and incubated in darkness at 30°C and a relative humidity of 70%, in the Laboratory of Entomology, Nuclear Institute of Agriculture, Tandojam. The larvae of *T. granarium* (3 mm length) were collected from same age rearing of the base culture maintained in the laboratory and used for present study. Three plant species used as pest protectants in the experiment were *Chenopodium album* L. (White goosefoot), *Cichorum intybus* L. (Chicory) and *Meliolotus parviflora* L. (Honey clover). The aerial parts of these plants were collected from the vicinity of the same Institute primarily when at flowering stage. Collected plant leaves were dried up under shade for 15 days and crushed into fine powder. The pulverized plant leaves were passed through 0.2 mm sieve mesh to separate fibrous matter from fine powder to use fine particles in the experiment. Fully matured, well-sieved, clean, healthy and untreated wheat grains of variety "Zardana" obtained from local genetic sources, were used in this experiment as test material. The seeds were then conditioned to room temperature before being used for experimental purpose. The seeds were air dried for 3 weeks to keep at 13-15% moisture content, enclosed in polythene bags, sealed and then placed in an air-tight container. Later on these seeds were disinfested by keeping them in a deep freezer at a temperature of -4°C for 7 days.

2. 2. Experimental Outline

Powdered aerial parts of each three plant treatments were applied at the rate of 2 percent into 20 gm of wheat grain in glass containers (10 cm in diameter) for their anti-feeding, toxic and insect growth inhibition effects to *T. granarium*. The contents of container were then mixed thoroughly for about 3 minutes to create a homogenous condition. To each container 5 freshly emerged larvae of *T. granarium* (nearly 2 days old) were transferred, subsequently roofed with muslin cloth for aeration and tightened with elastic rubber band to check entry or exit of any other arthropods. Experimental treatments were laid down in a Completely Randomized Design and each plant material (treatment) replicated three times with no choice test for pest. Each natural protectant was investigated against storage pest in a separate set of experiment but the experimental outline was the same for all treatments. A control treatment comprising test pest without natural protectants was also prepared in the same way for comparison in the experimental set up.

2. 3. Determination of Pest Damage Parameters

The trail was left without interruption to allow pest infestation, while damage assessment and weight loss estimation were made at monthly intervals for 60 days (2 months). The grains were sieved through a 3 mm sieve mesh, and the total populations of *T. granarium* in the seeds were recorded after counting the total number of larvae and adults emerged. Damage assessment involved sieving the grain samples using a sieve with 0.01 mm mesh diameter to remove dust and frass. The grain samples were then reweighed using digital Balance. Determination of comparative weights was calculated in terms of the whole sample to give percentage seed damage. The percentage seed weight loss was calculated as:

$$\frac{\text{Weight of control seeds - Weight of infested seeds}}{\text{Weight of control seeds}} \times 100$$

2. 4. Data Analysis

The data collected were subjected to Analysis of Variance (ANOVA) for calculating differences among all variables. The different means of the three replicates of all treatments were separated by LSD test using Statistix 8.1 software to determine level of significance at $P \leq 0.05$.

3. Results and Discussion

This study determined the efficacy of naturally available plant products to control *T. granarium* in stored wheat. Results showed a notable reduction in the number of live insect pest emerged and grain damage during storage in all protectants as opposed to control without pesticide application. It was worthwhile to mention that the extent of beetle damage differed significantly in different treatments. The *C. intybus* and *C. album* powders were the most effective in pest killing followed by *M. parviflora*. In all treatments total number of grains (in 20 gm) ranged from 472.33- 524.67 (Table 1).

Table 1. Laboratory comparisons of different plant products against *T. granarium* in wheat grain.

S. No.	Treatments	Total no. of grains (20 gm)	Percent infestation	Percent weight losses	Frass weight (grams)	Total no. of *Trogoderma* emerged	Percent germination
1	*Cichorum intybus* (Chicory)	472.33 b	3.23 d	2.16 d	0.40 d	12.33 d	97.00 a
2	*Chenopodium album* (White goosefoot)	481.67 ab	6.55 c	4.50 c	0.60 c	15.00 c	96.00 a
3	*Meliolotus parviflora* (Honey clover)	524.67 a	9.78 b	8.00 b	0.80 b	19.00 b	96.00 a
4	Control	488.67 ab	14.31 a	11.83 a	1.00 a	44.33 a	97.00 a
S. E.		20.806	0.435	0.333	0.022	0.666	0.816
LSD value		47.979	1.005	0.768	0.052	1.537	1.882

Values in the column with different letter (s) differ significantly at P≤ 0.05; while values in the column followed by common letter (s) did not differ significantly.

3.1. Percent Infestation

There were significant differences (P≤ 0.05) among treatments in the mean percent infestation of wheat seeds by *T. granarium*. Minimum mean percentage infestations were recorded in *C. intybus* (3.23) followed by *C. album* (6.55) and *parviflora* (9.78) treated seeds as compared to untreated (14.31).

3.2. Wheat Grain Weight Loss

Wheat grains treated with *C. intybus* (2.16) indicated lower percent weight loss, while, grains treated with *M. parviflora* (8.00) had also the lower weight loss in comparison to control (11.83). It could be accomplished that *C. intybus* and *C. album* (4.50) dusts were more effective in controlling *T. granarium* infestation and reducing mean weight loss of wheat seeds among different treatments.

3.3. Frass Weight

The least frass weight was noted in *C. intybus* (0.40 g) followed by *C. album* (0.60 g) and *M. parviflora* (0.80 g) treatments, while, significantly maximum recorded in control treatment (1.00 g).

3.4. Pest Emergence

Significantly higher population emergence (44.33) of *T. granarium* adult or larvae was observed from wheat with no pesticide application treatment. The three plant powder treatments however, prevented better larval emergence. Pest emergence was significantly reduced with plant products, thus, seeds treated with *C. intybus* and *C. album* dusts had the low number of live insects (12.33 & 15.00, respectively) followed by the treatment with *M. parviflora* (19.00) compared to the control.

3.5. Percent Germination

The differences among treatments of wheat seeds for the mean percentage germination were not significant (P≤ 0.05). The percentage germination of selected wheat variety ranged from 96- 97% in treated seeds and control treatment (Table 1).

In the present study, the efficacies of botanical powders in protecting stored wheat grains against storage pest *T. granarium* were validated. In general, all natural protectants tested have shown potentiality for the control of *T. granarium* as they were very effective against pest compared to no pesticide application treatment. Thus, plant products evaluated (*C. intybus, C. album* and *M. parviflora* dusts) could therefore serve as an economical substitute to expensive and imported synthetic insecticides employed to protect stored products. On the basis of criteria taken for measuring relative performance of test plants against this insect, a practical relation between emergence of progeny beetles (12.33- 19.0 adults),

with percent infestation (3.23- 9.78%) and percent weight loss (2.16- 8.0%) appeared which revealed that higher pest emergence caused more grain damage than lower beetle population. This finding is interrelated to previous studies that population growth of pest was related to percent weight loss, grain damage and viability of grain [7, 13]. In the present research, the results confirmed that *T. granarium* was more susceptible to all plant species used. This might be attributed due to the fact that *T. granarium* has the habit to survive within wheat grain or on the surface of the grain, and due to treated grains, it became more susceptible to powdered natural protectants. Further, the natural protectants might be additionally effectual to control pest owing to the reality that these penetrated and destroyed eggs, reduced oviposition and killed adult insect pest through suffocation. Similar observation was reported by earlier researchers that plant powders had pronounced protection effects against seed storage pests. Plant dusts had contact mode of action and affect on the insect's nervous system. The active ingredients work by creating multiple potentials across the membranes and disrupt signal transmission in the insect pest [14]. The tested different plant species contained different chemical compounds which were found very suitable for controlling wheat storage pest. Further, the fine powders block the spiracles and therefore, the insects are unable to respire. This physical action is common for most inert materials [15]. Such products are particularly recommended for the control of development stages of Coleopteran pests living on grains [16].

The responses of *T. granarium* varied with plant material, *C. intybus* presented high toxicity, antifeeding effects, insect population inhibition and affected significantly the larval growth of *T. granarium,* when applied. This plant species apparently appeared as more promising source of active substances when applied to grain depending on the source of active ingredients. The antifeeding activity of test plants against *T. granarium* could be related to many bio-chemicals known for their effectiveness on this serious pest feeding. For example, secondary compounds from plants include alkaloids, terpenoids, phenolics, flavonoids, chromenes and other minor chemicals which can affect insects in several ways. They may disrupt major metabolic pathways and cause rapid death, act as attractants, deterrents, phago-stimulants, antifeedings or modify oviposition. They can also delay or accelerate development or interfere with the life cycle of the insect in other ways [17, 18]. Moreover, products from several floral species were shown to act as repellents, toxicants and antifeedings against a number of Coleopterans that attack stored products [19, 20]. Additionally, further chemical researches should be performed to isolate and identify active ingredients of tested plants to develop environment friendly alternatives with the potentials to replace the highly toxic chemicals. Further studies on the mode of action of botanical tested are needed in order to arrive at definite conclusion with regard to promote the development of more potent fractions for use as grain protectant in integrated pest management protocol.

4. Conclusion

The results of this study revealed that application of plant products to stored wheat where *T. granarium* is a problem may possibly be successful for proper preservation of the wheat seeds. The order of effectiveness of the three plant products evaluated (*C. intybus, C. album* and *M. parviflora* dusts) could therefore serve as a substitute to expensive and imported synthetic insecticides employed to protect stored products. Nonetheless, further explorations on the active ingredients, their concentrations and improved methods of their application, would be requisite prior to any recommendations is suggested.

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