Abyss. J. Sci. Technol. Vol. 9, No. 2, 2024, 1-8.
ISSN 2616 – 4728 (Online); 2616 – 471X (Print).
DOI: https://doi.org/10.20372/ajst.2024.9.2.921
Publisher: Wollo University, Dessie, Ethiopia

Abyssinia Journal of Science and Technology

Influence of Type of Packaging Materials and Storage Period on Onion (*Allium cepa* L.) Seed Quality

Teshome Ashagrie[a] *, Derbew Belew[b] and Amsalu Nebiyu[b]

[a] Sirinka Agricultural Research Centre, P.O. Box 74, Sirinka, Ethiopia.
[b]College of Agriculture and Veterinary Medicine, Jimma University, P.O. Box 307, Jimma, Ethiopia.

ABSTRACT

Due to the rapid loss of onion seed viability after harvest, implementing proper storage methods is essential. This study aimed to investigate the influence of various packaging materials and storage durations on the quality of onion seeds (*Allium cepa* var. Bombay Red). The research was carried out at the seed laboratory of Sirinka Agricultural Research Center between June 2019 and June 2021. The study was carried out using Complete Random Design (CRD) with three replications and using version 9.4 SAS Software to analyze the collected data. The experiment had two factorial arrangements with five packaging materials (aluminum bags, nylon sacks, polythene bags, cloth bags, and glass jars) and two storage periods (12 and 24 months). The study showed that nearly all the parameters examined were significantly influenced ($p< 0.05$) by both the types of packaging materials and the storage durations. The mean and standard deviation of findings were germination percentage (81.4, 13.6), germination index (3.30, 0.59), germination rate index (0.041, 0.001), seed vigor index I (1143.53, 227.76) and II (8.14, 1.23) and field emergence percentage (82.33, 4.42), respectively. The maximum germination percentage (99.3%), germination index (4.2), germination rate index (0.042), seed vigor index I (1467.4) and II (9.9) and field emergence (90.7%) were observed from polythene bag storage materials and storage period of 12 months. Therefore, it can be concluded that onion seeds can be stored in polythene bags for one year without affecting seed quality.

Keywords: Onion seed, seed packaging, storage period and seed quality.

INTRODUCTION

Onion (*Allium cepa* L.) is a vital vegetable crop cultivated globally for various applications (Muluneh et al., 2019). In Ethiopia, onion cultivation spans approximately 25,129 hectares, yielding an annual bulb production of 207,662.67 tons, which corresponds to a productivity rate of 8.26 tons per hectare (CSA, 2021). Onions are a commonly cultivated herbaceous biennial vegetable characterized by cross-pollination and monocotyledonous traits, possessing a diploid chromosome count of 2n = 16 (Bassett, 1986). Unlike other edible allium species, onions are distinguished by their singular bulb and their typical propagation through true botanical seeds. In comparison to numerous other crops, onions exhibit a relatively intricate life cycle that encompasses several distinct developmental stages. To produce the bulb takes 3 to 4 months while seed production takes 6 to 7 months. Onion seeds are characterized by a relatively brief lifespan compared to other common vegetable seeds, as they tend to lose their viability quickly after post-harvest unless specific storage measures are implemented. (Thirusendura & Saraswathy, 2018). The seed is believed to remain in storage throughout all phases occurring between harvesting and sowing. These phases are regarded as integral components of the storage process. The degree to which seeds can be stored effectively is affected by the nature of the packaging material used (Amjad & Anjum, 2002). Onion seeds possess significant commercial importance, and it is essential to achieve favorable vigor test results for these seeds. (Patel et al., 2012).

Moisture-resistant, sealed containers create an ideal storage environment for seeds, providing superior protection against contamination and

***Corresponding author:** teshu34@gmail.com
Received: 22-04-2024, **Accepted:** 28-11-2024, **Published:** 31-12-2024
Copyright: © The publisher, 2024, **Open access**. This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format as long as you give appropriate credit to the original author(s) http://creativecommons.org/licenses/by/4.0/.
Journal homepage: https://abjol.org.et/index.php/ajst/index
Citation: Ashagriea, T., Belewb, D., and Nebiyub, A., (2024). Influence of type of packaging materials and storage period on onion (*Allium cepa* L.) seed quality. *Abyssinia Journal of Science and Technology*, *9*(2), 1-8.

serving as a more effective barrier against the loss of seed treatment chemicals, unlike containers that allow moisture to penetrate. The germination rates and percentages of onion seeds can vary significantly between different seed lots, which can impact the overall cost of the seeds. Research has shown that key factors influencing seed longevity during storage include moisture levels, temperature, and oxygen partial pressure (Amjad & Anjum, 2002). Among these, storage temperature and moisture content are crucial factors, with moisture content generally having a stronger effect on seed lifespan than temperature. Research has consistently highlighted that the decline in seed quality is primarily driven by factors including storage temperature, relative humidity, seed moisture levels, storage duration, seed type, and the initial condition of the seeds (Alhamdan et al., 2011).

Currah and Msika (1994) revealed that when seeds of two onion varieties were stored under similar ambient conditions, after three years the seeds stored in airtight jars retained their viability with little change in germination, compared to reduced viability in those stored in paper packets. Kumari et al., (2001) also reported that onion varieties Hisar and N-53 retained higher germinability over certification standards in ambient conditions in cloth bags up to eight and four months of storage, respectively. A study examining onion seeds with a 5% moisture content compared storage methods using moisture-permeable cloth bags, paper bags, wax paper-lined cardboard boxes, plastic bags, and aluminum foil packets. The results showed that seeds stored in plastic bags and aluminum foil packets retained a germination rate above 70% even after one year. In contrast, seeds stored in the other three types of containers maintained a 70% germination rate for only up to ten months. (Shelar et al., 1992). Caneppele et al. (1995) found that onion seed germination experienced the greatest decline when stored in permeable containers as opposed to impermeable ones. The observed discrepancy was ascribed to differences in the moisture content of seeds contained within permeable packaging materials, as well as the degree of hygroscopic equilibrium achieved between the seeds and their surrounding environment. Padma and Reddy (2002) documented the variations in moisture content. in brinjal seeds of up to 2.4 per cent in moisture-pervious and moisture-semi-pervious containers, while no such fluctuation occurred in vapour-proof containers (polythene and aluminum pouches) was observed.

Storing onion seeds for extended periods is challenging because they tend to lose viability and vigor quickly (Mumtaz et al., 2004). A study by Saxena et al. (1987) examined the storage of onion, cabbage, radish, cauliflower, okra, and pea seeds in polythene and cloth bags at room temperature over 24 months. The results indicated that seeds kept in cloth bags saw the greatest decline in germination rates, root length, shoot length, and vigor index, while those stored in polythene bags experienced the smallest reduction in these metrics. Similarly, research by Horky (1988) involved storing onion, carrot, lettuce, and cabbage seeds for 65 months in various packaging materials, including paper, biaxially oriented polypropylene film, and triple-laminated aluminum foil. Although the type of packaging did not significantly influence germination rates, a steady decrease in germination percentage was noted across all seed types as storage duration increased. Jyotindra et al. (2013) also observed that onion seed germination rates consistently declined over time, with seeds stored in plastic bags outperforming those in paper or cloth bags. A significant obstacle in onion cultivation is the scarcity of viable seeds during planting seasons, primarily due to their poor storage performance under varying ambient temperatures. While enhancing onion seed storage could significantly boost seed production in Ethiopia, no studies have yet explored the effects of different storage materials and durations in the country. Consequently, this study seeks to evaluate how various packaging materials and storage periods influence the quality of onion seeds.

MATERIALS AND METHODS

Description of the Study Area:

The study was conducted at the Seed Laboratory of Sirinka Agricultural Research Center from June 2019 to June 2021. Sirinka is situated 508 kilometers northeast of Addis Ababa, along the primary route to Woldia, at coordinates 11°45’00’’N latitude and 39°36’36’’E longitude, with an altitude of 1850 meters above sea level. The region experiences an average annual rainfall of 945 millimeters, with temperatures ranging between a maximum of 26°C and a minimum of 13°C (SARC, 2009). Throughout the research period, the ambient storage conditions fluctuated, with temperatures ranging from 11.5 to 18.7°C and relative humidity varying between 35% and 51.6%.

Treatments, Experimental Design, and Material:

The experiment consisted of five types of storage materials (aluminum bags, nylon bags, polythene bags, cloth bags and glass jars) and two storage periods (12 and 24 months). The experiment was arranged in 5×2 factorial combinations in Complete Random Design (CRD) with three replications. The Bombay Red onion variety seed was used for the study. It is a widely adapted and accepted variety for its earliness and high bulb

yield. Melkasa Agricultural Research Center (MARC). It is suitable for cultivation at elevations ranging from 700 to 2000 meters above sea level, with a seed yield potential estimated between 1.3 and 2.0 tons per hectare (Lemma & Shimelis, 2003).

Experimental Procedure and Management:

For each treatment, a 50 g seed sample was placed in different packaging materials and stored for either 12 or 24 months. Following the storage period, tests were conducted according to ISTA (1985) guidelines. To evaluate germination, seeds from each treatment were placed in Petri dishes lined with filter paper and moistened with 4 ml of distilled water for imbibition. The dishes were kept at room temperature and monitored for 12 days until full germination was achieved. Each Petri dish was watered daily with distilled water as needed. A composite sample of 50 seeds from three replications was used to calculate germination percentages. Germination was assessed by observing the emergence of a 1 mm radical daily, starting from the second day and continuing until no further radical emergence occurred for two consecutive days. The seedling length was measured in centimeters using a ruler.

To evaluate field emergence potential, 100 seeds from each treatment across three replications were randomly selected and manually sown with a spacing of 10 cm between rows and 2 cm between seeds. The seeds were lightly covered with fine soil, and the seedbed was maintained with adequate moisture. A seedling was considered emerged once it became visible on the surface of the soil.

Data collection:

Germination percentage: The number of normal germination seeds and total seeds planted on Petri dishes were used to calculate the percentage of germination.

Germination percentage = (No. of germinated seeds / Total no. of seeds planted) X 100

The germmination index was calculated as stated below:

Germination index = $\sum$ No. Of germinated seed in a day / Total no. Of seeds germinated within 12th day

The percentage of onion seeds that successfully sprout and grow into strong seedlings is known as the germination index.

Germination rate index = Germination index / Total germination percentage (Decimal)

Field emergence (%): On the fifteenth day after sowing seeds, the capacity of the seed for emergence was carried out by counting the seedlings emerged from the soil. Percentages were used to express the field emergence values.

Shoot length (cm): Ten healthy seedlings were used and the average shoot length was determined by measuring the length of each shoot from the collar area to the cotyledon attachment site.

Root length: Ten healthy seedlings were selected, and the average root length was calculated by measuring the length of each individual root.

Seed Vigor Index I: The calculation formula used was Germination (%) multiplied by seedling length, which is the sum of root and shoot length (in cm). This represents the product of the germination rate and the combined length of the roots and shoots.

Seed Vigor Index II*:* It was calculated as follows: Germination (%) x seedling dry weight (g), which is the product of the seed germination percentage and the seedling's dry weight.

Data Analysis:

The data were analyzed using the Statistical Analysis System (SAS) software, version 9.4 (SAS Institute, 2008). Separate analyses of variance (ANOVA) were conducted for each individual storage period. A combined analysis of variance across storage periods was conducted, as the homogeneity of variance test indicated no significant difference at the 5% level of significance. To compare means, the least significant difference (LSD) test was applied at the 5% probability threshold.

RESULTS

Germination Percentage:

The seeds stored for 12 months in polythene bag packaging material recorded the highest mean germination percentage (99.3). However, the lowest mean germination percentage (58.67) was recorded with nylon sack packaging materials stored for 24 months (Table 1). The mean germination percentage (81.40) was significantly ($p<0.0001$) influenced by the combined effects of the storage duration and the packaging materials used.

Germination index:

The analysis of variance showed that the mean germination index (3.30) was significantly ($p<0.05$) affected by the interaction between storage period and packaging materials. Seeds stored for 12 months in polythene bag packaging material recorded significantly maximum germination index (4.17). Whereas the minimum germination index (2.43) was recorded from seeds

stored for 24 months in nylon sack packaging materials (Table 1).

Germination rate index:

The mean germination rate index (0.041) was significantly affected ($p<0.05$) by the type of packaging materials used, while neither the storage duration nor their interactions showed a significant impact. Numerically, the highest germination rate index (0.042) was observed in seeds stored for 12 months in polythene and aluminum bag packaging. However, the other packaging materials had the same germination rate index value (0.041) for the storage periods of 12 and 24 months (Table 1).

Field emergence percentage:

The mean field emergence percentage (82.33) was significantly ($p< 0.001$) affected by the interaction between storage duration and packaging materials. The maximum field emergence percentage (90.67) was recorded from the 12-month storage period with packaging materials of polythene bags; whereas the minimum field emergence percentage (76.33) was recorded from the 24-month storage period with packaging materials of nylon sacks (Table 2).

Shoot length:

The mean length of the shoot (9.98 cm) was highly significantly affected ($p<0.0001$) by the main effects of the storage period and the packaging materials. Seeds stored both 12 and 24 months with polythene bags recorded the longest shoot length (10.87 cm). On the other hand, seeds stored for 24 months with cloth bags scored the shortest length of shoot (8.6 cm) (Table 2).

Root length:

The mean root length (3.95 cm) was not significantly affected by the main and interaction effects of packaging materials and storage periods.

Seed vigor index I and II:

The mean seed vigor index I (1143.53) was significantly ($p<0.001$) influenced by the interaction effects of the packaging materials and the storage period. Maximum seed vigor index I (1467.4) was recorded from 12-month storage

Table 1. Mean values of germination percentage, germination index, and germination rate index at Sirinka from June 2019 to June 2021

Treatments		Variables		
		Germination percentage	Germination index	Germination rate index
Storage period		**	**	ns
12 months		92.47[a]	3.76[a]	0.041
24 months		70.33[b]	2.85[b]	0.041
LSD (5%)		1.59	0.15	0.0003
Packaging Materials		**	**	*
Polythene bags		88.00[a]	3.63[a]	0.0418[a]
Aluminum bags		87.33[a]	3.58[a]	0.0415[ab]
Cloth bags		77.83[b]	3.10[b]	0.0413[ab]
Glass jars		77.50[b]	3.15[b]	0.0411[b]
Nylon sacks		76.33[b]	3.07[b]	0.0410[b]
LSD (5%)		2.51	0.24	0.001
Storage period * Packaging materials		**	*	ns
12 months	Polythene bags	99.33[a]	4.17[a]	0.042
	Aluminium bags	92.67[b]	3.80[b]	0.042
	Cloth bags	88.00[c]	3.60b[c]	0.041
	Glass jars	88.33[c]	3.50[bc]	0.041
	Nylon sacks	94.00[b]	3.70[bc]	0.041
24 months	Polythene bags	76.67[e]	3.07[de]	0.041
	Aluminium bags	82.00[d]	3.37[cd]	0.041
	Cloth bags	67.67[f]	2.66[f]	0.041
	Glass jars	66.67[f]	2.77[ef]	0.041
	Nylon sacks	58..67[g]	2.43[f]	0.041
SD		13.16	0.59	0.001
LSD (5%)		3.55	0.34	0.001
CV (%)		2.56	6.13	1.08

Where: SD = standard deviation, LSD (5%) = the least significant difference at 5%, CV (%) = coefficient of variation, ns = non-significant, * significant. Means with common letters within the column do not differ significantly ($p\geq 0.05$).

period with packaging materials of polythene bags; however, the minimum seed vigor index (771.53) was recorded from 24-month storage period with nylon sack packaging materials (Table 3). The mean seed vigor index II (8.34) was significantly ($p<0.05$) affected by the interaction effects of the storage period and the packaging materials. The highest seed vigor index II (9.93) was recorded from a one-year storage period with packaging materials of polythene bags; however, the lowest seed vigor index II (5.87) was recorded from a two-year storage period with packaging materials of nylon sacks (Table 3).

DISCUSSION

The current study's finding that the lowest seed germination percentage and germination index was recorded in those stored in nylon sacks could be due to the moisture-pervious nature of nylon sacks compared to the other packaging materials. Onion seeds also quickly lose viability due to their hygroscopic nature or capacity to absorb moisture from their surroundings. Because there is more seed leachate when storage times are extended, degradation rates rise. It most likely explains why there was less germination due to the higher rate of high seed moisture content. The seeds may have had a shorter shelf life due to their higher moisture content, and as the amount of storage time increased, the quality metrics likewise declined. According to Baldaniya et al., (2018) the combination of storage containers and durations had a substantial impact on onion seed germination percentage, germination index and germination rate index. This study observed the highest percentage of germination (87%) in seeds wrapped in polythene bags and kept in ambient storage for up to three months. Furthermore, Patel et al. (2012) showed that both the type of packaging materials and the length of storage significantly influenced the germination percentage and germination index of onion. Among the onions kept in polythene bags for three and six months, the authors found that the greatest proportion of germination was viable. According to the authors, seeds that were kept in a polythene bag for three months showed the highest mean percentage of germination; after six months, this percentage started to decrease. Onion seeds

Table 2 Effects of the storage period and types of packaging materials on field emergence %, shoot length and root length of onion seedlings at Sirinka from June 2019 to 2021

Treatments		Variables		
		Field emergence %	Shoot length (cm)	Root length (cm)
Storage period		**	**	ns
12 months		9.11^{a}	10.40^{a}	3.91
24 months		7.17^{b}	9.57^{b}	3.98
LSD (5%)		0.41	0.25	0.42
Packaging materials		**	**	ns
Polythene bags		8.80 ^{a}	10.65^{a}	3.97
Aluminium bags		8.73 ^{a}	10.25^{b}	3.78
Cloth bags		7.78 ^{b}	9.35^{d}	4.02
Glass jars		7.97 ^{b}	9.98^{bc}	3.92
Nylon sacks		7.40 ^{b}	9.68^{cd}	4.05
LSD (5%)		0.65	0.39	0.65
Storage period * Packaging materials		**	**	ns
12 months	Polythene bags	90.67^{a}	10.87^{a}	3.90
	Aluminium bags	85.00^{b}	10.57^{ab}	3.63
	Cloth bags	83.33^{bc}	10.07^{bcd}	3.97
	Glass jars	84.33^{b}	10.27^{bc}	3.97
	Nylon sacks	82.33^{bc}	10.23^{bcd}	4.07
24 months	Polythene bags	82.67^{bc}	10.43^{abc}	4.03
	Aluminium bags	82.00^{bc}	9.93^{cd}	3.93
	Cloth bags	77.33^{d}	8.63^{e}	4.07
	Glass jars	79.33^{cd}	9.70^{d}	3.87
	Nylon sacks	76.33^{d}	9.13^{e}	4.03
SD		4.42	0.70	0.47
LSD (5%)		4.02	0.55	0.93
CV (%)		2.86	3.23	13.87

Where: SD= standard deviation, LSD (5%) = the least significant difference at 5%, CV (%) = coefficient of variation, ns=non-significant, * significant. Means with common letters within the column do not differ significantly ($p\geq 0.05$).

stored in polythene bags exhibited greater germination (79.77%) over 24 months, exceeding the minimal seed certification level, compared to those packed in cloth bags (79.10%) for only four months (Patel et al., 2017). The current study also showed that onion seed germination (76.67 %) was recorded for seeds stored in polythene bags in 24 months, while in cloth bags the germination was reduced to (67.67 %). Polythene bags provide better moisture protection and prevent spoilage, thus they were ideal for storing onion seeds for a longer period than cloth bags.

Seeds packed in nylon sacks recorded lower field emergence compared to those in polythene bags, aluminum bags and glass jars. The utilization of these containers is crucial in inhibiting the ingress of vapor from the ambient environment. This approach effectively aids in maintaining a reduced moisture level in the seeds through the use of vapor-impermeable containers. During the storage phase, a decrease in moisture content and temperature contributes to a lower respiration rate and metabolic activity. Doijode (1995) observed similar results in onions, stating that seeds dried to an optimal moisture level, stored in aluminum foil, and kept for seven years showed improved germination and vigor. Likewise, Saxena et al. (1987) reported comparable findings in several crops, including onion, cabbage, radish, okra, and pea, while Padma and Reddy (2002) documented similar outcomes in brinjal. Both polythene bags and aluminum foil served effectively as vapor barriers, facilitating the maintenance of lower moisture levels in the seeds.

The study revealed that the greatest shoot length was recorded for seeds stored in polythene bags. This might be due to the fact that cloth bags absorb surrounding moisture more easily than polythene bags. As a result, onion seeds stored in cloth bags lose their quality more quickly than in polythene bags. This finding agreed with Baldaniya et al., (2018), which showed that the longest shoot length (6.31 cm) of onion was recorded from seeds packed in polythene bags and stored for a period of three months, while the shortest shoot length (1.97 cm) was recorded from 9 months of storage in cloth bags. Patel et al., (2017) reported that onion seeds packed in polythene bags recorded a longer

Table 3. Effects of storage period and types of packaging materials on onion seed vigor index I and seed vigor index II at Sirinka from June 2019 to 2021

Treatments		Variables	
		Seed vigour index I	Seed vigour index II
Storage period		**	**
12 months		1323.93[a]	9.11a
24 months		963.12[b]	7.17[b]
LSD (5%)		50.73	0.41
Packaging materials		**	**
Polythene bags		1304.93[a]	8.80 [a]
Aluminium bags		1226.13[a]	8.73 [a]
Cloth bags		1047.17 [b]	7.78 [b]
Glass jars		1081.23 [b]	7.97 [b]
Nylon sacks		1058.17[b]	7.40 [b]
LSD (5%)		80.207	0.65
Storage period * Packaging materials		**	*
12 months	Polythene bags	1467.40[a]	9.93[a]
	Aluminium bags	1315.67[b]	9.27[ab]
	Cloth bags	1234.27[bc]	8.80[bc]
	Glass jars	1257.53[b]	8.60[bc]
	Nylon sacks	1344.80[b]	8.93[bc]
24 months	Polythene bags	1142.47[c]	7.67[de]
	Aluminium bags	1136.60[c]	8.20[cd]
	Cloth bags	860.07d[e]	6.77[ef]
	Glass jars	904.93[d]	7.33[de]
	Nylon sacks	771.53[e]	5.87[f]
SD		227.76	1.23
LSD (5%)		113.43	0.92
CV (%)		5.82	6.67

Where: SD = standard deviation, LSD (5%) = the least significant difference at 5%, CV (%) = coefficient of variation, ns = non-significant, * significant. Means with common letters within the column do not differ significantly ($p \geq 0.05$).

shoot length than onion seeds in cloth bags. Patel et al., (2012) also reported that the highest shoot length was recorded from seeds stored for three months and packaging material of polythene bags, while the shortest shoot length was recorded from six months of storage and packaging material of cloth bags.

The root length was not notably influenced by either the main effects or the interaction effects of the storage durations. Numerically, the longest root length (4.1 cm) was recorded from one- and two-year storage periods with packaging materials of nylon sacks and cloth bags, respectively. The results of this study differ from those of Baldaniya et al. (2018), who found that onion seeds stored in polythene bags for three months exhibited the greatest root length (3.08 cm). In contrast, the shortest root length (1.08 cm) was observed in seeds stored in cloth bags for nine months. Patel et al., (2017) also reported that onion seeds packed in polythene bags recorded longer root length than those packed in cloth bags. In addition, (Patel et al., 2012) showed that the longest root length was recorded from three months and the packaging material of the polythene bags, whereas the shortest root length was obtained from nine months of storage and the packaging material of cloth bags**.**

According to the current investigation, types of packaging materials and storage period influenced both seed vigor index (I), seed vigor index (II) and field emergence percentage. Baldaniya et al., (2018) reported that the highest seed vigor index I was recorded from a storage period of 3 months with packaging material of polythene bags and the lowest seed vigor index was recorded from nine months of storage with packaging material of cloth bags. Patel et al., (2017) also indicated that onion seeds packed in polythene bags recorded higher seed vigor index I than those in cloth bags. According to Baldaniya et al., (2018), the highest seed vigor index II was recorded from a storage period of 3 months with polythene bag packaging material and the lowest seed vigor index II was recorded from a storage period of 9 months with packaging material of cloth bags. According to Patel et al. (2017), onion seeds stored in polythene bags demonstrated a higher seed vigor index II compared to those stored in cloth bags.

In conclusion, the findings of this study indicate that both the type of packaging material and the duration of storage significantly influence the germination percentage, rate, index, as well as the field emergence capacity of onion seeds. The seed quality parameters showed a decreasing trend with longer storage periods regardless of the packaging materials. Among packaging materials, polythene bags exhibited a higher germination percentage and field emergence percentage when onion seeds were stored for a 12-month period. Based on the findings, it can be inferred that onion seeds can be preserved in polythene bags for up to one year without considerable deterioration in seed quality.

Acknowledgements:

The corresponding author extends gratitude to the Sirinka Agricultural Research Center for their financial support of this research.

Funding:

This study was funded by the Sirinka Agricultural Research Center.

Data availability statement:

The datasets used in this study are available from the corresponding author upon reasonable request.

Declarations:

Ethics approval and consent to participate:

Not applicable.

Consent for publication:

The authors have provided their consent for publication.

Competing interests:

The authors affirm that they have no conflicts of interest.

References:

Alhamdan, A. M., Alsadon, A. A., Khalil, S. O., Allah, M. A., Nagar, M. E., Nagar, M. E., & Ibrahim, A. A. (2011). Influence of storage conditions on seed quality and longevity of four vegetable crops. *American-Eurasian Journal of Agriculture and Environmental Sciences, 11*(3), 353-359.

Amjad, M., & Anjum, M. A. (2002). Evaluation of physiological quality of onion seed stored for different periods. *International Journal of Agriculture and Biology, 4*(3), 365-369.

Baldaniya, N. K., Kalyanrao, A. P., Karjule, D. A., & Patel, D. A. (2018). Effect of containers and duration on seed quality of onion under ambient storage conditions. *Seed Research Journal, 45*(2), 1-4.

Bassett, M. J. (1986). *Breeding vegetable crops.* AVI Publishing Co. Inc.

Caneppele, M. A. B., Allvarenga, R. F. D. A., Junior, G. M., & Cardoso, A. A. (1995). Influence of packaging, environment, and storage period on seed quality in onion (*Allium cepa* L.). *Revista Brasileira de Sementes, 17*, 249-257.

Central Statistical Agency [CSA]. (2021). *The Federal Democratic Republic of Ethiopia central statistical agency agricultural sample survey.* Statistical bulletins. Addis Ababa, Ethiopia.

Doijode, S. D. (1995). Effect of silica gel and storage containers on viability and vigor in onion. *Seed Research, 18*, 163-165.

Currah, L., & Msika, L. (1994). Cheap methods of storing small quantities of onion seeds without refrigeration. *Onion Newsletter for the Tropics, 6*, 61-62.

Horky, J. (1988). Long-term storage of vegetable seeds at room temperature in different wrapping materials. *Sbornik, Zahradnictvi, 15*, 257-269.

International Seed Testing Association [ISTA]. (1985). International rules for seed testing. *Seed Science and Technology, 13*, 299-335.

Patel, J. N., Sasidharan, N., Chakraborty, S., Aher, B., Kumari, K., Thakare, I., & Limbachiya, G. (2013). Effect of different storage materials and storage periods on the germination of onion seeds (*Allium cepa* L.). *Research Journal of Agricultural Sciences, 3*(6), 1180-1182.

Kumari, P., Kumar, S., Tadava, T. P., Banerjee, M. K., & Dahiya, O. S. (2001). Efficacy of various containers in maintaining seed quality of onion (*Allium cepa* L.). *Agriculture Research, New Series, 22*(2), 171-176.

Lemma, D., & Shimeles, A. (2003). *Research experiences in onion production research report No. 55*. Ethiopia Agricultural Research Organization, Addis Ababa, Ethiopia.

Muluneh, B. E., Mosissa, C. A., & Bikila, O. F. (2019). Major onion (*Allium cepa* L.) production challenges in Ethiopia: A review. *Journal of Biology, Agriculture and Healthcare, 9*(7), 22-32. https://doi.org/10.7176/JBAH

Mumtaz, K., Javed, I., Abbas, M., Raza, H., Waseem, R., & Ali, A. (2004). Loss of vigour and viability in aged onion (*Allium cepa* L.) seeds. *International Journal of Agriculture & Biology, 6*(5), 834-837.

Padma, V., & Reddy, M. B. (2002). Storage of brinjal seed under ambient conditions at two moisture levels. *Journal of Research, Angrau, 30*(2), 6-10.

Patel, J. N., Sasidharan, N., Chakraborty, S., Aher, B., Kumari, K., Thakare, I., & Limbachiya, G. (2012). Effect of different storage materials and storage periods on the germination of onion seeds (*Allium cepa* L.). *Research Journal of Agricultural Sciences, 3*(6), 1180-1182.

Patel, C. A., Babariya, J. S., Sondarva, K. H., & Bhatiya, V. J. (2017). Effect of storage conditions, packing materials, and seed treatments on viability and seedling vigour of onion (*Allium cepa* L.) seeds. *Journal of Applied and Natural Science, 9*(2), 1054-1067.

Sirinka Agricultural Research Center [SARC]. (2009). *Sirinka Agricultural Research Center progress report*. Sirinka, Ethiopia.

SAS Institute. (2008). *SAS 9.4 copyright 2002–2008*. Cary, NC: SAS Institute Inc.

Saxena, O. P. (1994). Physiological and biochemical changes in relation to storage in some crop seeds. *Seed Technology News, 29*, 24.

Saxena, O. P., Singh, G., Pakeeraiah, H., & Pandey, N. (1987). Seed deterioration studies in some vegetable seeds. *Acta Horticulture., 215*, 39-44.

Shelar, V. R., Patil, R. B., & Gawade, N. D. (1992). Onion seed viability influenced by different storage containers. *Onion Newsletter for the Tropics, 4*, 39-42.

Thirusendura Selvi, D., & Saraswathy, S. (2018). Seed viability, seed deterioration, and seed quality improvements in stored onion seeds: A review. *The Journal of Horticultural Science and Biotechnology, 93*(1), 1–7.

Publisher's Note:

Abyssinia publisher from Wollo University remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.