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PHYSIOLOGICAL QUALITY OF STORED PEANUT SEEDS

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KEYWORDS

Arachis hypogaea L., germination, post-harvest.

ABSTRACT

Storage can reduce seed germination potential and viability, especially in high-lipid species, such as peanuts. This study evaluated the physiological quality of stored peanut seeds from different lineages under long-term storage conditions. The experiment followed a completely randomized design, including ten peanut lines, comprising four commercial cultivars and six genotypes from the Peanut Improvement Program (PMA) of EMBRAPA, with five replications. Seeds were evaluated at two time points: before storage (time zero) and after 12 months of storage. Assessments included moisture content, seed germination percentage, seedling emergence, and seedling development. Data were analyzed using analysis of variance (ANOVA), and means were compared using Tukey's test ($p < 0.05$). Results indicated that storage time reduced the physiological potential of peanut seeds. However, seeds from lines 5, 10, 4, and 9 maintained viabilities over 12 months, whereas lineage 8 exhibited low germination and seedling emergence after storage. The substrate emergence test proved to be a more sensitive indicator of physiological seed quality among peanut lines.

INTRODUCTION

Peanut (*Arachis hypogaea* L.), a dicotyledonous plant of the Fabaceae family with South American origins, is among the most widely cultivated oilseeds. Its seeds are rich in lipids, proteins, and vitamins, making them an important energy source (Nakagawa & Rosolem, 2011). Brazil, one of the world's leading peanut exporters (FAO, 2020; Sampaio & Fredo, 2021), concentrates production in São Paulo, Rio Grande do Sul, and Minas Gerais.

Crop performance in the field is influenced by genetic, soil, climatic, and management factors, which directly affect growth and yield and indirectly impact the quality of the harvested product (Marcos-Filho, 2015; Desmae et al., 2019). In the post-harvest stages, both field conditions and management practices play a critical role in maintaining seed quality (Saath et al., 2021; Pereira et al., 2023).

Post-harvest storage is a critical step in the production chain, ensuring product integrity and preserving seed vigor for future planting (Gebeyehu, 2020; Lima et al., 2021). However, maintaining seed quality during storage depends on factors such as seed composition, physical integrity, pest presence, and storage conditions (Sá et al., 2020; Zhang et al., 2021).

The post-harvest quality of seeds, whether determined by genetic characteristics or influenced by field conditions, has been the subject of numerous studies (Vitis et al., 2020; Lander et al., 2022). This study evaluated the physiological quality of different peanut genotypes, all

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originating from the same production field, under varying storage conditions.

MATERIAL AND METHODS

The study was conducted at the Agricultural Products Technology and Post-Harvest Laboratory, located at the Irrigation Technical Center (CTI), Agronomy Department (DAG), State University of Maringá (UEM). The experiment followed a completely randomized design (CRD), consisting of ten peanut lines, including four commercial cultivars and six genotypes from the Peanut Improvement Program (PMA) of EMBRAPA, with four replicates.

Freshly harvested peanuts were shelled, and seed samples were collected before and after storage to evaluate moisture content and physiological quality. Moisture content was determined using a forced-air circulation oven (105 ± 3 °C for 24 hours). Approximately 20 g of seeds were used per sample, with moisture content calculated as the difference between fresh weight and dry weight and expressed on a dry basis moisture (Mdb).

The seeds were stored in raffia plastic bags under uncontrolled environmental conditions at the Agricultural Products Technology and Post-Harvest Laboratory (Figure 1). Evaluations were conducted at two time points: time zero (initial storage) and after 12 months of storage.

Seed germination and emergence tests were performed following RAS (BRASIL, 2009) guidelines. For the germination test, 100 seeds per sample were placed in Germitest paper, moistened with distilled water, and incubated in a germination chamber. The final germination count was conducted 10 days after test initiation, with results expressed as a percentage (% germination).

For the emergence test, 100 seeds per sample were sown in trays filled with sand, with frequent moistening to ensure uniform conditions. The final emergence count was conducted 10 days after sowing, and results were expressed as percentages (% emergence).

To quantify water content and biomass accumulation in seedlings, seeds were sown in sand, and seedlings were evaluated at 7, 12, and 18 days. After evaluation, seedlings were harvested, washed with running water to remove sand, weighed, and dehydrated in an oven for biomass measurement.

Data were subjected to analysis of variance (ANOVA), and means were compared using Tukey's test ($p \leq 0.05$). Statistical analyses were performed using MS Excel and SISVAR software (Ferreira, 2019).

RESULTS AND DISCUSSION

Peanut crops exhibit strong adaptability to environmental conditions, primarily due to their morphological and physiological characteristics. Regarding seedling emergence, a significant difference was observed in the germination and final emergence percentages for seeds before storage (Table 1). The seed moisture content on a dry basis (db) ranged from 0.0776 to 0.0830 (decimal). The germination percentage (98.2%–99.2%) and seedling emergence in the substrate (98.4%–98.9%) varied significantly among the evaluated peanut lines.

TABLE 1. Average values of moisture content on a dry basis (Mdb), germination percentage (%), and seedling emergence in sand for ten peanut lineages before and after twelve months of storage.

Material	Mdb (decimal)	Germination	Emergence
		---------------------- (%) ----------------------	
		Before storage	
1	0.0815a	98.8aA	98.9aA
2	0.0830a	99.1aA	98.4bA
3	0.0821a	98.1bA	98.7aA
4	0.0789b	98.9a	98.8aA
5	0.0778b	98.6aA	98.5bA
6	0.0776b	98.9aA	98.9aA
7	0.0789b	99.0aA	98.8aA
8	0.0786b	99.2aA	98.7aA
9	0.08146a	98.3bA	98.5bA
10	0.0813a	98.2bA	98.4bA
CV (%)	0.1209	0.0915	0.0852
		After 12 months of storage	
1	0.069a	75.2cB	70.2bB
2	0.069a	75.2cB	74.2bB
3	0.068a	74.2cB	62.2cB
4	0.065b	85.2bB	92.2aB
5	0.068a	94.5aA	95.5aA
6	0.067a	89.6aB	88.6aB
7	0.069a	80.2bB	70.2bB
8	0.068a	70.2c	60.2cB
9	0.065b	86.6bB	91.6aB
10	0.065b	92.6aB	92.6aB
CV (%)	0.1119	0.1215	0.1052

Averages followed by the same letters within columns, lowercase for lineage and uppercase for storage time, do not differ from each other by Tukey's test (p≤0.05).

The results demonstrated that storage significantly reduced the physiological potential of peanut seeds, with a particularly sharp decline in seedling emergence for lines 1, 2, 3, 7, and 8, all of which had emergence rates below 75% (Table 1). Notably, line 8 exhibited the lowest emergence values, despite recording a germination percentage of 70.2% (Table 1), which is below the 80% minimum standard required for seed commercialization (MAPA, 2013).

In contrast, lines 5, 10, 6, 9, 4, and 7 maintained germination rates of 94.5%, 92.6%, 89.6%, 86.6%, 85.2%, and 80.2%, respectively, with seedling emergence rates of 95.5% (5), 92.6% (10), 92.2% (4), 91.6% (9), and 88.6% (6). Meanwhile, lines 2, 1, 7, 3, and 8 had significantly lower emergence rates of 74.2%, 70.2%, 70.2%, 62.3%, and 60.2%, respectively (Table 1), indicating a drastic loss of seed vigor.

The moisture content (Mdb) of the seeds decreased between 13.5% and 20.14% during storage, further contributing to the observed decline in physiological quality.

Differences in biomass accumulation were observed among peanut lines (Table 2), particularly in the shoot and root portions of seedlings. The lowest total biomass (BMT), shoot fresh mass (MFPA), and shoot dry mass (MSPA) were recorded in seedlings from lines 3, 2, 4, and 9. Additionally, the fresh root mass (MFR) and dry root mass (MSR) were lowest in seedlings from lines 3, 7, 6, and 2 (Table 2).

Although the shoot dry mass accumulation followed a similar pattern after 12 months of storage, the highest average values were recorded in freshly harvested seeds.

TABLE 2. Average values of total biomass (TBM), shoot fresh mass (SFM), shoot dry mass (SDM), root fresh mass (RFM), and root dry mass (RDM) of seedlings grown in sand from ten peanut lineages before and after 12 months of storage.

Material	Before storage				
	TBM	SFM	SDM	RFM	RDM
	(g)				
1	14.270cA	11.450cA	2.814bA	2.820bA	0.275bB
2	14.695bA	11.550cA	3.522aA	3.145aA	0.255aA
3	15.670aA	13.145aA	2.828bA	2.525cA	0.229cA
4	16.470aA	13.730aA	3.689aA	2.740bB	0.238cA
5	14.870bB	12.205bB	2.809bA	2.665cB	0.236cA
6	15.380bA	12.795bA	2.733bA	2.585cA	0.215cA
7	15.130bA	12.345bA	2.859bA	2.785bB	0.275bA
8	16.465aA	13.685aA	3.857aA	2.780bB	0.284bB
9	13.475cA	10.940cA	2.952bA	2.535cA	0.225cB
10	14.495bB	11.695cB	2.984bA	2.891bB	0.276bA
CV	0.1245	0.1265	0.1075	0.1458	0.1354
	After 12 months of storage				
1	13.77bA	11.10bA	2.135aB	2.670cB	0.325bA
2	9.195cB	6.440cB	1.565bB	2.755cA	0.155dB
3	8.970cB	7.845cB	1.205cB	1.125dB	0.091eB
4	11.48bB	8.005cB	1.715bB	3.475bC	0.220cB
5	19.37aA	16.425aA	2.255aB	2.945cA	0.240cA
6	13.38bB	10.895bB	1.575bB	2.485cA	0.150dB
7	13.63bB	9.845bB	1.625bB	3.785bA	0.135dB
8	13.515bB	9.655bB	1.795bB	3.860bA	0.585aA
9	9.975cB	7.640cB	1.380cB	2.335cB	0.395bA
10	18.34aA	13.84aA	1.965aB	4.500aA	0.280cA
CV	0.1445	0.1465	0.1475	0.1958	0.1854

*Averages followed by the same letter within columns, lowercase for lineages and uppercase for storage time, do not differ from each other by Tukey's test (p≤0.05).

Considering that the seed carries the full genetic potential of a cultivar (Amaro et al., 2015; Marcos-Filho, 2020), its quality directly influences the performance of peanut crops (Desmae et al., 2019). The seed plays a crucial role in ensuring the optimal spatial distribution of plants in the field (Xavier et al., 2022; Zammataro et al., 2021).

The storage environment, particularly temperature and relative humidity dynamics, had a lesser effect on the physiological quality of seeds from lines 5, 10, 4, and 9. However, the vigor of seeds from lines 8, 3, 1, 7, and 2 was drastically reduced, confirming that post-harvest conditions significantly impact seed quality. This highlights the importance of post-harvest management for maintaining competitiveness in the peanut production chain (Sá et al., 2020; Saath et al., 2021; Pereira et al., 2023).

During storage, seed deterioration can be monitored using vigor tests (Lima et al., 2021), which is particularly relevant given that seeds from the same origin can exhibit different aging patterns (Zhang et al., 2021). Additionally, variations in seedling mass accumulation provide further insight into seed performance over time (Marcos-Filho, 2015).

The findings of this study suggest that genetic origin plays a key role in mitigating the effects of storage conditions on seed physiological quality. Specifically, five peanut lines exhibited satisfactory emergence rates even after 12 months of storage, making them viable for commercialization. Moreover, the descriptors related to biomass accumulation—including seedling weight, shoot fresh mass, shoot dry mass, root fresh mass, and root dry mass—were consistent with those of commercially cultivated peanut seedlings.

The rate of seed deterioration is largely influenced by temperature and humidity, making the storage environment a determining factor in seed longevity (Vitis et al., 2020; Gebeyehu, 2020). Lower temperatures and controlled humidity levels slow down deterioration, thereby extending seed viability (Lander et al., 2022; Sá et al., 2020).

Future research should focus on quality management practices tailored to the peanut seed production chain, with an emphasis on minimizing pre-harvest losses (e.g., emergence and developmental growth) and ensuring seed health and sanitary quality for improved market viability.

The results of this study can serve as a valuable reference for assessing the viability of peanut seeds in different production regions. Within the context of genetic improvement programs, these findings provide technical knowledge to support decision-making under diverse soil and climatic conditions, contributing to the development of new peanut cultivars with enhanced storage resilience.

CONCLUSIONS

Storage time reduced the physiological potential of peanut seeds. However, seeds from lines 4, 5, 6, 9, and 10 maintained viability and can be stored for up to 12 months. In contrast, seeds from line 8 exhibited low germination and seedling emergence rates after 12 months of storage.

The emergence test in substrate proved to be a more sensitive indicator for assessing the physiological quality of peanut seeds. Additionally, the genetic origin of peanuts can serve as a valuable tool to mitigate the effects of storage conditions on seed quality.

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