

A comprehensive analysis of germination and pest dynamics in different storage receptacles

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Abstract

Post-harvest storage conditions critically influence wheat (*Triticum aestivum*) quality, impacting both germination potential and susceptibility to pest infestations. This study systematically evaluated five storage systems—heap in room, metal containers, hermetic bags, jute bags, and plastic bags—over a six-month period. Our findings demonstrate that metal containers and hermetic bags optimally preserved seed viability (germination >94%) while minimizing rice weevil (*Sitophilus oryzae*) infestation (14–17%). In contrast, heap storage exhibited the highest pest incidence (49%) despite superior germination metrics, and plastic bags showed significant declines in germination (86.52%) and vigor index (961.83). These results underscore the critical role of airtight storage technologies in mitigating post-harvest losses and enhancing food security. The study provides actionable insights for farmers and policymakers to adopt sustainable storage practices.

Keywords: Post-harvest storage, germination potential, pest infestations, airtight storage, food security

Introduction

Wheat is a cornerstone of global food security, yet post-harvest losses due to poor storage conditions remain a significant challenge. Insect infestations, particularly by the rice weevil (*Sitophilus oryzae*), and physiological degradation during storage can drastically reduce seed viability and market value (Tefera *et al.*, 2011). The choice of storage receptacle is pivotal, as it influences microclimatic conditions such as humidity, temperature, and gas exchange, all of which affect pest proliferation and seed physiology (Navarro, 2020).

Traditional methods like heap storage and jute bags are prone to pest attacks, while modern solutions like hermetic bags and metal containers offer improved protection but at varying costs and accessibility levels (Villers *et al.*, 2016). This study aims to

1. Compare the efficacy of five storage systems in preserving wheat germination and vigor.
2. Quantify rice weevil infestation rates across different storage conditions.
3. Identify the most effective storage method balancing pest control and seed quality.

Materials and Methods

Experimental Design and Storage Conditions

Wheat seeds (var. HD-2967) were procured from a certified supplier and stored for six months under ambient conditions (25–30°C, 60–70% RH) in the following receptacles

1. **Heap in room:** Uncontrolled, open storage.
2. **Metal containers:** Airtight, galvanized iron bins.
3. **Hermetic bags:** Polyethylene bags with oxygen barriers.
4. **Jute bags:** Traditional woven sacks.
5. **Plastic bags:** Low-density polyethylene (LDPE) bags.

Parameters Measured

1. Pest Incidence

- Rice weevil infestation (%) was calculated as

$$\text{Infestation (\%)} = \left(\frac{\text{Number of infested seeds}}{\text{Total seeds}} \right) \times 100$$

$$\text{Infestation (\%)} = \left(\frac{\text{Total seeds} - \text{Number of infested seeds}}{\text{Total seeds}} \right) \times 100$$

- Assessments were conducted monthly using standard entomological techniques (AACC, 2022).

2. Germination and Seedling Vigor

- **Germination %:** 200 seeds per replicate were placed on moist filter paper (25°C, 7 days).

- **Germination index (GI):** Calculated as

$$GI = \frac{\sum (\text{Number of germinated seeds} \times \text{Days to germination})}{\sum (\text{Days to germination} \times \text{Number of germinated seeds})}$$

- **Root and shoot length:** Measured at 7 days post-germination.

- **Vigor index (VI):** Computed as

$$VI = \text{Germination \%} \times (\text{Root length} + \text{Shoot length})$$

- **Significance of viability:** Determined via ANOVA followed by Tukey's HSD test ($p < 0.05$).

Statistical Analysis

Data were analyzed using RStudio (v4.2.1). Mean comparisons were performed with one-way ANOVA, and significant differences were identified at $p < 0.05$.

Results

Table 1: Rice Weevil Incidence in Different Storage Receptacles

S.No.	Receptacle	Rice weevil incidence%
1	Heap in room	49
2	Metal containers	14
3	Hermetic bags	17
4	Jute bags	34
5	plastic bags	30

- Values with different superscripts (a–d) differ significantly ($p < 0.05$).

- **Heap storage:** showed the highest infestation (49%), while metal containers were most effective (14%).

Table 2: Germination and Seedling Vigor Parameters

S.No.	Receptacle	Germination %	Germination index	Root length	Shoot length	Vigor index	significance of viability
1	Heap in room	96.46	3.21	6.6	7.67	1371.17	1.08
2	Metal containers	97.67	3.25	5.6	6.37	1142.37	1.08
3	Hermetic bags	94	3.13	5.33	6.77	1136.37	1.07
4	Jute bags	95	3.16	5.63	6.67	1154.86	1.12
5	plastic bags	86.52	2.87	5	5.87	961.83	1

- **Germination %:** Plastic bags underperformed (86.52%), while other systems maintained >94%.
 - **Vigor Index:** Heap storage had the highest vigor (1371.17) but was offset by pest vulnerability.
 - **Seedling Growth:** Root/shoot lengths were significantly shorter in plastic bags ($p < 0.05$).
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Discussion

Pest Incidence and Storage Efficacy

The 49% weevil infestation in heap storage aligns with studies highlighting the risks of open storage (Murdock *et al.*, 2012). Metal containers (14%) outperformed other systems due to their impermeability, consistent with Navarro (2020). Hermetic bags (17%) also demonstrated efficacy, leveraging oxygen deprivation to suppress pests (Villers *et al.*, 2016).

Germination and Physiological Quality

The decline in plastic bags’ germination (86.52%) likely stems from anaerobic stress and condensation (Moreno-Martinez *et al.*, 2021). Heap storage’s high vigor (1371.17) reflects natural aeration but is impractical due to pest risks. Metal/hermetic systems balanced moderate vigor (~1140) with low infestation, making them ideal for long-term storage.

Practical Implications

1. **For Smallholders:** Hermetic bags offer a cost-effective alternative to metal containers.
2. **Industrial Storage:** Metal bins are optimal for large-scale operations.
3. **Policy Recommendations:** Subsidies for airtight storage technologies can reduce post-harvest losses.

Conclusion

This study demonstrates that airtight storage systems (metal/hermetic) optimally preserve wheat quality while minimizing pest damage. Plastic bags are unsuitable for long-term storage, and heap storage, despite high vigor, is impractical. Future research should explore climate-smart storage innovations for diverse agroecological zones.

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