



RELATIONSHIP BETWEEN STORAGE DURATION AND QUALITY INDICATORS OF COTTON SEEDS

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Abstract: *The storage of cotton seeds (*Gossypium hirsutum* L.) plays a critical role in determining seed viability, vigor, and germination performance. Over time, physiological and biochemical deterioration reduces the seed's ability to germinate effectively, directly impacting cotton yield and fiber quality. This research investigates the relationship between storage duration and key quality indicators such as germination rate, moisture content, electrical conductivity, enzyme activity, and seed vigor index. Seeds of different storage ages (0, 6, 12, 18, and 24 months) were analyzed under controlled temperature and humidity conditions. Results demonstrated a significant inverse relationship between storage duration and seed quality parameters. Germination percentage declined from 94% (fresh seeds) to 58% (after 24 months), while lipid peroxidation and electrical conductivity increased markedly. The findings emphasize the necessity of maintaining optimal storage conditions—temperature below 15°C and relative humidity below 45%—to preserve cotton seed viability for extended periods.*

Keywords: *Cotton seed, storage duration, seed quality, germination, viability, physiological aging, biochemical degradation, Uzbekistan.*

Cotton (*Gossypium hirsutum* L.) is a cornerstone of Uzbekistan's agricultural economy, serving as a vital source of fiber, oil, and animal feed. Ensuring high-quality seed is fundamental for successful cotton production, as seed viability and vigor determine field emergence and crop uniformity. However, during long-term storage, cotton seeds undergo gradual deterioration due to metabolic activity, oxidative stress, and unfavorable environmental factors.

The rate of seed deterioration depends on both intrinsic factors (genetic characteristics, seed maturity, and moisture content) and extrinsic factors (temperature, relative humidity, oxygen level, and storage duration). This study aims to evaluate how storage time quantitatively affects cotton seed quality indicators and to propose optimal storage strategies to maintain seed performance.



Significance of the Study

Maintaining cotton seed quality during storage is a strategic agricultural challenge in Uzbekistan, especially given the high seasonal temperatures and variable humidity in storage facilities. Poorly managed seed storage not only leads to economic loss but also results in non-uniform germination, delayed emergence, and yield reduction.

This study holds significance for:

- Improving seed preservation technology in local seed centers.
- Supporting seed certification programs and quality control systems.
- Ensuring food and fiber security by maintaining genetic integrity of cotton varieties.

Literature Review

Previous research has confirmed that cotton seed quality declines steadily over time due to oxidative stress, membrane disintegration, and enzyme deactivation. According to Bewley and Black (2014), lipid peroxidation in seed membranes leads to increased permeability, causing leakage of electrolytes and nutrients.

Rajjou et al. (2008) emphasized that enzymatic antioxidants such as catalase (CAT) and peroxidase (POD) decrease with prolonged storage, accelerating physiological aging. Additionally, Pukacka and Ratajczak (2005) demonstrated that seed moisture levels above 12% significantly increase respiration rates and fungal infection risk.

Despite global research, few systematic studies have addressed the storage–quality correlation under arid and saline conditions of Central Asia, where unique climatic conditions influence seed physiology.

Methodology

Experimental Design

The study was conducted at the Seed Quality Control Laboratory, Gulistan State University, from 2023 to 2025. Seeds of the cotton variety Sulton were stored for different durations:

- 0 months (freshly harvested),
- 6 months,
- 12 months,
- 18 months, and
- 24 months.

Storage Conditions

All samples were stored in hermetically sealed bags under two environmental regimes:

1. Controlled storage: temperature $12 \pm 2^\circ\text{C}$, relative humidity 40–45%.



2. Ambient storage: temperature fluctuating between 18–32°C, humidity 55–70%.

Parameters Measured

1. Germination rate (%) – determined by ISTA standard method.
2. Moisture content (%) – measured using an electronic moisture analyzer.
3. Electrical conductivity ($\mu\text{S cm}^{-1} \text{g}^{-1}$) – to assess membrane integrity.
4. Seed vigor index (SVI) – calculated as germination percentage \times seedling length.
5. Biochemical markers – catalase and peroxidase enzyme activities measured spectrophotometrically.

Statistical Analysis

All data were analyzed using one-way ANOVA ($p \leq 0.05$) with Tukey's post-hoc test. Correlation coefficients (r) were computed to quantify relationships between storage duration and seed quality traits.

Results and Discussion

Germination and Vigor

Germination declined linearly with increasing storage duration. Fresh seeds exhibited a 94% germination rate, decreasing to 58% after 24 months. The seed vigor index dropped by 46%, indicating significant loss in metabolic energy and enzymatic activity.

Moisture and Electrical Conductivity

Moisture content increased slightly over time, particularly in ambient storage, which accelerated deterioration. Electrical conductivity values rose from 38 to 91 $\mu\text{S cm}^{-1} \text{g}^{-1}$, confirming increased membrane leakage.

Biochemical Changes

Catalase and peroxidase activities decreased by 40–50% over two years. This reduction reflects impaired antioxidant defense, leading to accumulation of reactive oxygen species (ROS). Lipid peroxidation, measured via malondialdehyde (MDA) content, doubled after 24 months.

Correlation Analysis

A strong negative correlation ($r = -0.92$) was found between storage duration and germination rate, and a positive correlation ($r = 0.88$) between duration and electrical conductivity. This suggests that prolonged storage significantly accelerates physiological aging processes.

Problems Identified

- Lack of temperature and humidity control in many regional seed depots.
- Inadequate packaging materials allowing oxygen and moisture exchange.



Poor understanding among seed producers of physiological seed aging.

Limited access to modern seed testing laboratories for quality monitoring.

Proposed Solutions

Establish modernized seed storage facilities with automated temperature and humidity control systems.

Promote vacuum-sealed or multilayered packaging to prevent moisture uptake.

Implement periodic seed quality assessment every six months to detect early deterioration.

Introduce training programs for seed specialists on post-harvest handling and physiology.

Scientific Novelty

This research provides a quantitative correlation model linking storage duration with physiological and biochemical indicators of cotton seed quality. The study's novelty lies in:

Determining specific thresholds beyond which cotton seed viability drops below 70%.

Identifying the critical role of enzyme activity as an early indicator of deterioration.

Proposing region-adapted storage protocols for Uzbekistan's dry continental climate.

Practical Recommendations

For commercial seed storage, maintain conditions below 15°C and 45% relative humidity.

Use hermetically sealed bags to prevent oxidative degradation.

Apply seed rejuvenation treatments (e.g., hydropriming with antioxidants) before sowing old seeds.

Integrate storage data into digital seed traceability systems for better management.

CONCLUSION

The study conclusively demonstrates that cotton seed quality indicators—particularly germination rate, vigor, and enzymatic activity—decline significantly with prolonged storage. The deterioration is accelerated by high temperature and humidity, leading to increased membrane damage and oxidative stress. Maintaining optimal environmental conditions and implementing periodic quality assessments are essential to preserve seed viability and productivity in Uzbekistan's cotton industry.



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