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# Maize Seed Quality Evaluation at the Temperature Room Storage with Open Package Condition

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**ABSTRACT**

Traditional farmers do seeds storage simply by putting it on the floor of their home without a specific treatment. The seed quality testing carried out in several varieties was stored at room temperature with open packaging condition to determine the viability and vigor. The experiment was conducted in ICERI, Maros, South Sulawesi from May 2014 to January 2015. Research was arranged in a randomized complete design with four replications. Seeds were taken from ICERI seed storage warehouse. Furthermore, seeds were stored in temperature room with an open packaging condition. Parameter observations conducted on moisture content of seed, 1000-grain weight, electrical conductivity, germination, growth rate, primer root length and shoot length. Stored period of seeds in an open package at room temperature shelf life was strongly influenced by previous seed storage and seed weight of current variety. Seed that had long been stored in storage shed and small seed weight would accelerate the decline of physiological seed quality, especially growth rate and percentage of germination. Storage of seeds in an open package at room temperature could maintain quality of the seeds up to 3 months with large grain weight on the varieties and the low water content of the initial storage.

## INTRODUCTION

A successful cultivation in the field is strongly influenced by the use of quality seeds other than the application of proper cultivation techniques. Good quality seed can be obtained by performing an appropriate post-harvest process. Starting from harvesting, drying, selection cob, shelling, grain drying, seed sorting, packaging and storage. Harvesting maize for seed required physiologically ripening, cobs dried until the moisture content of 17-18%, the selection is done by separating the large cob from the small one and diseased. Shelling performed on the selected cob, then dry the seeds to moisture content 10-11%. The sorting is done to separate small and large seeds, then packed using airtight packaging and storage in the low temperature. Oyekale, Daniel, Ajala, & Sanni (2012) stated that during the storage period, protection from exposure to the growth of microorganism and pests, air humidity and temperature is required to maintain the quality of the seeds.

Deterioration of the seed is a process of degradation gradually and cumulative also irreversible as the result of physiological changes due to inside factors. Seed aging decrease seed quality, whereas it has an impact to the declining of seed germination at the initial stage, thus abnormal seedlings occurrence increased due the low growth ability.

Ending stages of seed deterioration is attributed to the significant death of tissues in different seed parts, particularly in meristematic tissues (Marcos-Filho, 2015). Kumar & Kumar Rai (2009) reported that maize seed response to the period of aging varied depend on the period of aging. Seed aging caused a rapid decrease of germination percentage, seed's viability, root length, moisture content, dry matter and vigor index of maize seed. Selvi, Srimathi, & Senthil (2014) revealed that the accelerated maize aging will reduce maximum seed germination depend on the kernel type and color of maize (yellow maize, white

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maize, and purple maize). Yellow maize had higher germination percentage than purple maize during the accelerated seed aging.

To suppress the deterioration of seed quality during storage was required a good seed storage method so that the rate of decline in seed quality can be pressed. Maize seeds classified as orthodox seeds, so extend the shelf should use low temperatures with air-tight packaging and storage initial moisture content was reduced to a safe moisture content for storage.

Sveinsdóttir, Yan, Zhu, Peiter-Volk, & Schubert (2009) stated that when the seed of maize imposed to the aging condition at 45°C for more than 48 hours is the point to begin of the germination decreasing. After 24 hours imposed in the aging condition seed germination decreased to 40% and 70% after 72 hours respectively, and no germination after 168 hours imposed to the aged condition. In ageing conditions, interactions among starch, protein and cell walls increased within the endosperm. Pramesti & Syamsuddin (2015) reported that maize seed stored for 6 months tend to reduce the hypotetic vigor index of the seed from average value of 9.9 to 4.9 due to the seed respiration activity. Furthermore, Rahmawati & Saenong (2010) showed that the storage of maize seed Lamuru, Anoman and Srikandi Kuning-1 varieties which packed with polyethylene plastic, initial moisture content below 11% and stored in plastic silo for 10 months still had germination exceed 85%. Another study of maize seed storage used several initial seed moisture content and different packaging materials (super hermetic bag, paper bag, polypropylene bag, cloth bag, jute bag) resulting various germination rate. The highest germination (85%) of the seed was recorded when stored in hermetic super bag plastic at 8% initial moisture content (Bakhtavar, Afzal, & Ahmed Basra, 2019). Hermetic storage relieve accumulation aflatoxin on the seeds. During the storage time, $CO_2$ was increasing and $O_2$ decreasing inhibiting growth of aerobic yeast, mold, insects and pest (Suleiman, Berna, Brumma, & Rosentrater, 2018).

That technology was difficult to applied in farmers level because of limited facilities. Some farmers do seed storage simply by putting it on the floor in their house without treatment. In addition, some farmers obtain seed from the breeder or other seed producers which are already packed. When planting time, delays often occur because of any particular case. Seeds have been opened from the packaging left without repackaged resulting in a decrease in viability and vigor.

The objective of the study was to determine the viability and seeds vigor impairment during open packaging by placed it in room temperature with open packaging condition. The result of this study was confirmation of the expired time on the open packaging condition seeds after taken from the warehouse.

## MATERIALS AND METHODS

The experiment was conducted in Seed Testing Laboratory, Indonesian Cereal Research Institute, Maros, South Sulawesi from May 2014 to January 2015, arranged by a randomized complete design with four replications. The research was split into two periods. The seed samples were taken from the seed storage warehouse of and stored in room temperature with open packaging condition. Maize seeds sample in the first study were Lamuru variety (9 months storage), Srikandi Kuning variety (19 months months storage), Anoman variety (11 months storage). Furthermore, the second study involved Anoman, Bisma, Lamuru variety storage in seed warehouse for 2 months. In the first study, the storage temperature ranges were kept between 28-31$^{o}$C and the relative humidity ranged from 58-68%, while in the second study the storage temperature ranged between 28-32$^{o}$C and the relative humidity ranges were from 44-70%. The first study observations was conducted at 0, 2, 4, 6, 8 and 10 weeks after the packaging was opened while the second study was conducted at 0, 1, 2 and 3 months after the packaging was opened. The parameter observations were the seed moisture content, 1000-grain weight, electrical conductivity, germination, growth rate, root length and shoot length.

### Moisture Content

Moisture content measurement was carried out on seed samples tested, using a water content measuring device models Kett PM-400.

### 1000-Grain Weight

1000-grain weight of seed was done by taking samples randomly, then counted the seeds in 1000 and subsequently weighed using electric scales.

**Electrical conductivity (EC)**

Electrical conductivity was observed with a conductivity meter. Twenty five seeds were taken randomly and then each was weighed, washed and soaked in deionized water for 24 hours with a water volume of 75 ml in a glass bottle, then it was measured using conductivity meter.

**Germination**

Prepared two sheets of paper that had been wetted and covered with plastic. The seeds were then sown in the top half of the paper. Furthermore, the other half of the paper closed with the seed that had been planted, then rolled and labeled (the date of planting, the seed code and replication number). Germinating used a room germinator and was observed. Each observation, normally sprouts grow was calculated and moldy/rotten seeds were counted and discarded. The test was carried out using 4 replications, each replication using 100 grains of maize consisted of two media rolls (1 roll of 50 seeds).

**Growth Rate**

The data obtained from the test substrat seed germination result. In the each observation, the percentage of normal seedling was divided by etmal (24 hours). Etmal cumulative value was obtained when the seeds were sown until the time of observation. The growth rate was calculated with the following formula:

$$GR = \frac{\sum(X_i - X_{i-1})}{T_i} \quad \text{.................................................1)}$$

Where: GR = Growth Rate, $X_i$ = Percentage of normal germinate at the etmal i, $T_i$= Time of observation (etmal).

**Root Length**

The primary root length measurement was done by using gauges/ruler. Sprouts roots were stretched then measured from the base to the tip of the root.

**Shoots Length**

Measuring the length of shoots was done using gauge/ruler. Shoots were stretched then measured from the base to the tip of the leaf.

**Data Analysis**

The collected data was analyzed using SAS 9.3 program, significant different data will be tested further using DMRT (Duncan Multiple Range Test).

## RESULTS AND DISCUSSION

**Moisture Content**

Seed quality is strongly affected by moisture content, particulary if the seeds are stored in a long term. Maize is an orthodox seed group, which require low water content during storage process. Storage of seeds ought to control the environmental condition. The availability of water is one condition to activate biological and biochemical process to damage seed. Controlling the seed storage environment is required to ensure the temperature surrounding air remain low, therefore the seed storage should use low grain moisture content (Jayas & White, 2003). Temperature and moisture content are among the major factor influence the quality of the seed besides biochemical process, duration of storage time, the loss of dry matter and overall storage management of the grain (Gonzales, Armstrong, & Maghirang, 2009; Lawrence & Maier, 2010). Samuel, Saburi, Usanga, Ikotun, & Isong (2011) reported that under tropical condition, there should be moisture content exchanges among seed and peripheral transpire up to the equilibrium point. When the temperature is high, afterward water vapor will occur and trigger the biological and biochemical activity of the seeds thus low moisture content is preferred to maintain seed quality. The average moisture content, 1000-grain weight and electrical conductivity of Anoman, Srikandi Kuning and Lamuru varieties during the open packaging stored at room temperature is shown in Table 1.

The increase of seed moisture content during open packaging treatment affected by the condition of storage space. In the first study the condition of store space had a temperature range from 28-31$^{o}$C and relative humidity ranges from 58-68%, while the second study the condition of store space had a temperature range from 28-32$^{o}$C and relative humidity ranges were from 44-70%. At the second study humidity greatly varied from low to high due to seed storage treatment held at the end of the dry to the rainy season. Surki, Sharifzadeh, & Afshari (2012) stated that unfavorable storage conditions, especially temperature and humidity, accelerating damage to the seed during storage. Stored maize are hygroscopic and tend to absorb or emit water (Suleiman, Rosentrater, & Bern, 2013). During a certain time there will be equilibrium moisture content of seeds. Relative Humidity (RH) conditions of environment greatly affects the occurrence of moisture balance.

The absorption process in the seed maize was faster than a desorption (release) of water vapor from the seed. Chattha, Lee, Mirani, & Hasfalina (2014) reported that storage type and duration exhibited a significant effect on the temperature and equilibrium moisture content of stored seed. Seed storage at that the equilibrium moisture content of maize seed can be obtained at 50 days of storage at 80% RH and the average temperature of 36$^{o}$C. Storage of 12 months showed a slightly increasing in moisture content magnitude from 14.4$^{o}$C to 15.04$^{o}$C. Similar result was obtained by Sawant, Patil, Kalse, & Thakor (2012) who reported that after 5$^{th}$ month of wheat storage up to 12$^{th}$ month, the temperature of grains was observed increased from the optimal temperature. Samuel, Saburi, Usanga, Ikotun, & Isong (2011) also argued that the maize harvested in the tropics, after drying to certain moisture content, when placed in open air, the water content of seeds exchanged with the environment until it reaches the equilibrium moisture content.

### 1000-Grain Weight

Each maize variety had different grain weight and was influenced by genetic factors. The observation result of the grain weight in the first study (Table 1) showed the average seed weight each varieties stable during open package stored at room temperature, while in the second study (Table 2), seed weight increased during the storage period. Seed weight increased influenced by the increase of moisture content (Table 2), whereas in the first study (Table 1) moisture content increase obtained doesn't effect to changes in seed weight. The average moisture content increase of the seeds since the beginning to the termination of the storage period in the first study was lower than the second study.

**Table 1.** Average moisture content, 1000-grain weight and electrical conductivity of Anoman, Srikandi Kuning and Lamuru varieties during the open packaging stored at room temperature (first study)

| Variety | Storage period (weeks) | Moisture content (%) | 1000-grain weight (g) | Electrical conductivity (µS/cm/g) |
|---|---|---|---|---|
| Anoman | 0 | 11.00def | 267.90de | 14.59ab |
| | 2 | 12.50a | 262.67e | 12.69ab |
| | 4 | 12.00abc | 268.98cd | 14.85ab |
| | 6 | 11.83abcd | 267.83de | 16.59a |
| | 8 | 12.23ab | 267.70de | 14.24ab |
| | 10 | 12.53a | 269.73bcd | 12.23bc |
| Srikandi Kuning | 0 | 11.23cdef | 271.60bcd | 8.22d |
| | 2 | 11.63a-e | 271.57bcd | 7.63d |
| | 4 | 11.63a-e | 272.15bcd | 8.87cd |
| | 6 | 11.47b-f | 272.80bcd | 5.96de |
| | 8 | 11.57a-e | 274.27bc | 5.40de |
| | 10 | 12.07abc | 275.00b | 6.68de |
| Lamuru | 0 | 10.57f | 307.60a | 6.77d |
| | 2 | 11.93abcd | 310.40a | 5.28de |
| | 4 | 11.57a-e | 308.86a | 7.53d |
| | 6 | 11.20cdef | 309.63a | 6.50d |
| | 8 | 10.70ef | 308.97a | 6.56d |
| | 10 | 12.40ab | 307.33a | 6.70d |
| CV (%) | | 4.26 | 1.06 | 25.19 |

Remarks: Means in each column, followed by different letters are significantly different at 5% probability level using duncan test; CV = Coefficient of Variance

The result study of Seifi & Alimardani (2010) reported that the 1000 maize grain weight increased from 271 to 321 g concomitant with the increasing moisture content of 4.73 to 22% wet basis, and the result study of Shirkole, Kenghe, & Nimkar (2011) also showed 1000-grain weight of soybean seed cultivar TAMS-38 and JS-335 increased with increasing moisture content. TAMS-38 increased moisture content of 7.30% to 30.80% and the weight of 1000-grain of 124.2 g to 154.4 g. Similarly, the JS-335 varieties moisture content was increased from 7.35% to 30.70% (based on dry weight) and the weight of 1000 grain was increased from 103.5 g to 137.3 g respectively.

**Electrical Conductivity (EC)**

The observations of electrical conductivity in the first study (Table 1) shows that there is no difference between the storage period for all varieties, but the electrical conductivity at Anoman varieties is different from Srikandi Kuning and Lamuru. Anoman variety had a lower shelf life in the barn (11 months) compared to Srikandi Kuning (19 months). Anoman seed variety had lower weight than other varieties so it rapidly deteriorated during storage, but the electrical conductivity was obtained good. Biochemical and metabolic alterations may be associated with the loss of membrane integrity and accelerate seed properties. The decreased seed viability in several species is caused by dissappereance of cell membrane integrity resulting in electrolyte leakage which triggers the increase of electrical conductivity due to seed leaching (Mira, Estrelles, González-Benito, & Corbineau, 2011).

In the second study (Table 2) shows that there was difference in electrical conductivity in the storage period of 0 and 3 months on Anoman and Bisma varieties, while Lamuru variety does not show any different on electrical conductivity between the storage period of 0 and 3 months, although Anoman, Bisma and Lamuru had the same shelf life (2 months). Lamuru is a maize variety that has a large enough grain weight so as to maintain its quality despite experiencing deterioration process of seeds. Keep moisture content high seed will accelerate the deterioration of seed. At 3-month storage period, the moisture content of Lamuru was lower than Anoman and Bisma. Sivritepe, Senturk, & Teoman (2015) observed various factors that influence the electrical conductivity measurement such as differences in the amount of electrolyte leakage in different species, test period of maize seed, measurement temperature, seed moisture content, seed size and seed amounts. Therefore electrical conductivity test should follow the protocol for determining vigour of maize seeds.

**Table 2.** Average moisture content, 1000-grain weight and electrical conductivity of Anoman, Bisma and Lamuru varieties during the open packaging stored at room temperature (second study)

| Variety | Storage period (month) | Moisture content (%) | 1000 grain weight (g) | Electrical conductivity (µS/cm/g) |
|---|---|---|---|---|
| Anoman | 0 | 9.13e | 250.63h | 3.24e |
| | 1 | 10.50d | 253.27g | 5.27d |
| | 2 | 11.80a | 253.10g | 3.49e |
| | 3 | 12.13a | 256.87f | 9.47b |
| Bisma | 0 | 10.23d | 259.33e | 10.87b |
| | 1 | 11.37b | 262.13d | 11.13b |
| | 2 | 11.93a | 263.77d | 10.82b |
| | 3 | 12.13a | 263.13d | 14.51a |
| Lamuru | 0 | 9.10e | 268.43c | 5.32d |
| | 1 | 10.26d | 276.07b | 6.88cd |
| | 2 | 11.00c | 277.17ab | 7.25c |
| | 3 | 11.30bc | 278.60a | 6.42cd |
| CV (%) | | 2.08 | 0.57 | 14.56 |

Remarks: Means in each column, followed by different letters are significantly different at 5% probability level using duncan test; CV= Coefficient of Variance

**Germination**

Lamuru variety germination did not show any differences between storage period, while Anoman and Srikandi Kuning germination were decreased on 0-10 weeks storage period at room temperature in the first study (Table 3). These three varieties of the Anoman and Srikandi Kuning germination percentage decreased rapidly compared to Lamuru, and both varieties shelf life longer than Lamuru varieties. Otherwise Lamuru seed weight was greater than both varieties. Moshatati & Gharineh (2012) stated that 1000-grain weight was the important scale in the seed quality. Seed size related to the size of the seed embryo and seed storage that give effect to the germination and growth. Mandal, Chakraborty, & Gupta (2010) stated that large seeds brought to a good germination in unfavorable environmental conditions. The varieties of Anoman, Bisma and Lamuru were used in the second study (Table 4) had 2 months long storage in warehouses seed, so it didn't affect the decrease in the percentage of germination. The initial seed quality (seed moisture content, vigor, and germination) under humid tropical conditions in concomitant to seed storability enhancement under various seed storage conditions (Oyekale, Daniel, Ajala, & Sanni, 2012). Furthermore, various response-reactions of seeds indicated the storage potential (Sivritepe, Senturk, & Teoman, 2015) which included germination rate and seedling growth (Marcos-Filho, 2015), glutamic acid decarboxylase activity and the rate of respiration (Sveinsdóttir, Yan, Zhu, Peiter-Volk, & Schubert, 2009). The longer seeds stored, the opportunity to lose food reserves are greater.

The duration of seed saving has an effect on the lost seed reserves. Seed storage time also correlates with germinative responses. The shelf life affects the germination rate, seedling growth, glutamate acid decarboxylase activity and respiration rate.

**Table 3.** Average germination, growth rate, primary root length and shoot length of Anoman, Srikandi Kuning and Lamuru varieties during the open packaging stored at room temperature (first study)

| Variety | Storage period (weeks) | Germination (%) | Growth rate (%/etmal) | Primary root length (cm) | Shoot length (cm) |
|---|---|---|---|---|---|
| Anoman | 0 | 83.33cde | 25.33def | 14.60abc | 8.93a-d |
| | 2 | 78.00def | 22.93g | 15.07ab | 9.37ab |
| | 4 | 75.33ef | 21.82gh | 15.75a | 9.91a |
| | 6 | 72.00f | 19.00i | 13.19b-e | 7.67c-f |
| | 8 | 78.00def | 19.23i | 12.98b-e | 7.18efg |
| | 10 | 72.00f | 16.23j | 11.53d-g | 5.87g |
| Srikandi Kuning | 0 | 91.33abc | 27.63a-d | 12.90b-e | 7.46def |
| | 2 | 90.00abc | 26.17cde | 12.37c-f | 8.33a-f |
| | 4 | 90.00abc | 27.77a-d | 15.77a | 9.05a-d |
| | 6 | 86.67bcd | 23.72efg | 13.63a-d | 7.80b-f |
| | 8 | 78.00def | 19.00i | 13.15b-e | 7.53def |
| | 10 | 78.67def | 19.33hi | 11.05efg | 7.13fg |
| Lamuru | 0 | 98.00a | 29.39ab | 13.65a-d | 8.77a-e |
| | 2 | 96.67ab | 29.03abc | 13.97a-d | 8.47a-f |
| | 4 | 95.33ab | 27.82a-d | 14.45abc | 9.64a |
| | 6 | 95.33ab | 24.37efg | 14.41abc | 9.25abc |
| | 8 | 97.33a | 25.51def | 12.58b-e | 7.80b-f |
| | 10 | 98.67a | 24.76d-g | 12.85b-e | 7.88b-f |
| CV(%) | | 6.04 | 6.47 | 9.75 | 10.08 |

Remarks: Means in each column, followed by different letters are significantly different at 5% probability level using duncan test; CV = Coefficient of Variance

**Table 4.** Average germination, growth rate, primary root length and shoot length Anoman, Bisma and Lamuru maize seed varieties during the open packaging stored at room temperature (second study)

| Variety | Storage period (month) | Germination (%) | Growth rate (%/etmal) | Primary rooth length (cm) | Shoot length (cm) |
|---|---|---|---|---|---|
| Anoman | 0 | 99.50a | 33.15a | 12.44a | 4.36bc |
| | 1 | 99.50a | 33.02ab | 9.90cde | 3.78cd |
| | 2 | 97.75abc | 31.22d | 10.45cd | 3.36d |
| | 3 | 98.00abc | 32.60ab | 9.84cde | 3.53d |
| Bisma | 0 | 97.25abc | 32.38abc | 12.46a | 4.92ab |
| | 1 | 96.75bc | 32.17bc | 11.13bc | 4.80ab |
| | 2 | 96.50c | 31.73cd | 8.89e | 4.39bc |
| | 3 | 93.25d | 30.98d | 9.35de | 5.19a |
| Lamuru | 0 | 98.75abc | 32.92ab | 11.79ab | 4.60ab |
| | 1 | 99.25ab | 33.00ab | 10.84bc | 4.94ab |
| | 2 | 99.25ab | 31.21d | 9.76cde | 3.72cd |
| | 3 | 99.50a | 33.15a | 9.85cde | 4.25bc |
| CV (%) | | 1.59 | 1.71 | 7.89 | 10.37 |

Remarks: Means in each column, followed by different letters are significantly different at 5% probability level using duncan test; CV= Coefficient of Variance

**Growth Rate**

Seed growth rate of Lamuru, Srikandi Kuning and Anoman varieties in the first study (Table 3) decreased at 10 week of the storage period. The growth rate determines the level of a seed vigor. In the first study (Table 3) seeds were used had storage for a long time (9-19 months) so to provide opportunities for seed deterioration. In addition to the storage conditions after open packaging (storage at room temperature 28-31$^{o}$C) and high water content further accelerate the deterioration of seed, it appears that the seed growing rate declined rapidly. Marcos-Filho (2015) reported that the seed moisture content increased the respiration rate. Temperature and high moisture content will accelerate the seeds respiration rate so the faster shake-up of food reserves and gradually reduced food reserves were a source of energy to generate the growing seed. Thus the growth rate of seeds would decrease.

In the second study (Table 4), the varieties of Anoman, Bisma and Lamuru did not indicate a significant decline on growth rate, except the Bisma variety has shown decline in growth rate at three months storage period (30.98%/etmal), however still in a state the good condition. The varieties of Anoman, Bisma and Lamuru had a shelf life in the seed storage for 2 months and there was not much changes happened to food reserves in seeds. This affected to resilience seeds when that was stored in an open package at room temperature.

**Primer Root Length**

The observation of the primary root length in the first study (Table 3), indicated Srikandi kuning and Lamuru had no difference of root length on storage period of 0 and 10 weeks except Anoman. Contras to the first study, the second study (Table 4), shows that the varieties of Anoman, Bisma and Lamuru had different primary root length of the storage period of 0 and 3 months. Seedling root growth was affected by the weight of the seed of a variety. Seeds that have greater grain weight effect the length of the primary root because they provided greater energy to help the root growth. Moshatati & Gharineh (2012) reported that the germination and emergence of shoots requires a amount of energy that was produced from the oxidation process in seeds stored. In the second study (Table 4), the weight of seeds of each variety is small enough so that within 3 months had begun to appear long decline roots, although the percentage of germination and seed growth rate was constantly high.

**Shoot Length**

The result of shoots length observation in the first study (Table 3) and the second study (Table 4) showed a decline shoots length of Anoman variety, while Srikandi Kuning and Lamuru (first study) Bisma and Lamuru (second study) did not show differences of shoots length on 0 and 10 weeks (first study) or 0 and 3 months (second study) storage period. 1000-grain weight of Anoman variety were lower than other varieties, so it affected the length shoots growth. Moshatati & Gharineh (2012) showed the result of sprouts growth (shoot + root), 1000-grain weight affected on sprouts length (shoot + root) and dry weight of sprouts (shoot + root). Weight of 1000 grain provided higher sprouts length (shoot+ root) and at the opposite, a lower 1000-grain weight gave lower sprouts length (shoot + root), as well as the dry weight of sprouts (shoot + root).

## CONCLUSION

Stored period of the seeds in an open package at the room temperature was strongly affected by previous seed shelf life (in the seed storage warehouse) and the variety seeds weight. The old stored seed and light weight seed accelerated the declining of physiological seed quality, particulary the growth speed and percentage of germination. Storage of seeds in an open package at room temperature maintained seeds quality up to 3 months in the condition that the varieties have large seeds and the initial moisture content of storage was low. From the experiment, Lamuru showed as the most resistant variety to be stored at open packaging under room temperature.

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