IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

REDUCING POST HARVEST LOSSES OF STORED GRAINS DUE TO STORED GRAIN PESTS TO INCREASE FOOD AVAILABILITY

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Abstract:

Grains serve as a primary source of nutrition for the global population. Wheat, rice, maize, and millets collectively account for 85% of the total worldwide grain production. The storage of grains for future use has been a practice since ancient times. In India, post-harvest losses represent approximately 10% of the overall grain production. During the storage period, various pest insects, microorganisms, and rodents can infest the grains, resulting in significant qualitative and quantitative losses during extended storage. Significant harm was inflicted by insect pests affecting stored grains. The losses attributed to inadequate post-harvest management of grains represent one of the primary challenges to enhancing food security. The aim of the study was to examine the infestation of insect pests in stored grains, which leads to considerable post-harvest losses, by sampling various storage facilities and evaluating the methods employed for the extended storage of grains in the Jodhpur region.

Keywords: Stored grains, post-harvest losses, Stored grain insect pests.

Introduction

The United Nations' "World Population Prospects" study from 2016 anticipated that there would be 7.56 billion people on the planet by 2050, 9.7 billion by 2050, and 11.2 billion by 2100. All facets of food security—including food availability, access, utilization, and stability—are adversely impacted by the changing climate and extreme weather. These factors also exacerbate underlying causes of malnutrition that are linked to child care and feeding practices, health services, and environmental health. According to the latest data (FAOSTAT) (2019), 10 percent of the world's population is at danger of suffering from extreme food insecurity, which affects about 770 million people. According to the Food Insecurity Experience Scale (FIES), food insecurity affects 29.8% of the population in Africa, 6.9% in Asia, and 9.8% in Latin America, while only 1.4% of individuals in Europe and North America experience this issue, based on FAO data from 2018. Grains, along with dairy products, fruits, and vegetables, are vital dietary components that supply essential energy and nutrients to humans, as noted by Thielecke et al. (2021). Essential grains include 17 different crops such as wheat, rice, barley, maize, popcorn, rye, oats, millet, buckwheat, and sorghum, which are primarily members of the Gramineae family and are harvested in their entirety when dry, as reported by FAO (1994). In terms of global agricultural land, maize, wheat, and rice are the most significant cereals, providing a primary source of nutrition for many people, as highlighted by Spaggiari et al. (2019)

Indian agriculture serves as a cornerstone of the economy, contributing over 24% to the Gross Domestic Product (GDP), with food crops playing a significant role by accounting for 68% (Akhtar et al., 2022). In India, around 30% of the grains produced on farms are procured by various agencies and subsequently stored in substantial quantities within warehouses or scientific food storage facilities. The government agencies tasked with the storage of food grains in India include the Food Corporation of India (FCI), the Central Warehousing Corporation (CWC), the State Warehousing Corporation (SWC), and state civil corporations. It is estimated that the annual loss of stored food commodities in India post-harvest can reach as high as 16 million metric tons, with a value of Rs. 50,000 crores (Somavat et al., 2017).

Stored product insect pests are estimated to result in a loss of approximately 5-10% of commodities on a global scale, with this figure likely being higher in tropical regions, as noted by Mondal and Port (1995). These various insect pests adversely affect both the quality and quantity of food grains during storage. They pose a considerable threat to a wide range of agricultural products, including both durable and perishable items, as well as non-food derivatives worldwide. The primary reason for the high prevalence of these pests is the favorable climate that facilitates their growth and development. Typically, stored product pests thrive in ambient temperatures ranging from 27 to 33 °C and humidity levels of 65-70% relative humidity. Insect pests can lead to losses of up to 5-10% in temperate zones and 20-30% in tropical zones concerning stored grains and grain products, as reported by Nakakita (1998).

During prolonged storage of bulk grains, insect infestations significantly modify the storage environment in three primary ways: these pests generally consume the grain, invade the kernels, and ultimately compromise the germ portion. This activity generates heat and contributes to the degradation of stored grain products, leading to considerable losses, primarily due to the reduction in nutritional value, rendering the grain unsuitable for human consumption. Both abiotic and biotic stressors that influence insect morphology, physiology, and environmental adaptation affect the abundance and population dynamics of insect pests in stored grains [Tefera T, Mugo S, Likhayo P (2011)]. As noted by Danks [2007], the suitability of habitats is directly affected by the climate's appropriateness for insect development and population dynamics.

The population dynamics of insect pests affecting grain stored for prolonged durations have been extensively studied. A research investigation was carried out to examine the population dynamics of these pests in various government and commercial storage facilities within the Jodhpur Region. This study focused on the seasonal fluctuations in insect pest density, the composition of insect species, and the extent of damage inflicted by insects on wheat stored in commercial grain storage facilities.

The objective of this study was to investigate the seasonal fluctuations in the density of insect pests, the composition of insect species, and the percentage of damage caused by insects in wheat stored in commercial grain storage facilities. A one-year study was conducted in 2023 to monitor the population dynamics of stored insect pests and assess post-harvest losses of stored grains, focusing mainly on commercial grain mandi and warehouses in the Jodhpur region.

The goal is to create realistic, safe, and affordable preventive strategies for managing stored grain insect pests.

CLIMATOLOGY:

Jodhpur city is located at 26°18\'north and 73°1\' east, and is located in the middle of the Tar River in the desert in West Rajasthan, about 250 km from the border with Pakistan. Jodhpur, the second largest city in Rajasthan, is a rapidly growing city surrounded by sandstone, rocky areas, malicious zones and industrial prey. Jodhpur was designated as "Suncity of India" in the "Indian Solar Data Handbook" (Development of Science and Technology, Development of the Government of India, 1981). Generally, Jodhpur's climate is hot and dry with lowest temperatures of 22°C (summer) and 10°C (winter) and highest temperatures of 41°C (summer) and 36°C (winter). Data with meteorological variables were collected from Cazari (Jodhpur) during the study period. The average maximum temperature in 2023 was 37.3ºC and the minimum temperature is 16.2 ^{0}C, and the minimum relative humidity is 8.4%of the maximum relative humidity of 93.5%, and the average relative humidity is 43.3%.

Materials and Methods

Survey and sample collection methods

Food grain samples (wheat) were gathered from different storage bags at Basni Grain Mandi and Siwanchi Gate mandi during the first week of each month and kept in insect culture rooms in the Department of Science and Science and Lachoo (autonomous), Jodhpur (Rajasthan). Three samples of grain, each weighing 250 g, were obtained from various storage bags for the insect laboratory. The grain was sieved through 2 mm mesh sieve (to remove dead and alive insects from the sample taken and grains to left the grain on the sieve) as method used by Compton JAF, Sherington J (1999).

Identification of major harmful insects:

The species of stored grain insects (beetles) in samples collected from stored wheat are Rhyzopertha dominica, Tribolium castaneum, T. confusum, Oryzaphilus surinamensis and Sitophilus oryzae.

TABLE

Mean population of different stored product insect observed in wheat during the year 2023 at Jodhpur

NAME OF STORED GRAIN INSECT PESTS					
MONTH OF OBSERVATION	***Oryzaephilus surinamensis***	***Sitophilus oryzae***	***Tribolium confusum***	***Tribolium casteneum***	***Rhyzopertha dominica***
	MEAN	**MEAN**	**MEAN**	**MEAN**	**MEAN**
Jan	**1.00**	**1.00**	**0.00**	**5.66**	**8.33**
Feb	**3.00**	**1.00**	**0.33**	**9.00**	**3.0**
Mar	**1.66**	**0.66**	**1.00**	**13.66**	**15.33**
April	**1.66**	**0.33**	**1.33**	**19.00**	**21.00**
May	**1.00**	**3.33**	**2.00**	**11.00**	**28.66**
June	**1.33**	**1.00**	**2.00**	**8.00**	**15.00**
July	**1.66**	**1.33**	**4.67**	**11.66**	**17.33**
August	**1.00**	**2.66**	**6.33**	**11.00**	**11.00**
Sept	**1.00**	**3.66**	**9.33**	**9.00**	**15.66**
Oct	**3.00**	**1.00**	**2.33**	**7.00**	**9.33**
Nov	**1.66**	**1.33**	**5.33**	**9.66**	**6.00**
Dec	**1.33**	**1.00**	**1.00**	**6.00**	**3.00**

Conclusive data of “Peak Period” of different stored grain insect pest(beetles).

S.NO	Name of Insects	Month of Observation
1.	*Rhyzopertha dominica*	September
2.	*Tribolium castaneum*	July
3.	*Tribolium confusum*	July
4.	*Sitophilus oryzae*	August
5.	*Oryzaephilus surinamensis*	August

Assessment of grain damaged:

Insect damage was assessed using both counting and weighing techniques. A sample of 250 grams of grains was collected from the beginning to the end of the storage periods, as well as from each type of storage. The number of grains affected by insects, as well as those that remained undamaged was determined with the aid of a hand lens by inspecting the seeds for any signs of holes. The percentage of insect-damaged grains was calculated following the methodology established by Wambugu PW et al. (2009)

$$\text{Insect damaged grain (\%)} = \frac{\text{Number of insect damaged grains} \times 100}{\text{Total Number of Grains}}$$

Grain weight loss:

The damage percentage of wheat grains was assessed based on weight by measuring the weight difference between 200 uninfected grains and 200 infected grains. Two sets of 200 grains were randomly selected from each sample, with one set consisting of healthy grains and the other comprising damaged grains. Both sets were weighed using an analytical balance, and the percentage weight loss of Bajra was calculated employing the formula established by Adams and Schulten (1978)..

% Weight Loss = Und-DNu x 10/ U(Nd + Nu)

Where U = Weight of undamaged grains
D = Weight of damaged grains
Nu = Number of undamaged grains
Nd = Number of damaged grains

Result and Discussion:

The insect species identified in the laboratory from the analyzed wheat samples included *Rhyzopertha dominica, Tribolium confusum, Tribolium castaneum, Oryzaephilus surinamensis, and Sitophilus oryzae*. The population density of the five predominant insect species—R*hyzopertha. dominica, Tribolium confusum, Tribolium castaneum, Sitophilus oryzae, and Oryzaephilus surinamensis* exhibited a rapid increase from June to October. Between October and February, the average density of these species remained relatively stable, ranging from approximately 2-10% per kilogram of wheat. Following January, there was a gradual decline in insect pest density, likely due to the cooler temperatures of the grain during this time. When the mean numbers were assessed, *Tribolium castaneum* ranked first, followed by *Rhyzopertha dominica* in second place, while *Tribolium confusum* occupied the third position. In contrast, *Oryzaephilus surinamensis* consistently ranked the lowest across all samples. The variations in mean numbers and the identified "Peak Period" for stored grain insects can be attributed to differences in the varieties of grains stored, the management practices employed during storage, as well as the varying temperature and humidity conditions that may favor certain species over others. Throughout the study period, the average percentage of weight loss in wheat grains due to prolonged storage was recorded at 8.8%.

Considerable efforts must be made not only to identify species and causes of variation in grain losses but also to introduce improvements in storage management; including both commodity and pest management, that will regulate the losses at or below the lowest observation level.

Conclusion

Five weevil species were identified from the collected samples. *Tribolium casteneum* was the dominant species followed by *Rhyzopertha dominica* occurred with heavy infestation inthe sample collected from warehouses. The mean number of weevil species, percentage of weight loss and grains damage showed an increasing trend as the storage periods increased which favors moisture development and temperature increment in the stored grains. Significant efforts are required not only to identify the species and factors contributing to variations in grain losses but also to implement enhancements in storage management to increase food availability for future.

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