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Effects of Storage Methods on Lesser Grain Borer (*Rhyzopertha dominica*) during Rice (*Oryza sativa*) Storage in Yola, Adamawa State-Nigeria

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Abstract— *This study aimed to assess the effectiveness of some storage methods in controlling the effect of Lesser Grain Borer (LGB) on rice quality during storage. The experiment consisted of four treatment storage methods and laid in a Completely Randomized Design (CRD). Ten unsexed adults LGB were then introduced into a jar containing 200 g of rice grains and kept for 7 days under ambient conditions. Data were collected on the percentage mortality, weight loss, and 100 seeds weight loss and were analyzed using Analysis of Variance (ANOVA) and SAS (Statistical software version 9.0) and means were separated using Least Significant Difference (LSD) at a five percent level of significance ($P \leq 0.05$). Percentage weight loss was impacted by the storage method in a highly significant ($P \leq 0.01$) and floor storage gave the highest percentage weight loss of 9.12% whereas metallic and plastic containers had the lowest percentage weight loss (5.57% and 4% respectively). Similarly, it affected adult mortality of the lesser grain borer in a highly significant ($P \leq 0.01$) with highest number of dead insects at 21 days (5.33 from jute bag and 4.67 from metallic jar). However, at 21 days, mortality was also highly significant ($P \leq 0.01$) and polythene bag gave the highest value of 2.67 while lowest value was recorded of 0.00 floor storage. Plastic containers is the best for reducing percentage weight loss during storage of rice while polyethylene, plastic and metallic containers are the best for controlling Lesser Grain Borer during rice storage..*

Keywords— ***Lesser Grain Borer, Rhyzopertha dominica, Oryza sativa.***

I. INTRODUCTION

Rice (*Oryza sativa*) is an essential component of the diet of many people (Divyasree and Yadav, 2023) and it was estimated that half of the world's population subsists partly or wholly on rice (Karunakaran et al., 2004; Chougourou et al., 2013; Nehemiah et al., 2020; Pungavil et al., 2023). The byproducts are also used as animal feed, oil extraction, and manufacture of glass, solar panels, construction materials, biofuel, paper products, and flour (Nehemiah et al., 2020; Wastex, 2022). Broken rice grains are used for the distillation of alcohol and in the production of laundry starch. Traditionally, rice grains are stored in granaries, either in the threshed or uncherished forms. These traditional methods exposed stored grains to pest infestation.

Pest infestation in the field and during storage has greatly reduced the production of rice. In Nigeria, pest infestation plays a key role in keeping cereal production below the quality and quantities demanded by an increasing population and rapidly expanding livestock industry (Jia et al., 2008). The Lesser Grain Borer (LGB) (*Rhyzopertha dominica*) is a major cosmopolitan pest affecting stored rice the world over (Chougourou et al., 2013). A survey on the incidence of major pests of rice in different agro-ecological zones of Nigeria showed in general, that the amount of damage caused by LGB was high (Soto et al., 1976; Chougourou et al., 2013; Suleiman et al., 2020). It also shows that both the larvae and adult stages of this insect devour the kernel, causing weight loss (Johnson, undated; Ahmad et al., 2021).

Different methods such as safe handling practices to avoid mechanical damage, cold and modified storage atmosphere, application of chemical pesticides, biocontrol agents botanicals and UV-C treatment have been used to control postharvest losses of produces as reported by Al-Hdhrami et al. (2023) but due to lack of knowledge or cost had made them unavailable. Planting of resistant varieties has been reported to be effective in the control of insect pest as reported by Kumar and Kalita (2017); and Chougourou et al. (2013) that resistant rice varieties IIA306 and American Lamonant inhibited LGB infestation. The most important and commonly used control measure is chemical control (Ahmad et al., 2021). This involves the use of synthetic chemicals such as primoplosmethy (Acetelic), permitri (Copera), etc. which are effective in controlling lesser grain borer (Agunbiade et al., 2009; Ahmad et al., 2021).

Although the use of synthetic chemical insecticides is a powerful tool against insect pests, the indiscriminate use of different conventional insecticides by farmers and marketers has led to the development of resistance and a resurgence in some insect pests (Ahmed et al., 2024). For example, it was documented that LGB showed resistance to deltametrin (Ceruti and Lazzari, 2003; Ahmad et al., 2021). Insecticide resistance and the consequent losses of food arising from the failure of chemicals to control pests have caused economic losses of several billion dollars worldwide each year (Elzen and Hardee, 2003; Nehemiah et al., 2020) in addition to its harmful effects on both the environment and human beings.

The control of pests using synthetic insecticides has its attendant problems which include high cost of procurement, unavailability at critical periods, and may pose health hazards to men and livestock (Pungavil et al., 2023). The use of these synthetic chemicals in the control of stored products is of global concern concerning environmental hazards, chemical residues in foods, side effects on non-target organisms, resistance development, etc (Pungavil et al., 2023).

The present policy of the Federal Government of Nigeria encourages the attainment of self-sufficiency may not be achieved due to postharvest loss which constitutes one of the main obstacles to ensuring food security (Al-Dairi et al., 2021). Sustainable rice production can only be realized if affordable and effective means of storage are achieved (Otitodun et al., 2017; Pungavil et al., 2023). One of the most important problems facing rice farmers in the country is that of lesser grain borer due to a lack of enough research to find a safer and cheaper method. This is poised to address this problem, by seeking a cheap, safe, and effective method for reducing postharvest losses caused by LGB. This study, therefore, was carried out purposely to determine the effectiveness of the various storage methods in reducing the effect of LGB on rice quality.

II. MATERIALS AND METHODS

The experiment was conducted at the Postharvest Technology Laboratory of the Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola located between Latitude 9°11'N, 9°19'N and Longitude 12°20'E and 12°31'E (Adebayo and Tukur, 1999). The paddy rice Faro 44 variety used for the study was obtained from Adamawa State Agricultural Development Programme (AADP) Yola, Adamawa State.

The experiment consisted of four treatments (storage methods), namely; [floor (control), jute bag, polythene bag, plastic jar, and metallic jar] and was replicated three times in a Completely Randomized Design (CRD) in the Laboratory. Adult LGB was obtained from infested grains in the Yola grain market. This was reared on a susceptible rice variety (Faro 44) and later introduced into a transparent jar. Disinfection was achieved by drying for an hour at 60°C. Ten unsexed adults were then introduced into a jar containing 200 g of rice grains. The jar was covered with 10 mm mesh muslin cloth to allow for ventilation and also to prevent insects from escaping while the weevil was safely kept at room temperature (35±2 °C) and relative humidity (65–85%).

The jar was kept for 7 days after which the required quantity of the LGB was obtained and kept under laboratory conditions until all F1 progeny emerged and was harvested for the experiment as reported by Abebe et al. (2009).

2.1 Data Collection

Data were collected on the following parameters.

2.1.1 Percentage Mortality

This was done by emptying each container on a piece of white cloth separating both dead and live weevils in each container physically counting the dead insects then expressed in percentage using equation 1.

$$Percentage\ mortality = (Ti - Li)/Ti \times 100 \tag{1}$$

Where Ti = Total number of insects both live and dead; Li = number of live insects.

2.1.2 Percentage Weight Loss of Seeds

One hundred seeds were randomly taken at the end of the storage period (21 days) and the number of damaged seeds was then assessed. This was done by expressing the seeds damaged as a percentage of the total number of seeds sampled. Weight loss was then determined using Equation 2.

$$Percentage\ weight\ loss = [(Wu \times Nd) - (Wd \times Nu) \div Wu(Nd + Nu)]100 \quad (2)$$

Where: Wu = weight of undamaged seed; Wd = weight of damaged seed; Nu = Number of undamaged seed; Nd = Number of damaged seed.

2.2 Data Analysis

Data collected was subjected to Analysis of Variance (ANOVA) using SAS Software (Version 9.0) and means were separated using Least Significant Difference (LSD) at a five percent level of significance ($P \leq 0.05$).

III. RESULTS AND DISCUSSION

3.1 Effect of Storage Methods on Percentage Weight Loss of Rice Grain Caused by Lesser Grain Borer

The storage method had a significant ($P \leq 0.05$) influence on 100 seed weight of rice grain caused by lesser grain borer as depicted in Table 1. The various methods of storage used revealed that floor storage gave the highest percentage weight loss of 9.12% then followed by polythene bags which recorded 6.49% weight loss. Whereas metallic and plastic containers had the lowest percentage weight loss (5.57% and 4% respectively) are statistically the same.

TABLE 1
PERCENTAGE WEIGHT LOSS OF RICE AFTER INFESTATION WITH LESSER GRAIN BORER

Storage method	Weight loss (%)	Weight of 100 seeds (g) (before)	Weight of 100 seeds (g) (after)
Floor	9.12	2.333	2.567
Jute bag	6.93	2.367	2.6
Polythene bag	6.49	2.2	2.6
Plastic container	5.57	2.433	2.537
Metallic container	4	2.267	2.767
P of F	0.001	0.067	0.027
LSD	1.867	0.367	0.23

Both plastic and metallic containers had the best percentage of weight loss during the study because they provided hermetic storage conditions by cutting off the supply of oxygen to both the produce and weevils inside the containers thereby asphyxiating the pests. This finding is in line with that of Kumar and Kalita (2017); Suleiman et al. (2020) and Abdulazeez et al. (2023) who reported that scientific storage methods such as air-tight containers can reduce postharvest grain losses to as low as 1%–2%.

3.2 Effect of Storage Methods on Mortality of Lesser Grain Borer

From the result obtained, the storage method affected adult mortality of the lesser grain borer on rice in a highly significant ($P \leq 0.01$) way as illustrated in Table 2. Number of dead insects at 7 and 14 days were highly significant ($P \leq 0.01$). The maximum mean recorded for insects dead at 7 days was 6.00 for polyethylene bag and 5.67 for plastic container while the minimum value of 0.00 occurred in floor storage. However, at 14 days, mortality was highly significant ($P \leq 0.01$) on insect mortality with the polythene bag giving the highest value of 2.67 for most of the containers (metallic, plastic and jute) whereas floor storage recorded zero mortality. At 21 days, the highest adult mortality value was recorded against jute bag (2.33) whilst floor storage had the lowest value (0.00).

TABLE 2
MORTALITY OF LESSER GRAIN BORER

Storage method	Storage Period (Days)		
	7	14	21
Floor	0	0	0
Jute Bag	4.67	2.67	2.33
Poly. Bag	6	2.33	1.67
Plastic	5.67	2.67	1.67
Metallic	5.33	2.67	1.67
P of F	0.001	0.021	0.021
LSD	1.993	1.485	1.485

These findings could be due to the hermetic effect of the storage methods in question which asphyxiate the insects inside the container while the floor storage allow the insect to escape to safer hiding places as reported by Kumar and Kalita (2017); Ahmad et al. (2021).

IV. CONCLUSION

It can be concluded from the results obtained in this study, that plastic containers is the best for reducing percentage weight loss during storage of rice while polyethylene, plastic and metallic containers are the best for controlling Lesser Grain Borer during rice storage. Farmers in the study area can therefore adopt it as an eco-friendly and low rice storage method.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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