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The effect of temperature and humidity of storage on maize seed quality

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The effect of temperature and humidity of storage on maize seed quality

Rahmawati and Muhammad Aqil
Indonesian Cereals Research Institute

Email: *wati_syam99@yahoo.com*

Abstract. Orthodox seed storage involves storage conditions under low temperature and humidity. Various factors affecting seed storage include: the initial moisture content of seeds, the use of packaging or an airtight packaging and low temperature storage system. Seed storage using different temperatures and humidity will affect the quality of the seeds during the storage period. Storage using room temperature is very crucial particularly on seeds that have deteriorated during handling process prior to storage. In addition, the rate of seed quality decline is relatively drastic. The use of low temperature and air humidity can keep the viability and vigor of seeds even though it has deteriorated. Thus, the quality of seeds during the storage period is strongly influenced by the quality of the initial seed (before storage), seed moisture content, temperature and humidity during the storage period.

1. Introduction

Seeds play an important role in crop production. Healthy seed will produce high viability and vigor as well as maintaining its purity. Contrarily, non-uniform seeds give poor performance when growing in the field. In order to obtain uniformity of seeds, sortation of the seed must be done by using seed grader based on the seed size. Orthodox seed storage requires storage conditions with low temperature and humidity. Storage of cereal seeds require low seed moisture content and free from fungal infestation. [8]. Reported that in order to maintain the quality of maize during storage, maize should be protected from moisture and temperature, the growth of microorganisms and pest attacks. When the seed storage is carried out for a long period, the seed must be dried until the moisture content falls below 11% and the storage room temperature is preferred below 20°C and 50% humidity. In addition the seed must be packaged using a watertight container [20]. [5], states that seed vigor decreases with increasing water content especially in high temperature environments and high air humidity.

Various research findings indicated that seeds stored with low water content, airtight packaging and storage conditions that facilitated by low temperature and humidity controls will prolong the lifeuse of the seeds. The results of testing the Lamuru variety maize (OPV maize released in Indonesia) seeds stored in seed storage warehouses with temperatures ranging from 18-21°C for 23 months using high density polyethylene plastic packaging still had a germination of higher than 86.50% [10]. Seeds with a storage life of 5 years (Gumarang, Srikandi Kuning and Bisma varieties) still have germination above 90%. The use of polyethylene plastic packaging with a thickness of 0.09 mm and stored at room temperature of 18-21°C with relative humidity of 50-55% can suppress the occurrence of degradation of seed quality both physically and physiologically [9]. In connection to this condition, several research results related to orthodox seed storage need to be reviewed which are influenced by the temperature and humidity of the storage room.



2. Seed and Storage

Seed storage need special treatment to maintain the quality of seeds during the storage period. Various factors that greatly affect the storage of seeds include: the initial moisture content seeds when stored, the use of packaging or an airtight container and storage space with low temperature and humidity. Generally, cereal seeds are stored at a moisture content of around 10-11% with a storage room temperature below 20°C. [12], reported that seed moisture content and storage temperature have a large influence on the viability of stored seeds. In general, seeds can be stored for a longer period considering quality of seed, moisture content, and temperature controlled for long-term storage [2]; [11]. Furthermore, as the seed hygroscopic absorb or release water during storage, controlling the seed condition is crucial [15]. [17] also mentioned that unfavorable storage conditions, especially air temperature and humidity will accelerate the seed damage during storage.

Various equipment are now available and can be used to store the seed. Among the best materials are airtight packaging (laminated plastic bags) and plastic silos with airtight covers. The plastic used as packaging has a thickness of 0.2 mm so that it can prevent the seed from surroundings air. In addition, the packaging must be sufficiently elastic (not too rigid) so that it free from breaking or stacking during handling or storage. The results of the study of [3], indicated that storage of barley seed (pearl millet) at cold temperatures (4°C), after 16 months of storage, viability and germination remained high in seeds stored using plastic packaging (around 80%) compared with cement bag packaging (<20%) and containers made of wood (20% germination and 60% viability).

3. Seed Quality at Room Temperature Storage

Seeds stored at room temperature tend to decrease the viability and vigor of seeds faster than storage at low temperatures. Environmental conditions surrounding the storage will affect the quality of seeds during the storage period. Wet and humid conditions during storage enables seeds to absorb water from the surroundings [1]), increasing water content will accelerate deterioration. Furthermore [18], reported that water content and high temperature increased the attack of *A. flavus* and decreased germination on soybean seeds. Some results of research on storing maize seeds and barley can be seen in figure 1-11. Storage uses room temperature and low temperatures.

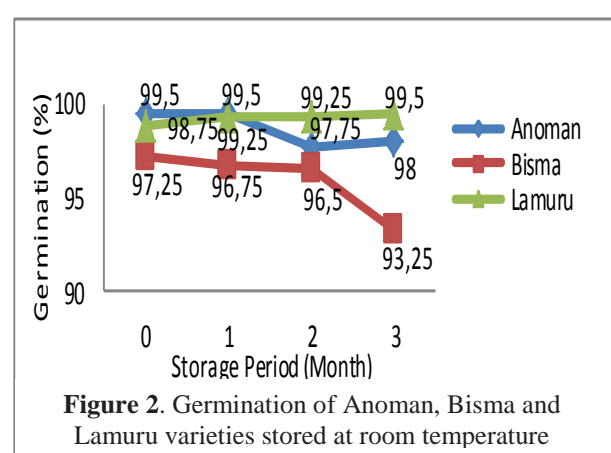
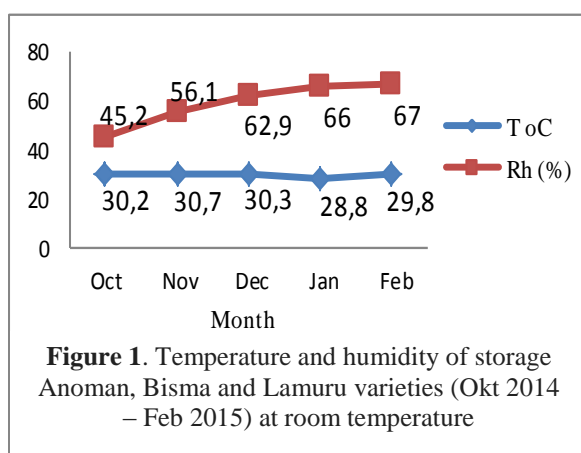
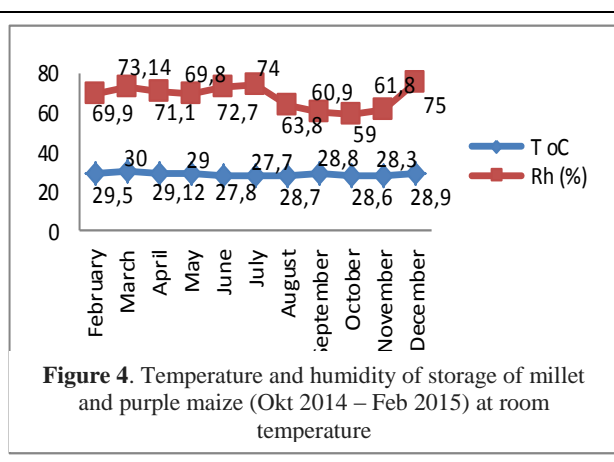
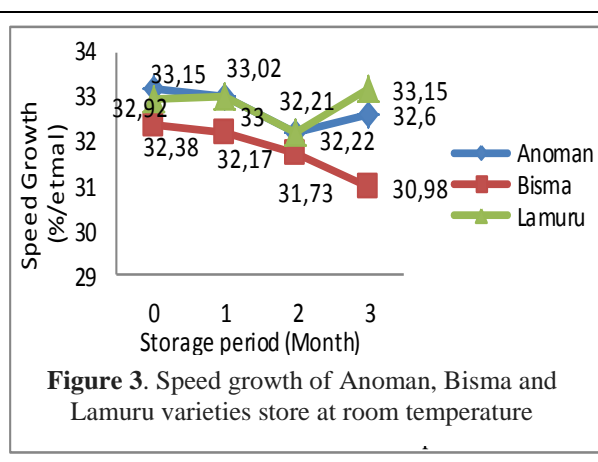
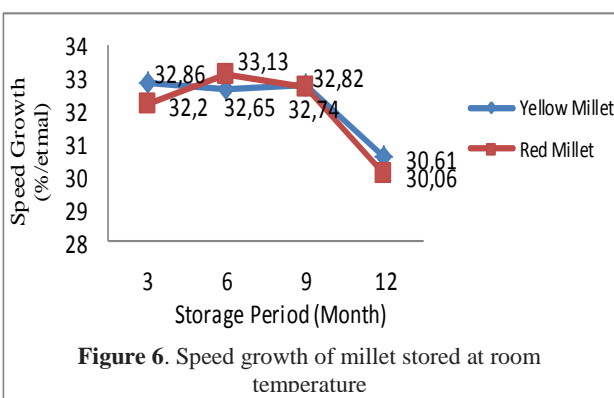
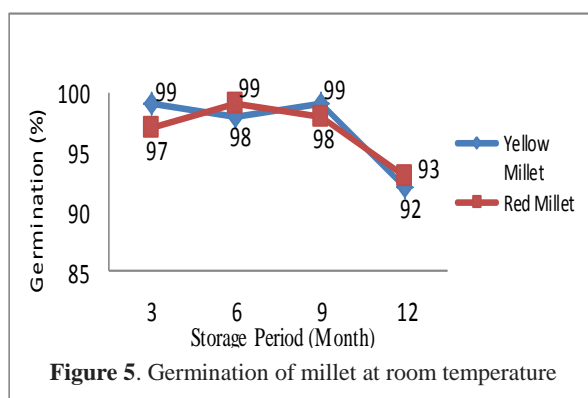


Figure 1 indicated the temperature and humidity of the storing room at OPV maize seed i.e. Anoman, Bisma and Lamuru using plastic packaging. Air humidity during the storage period ranged from 45.2 to 67% and temperatures ranged from 28.8 to 30.7°C. The initial moisture content of the storage period ranged from 9-11%. During the storage period (October 2014 - February 2015), there was an increase in air humidity in the storage room, while the air temperature experienced only a slight decrease. Among these three varieties, Bisma and Lamuru varieties decreased germination, while Anoman kept the germination higher during storage. The decrease in germination that occurred did not

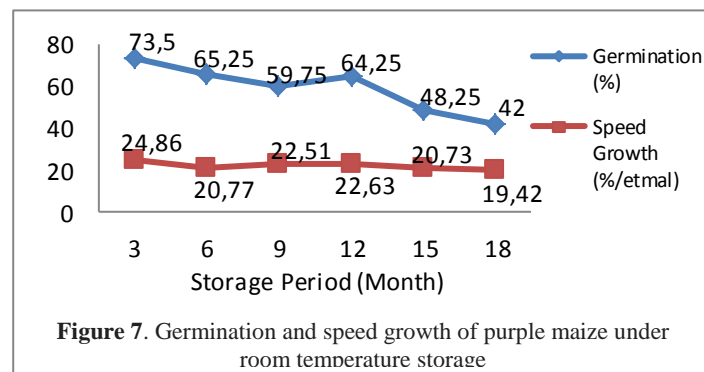
affect seed quality significantly (still above 90%) (Figure 2). In observing the speed of growing seeds also shows similar conditions. The value of seed growth velocity is still above 30% / etmal which means that the seed still has high vigor (Figure 3).



Higher viability and vigor of seeds during room temperature storage are mainly due to the storage conditions and seed quality at the beginning of storage. Genetic seed, the environment in which the seed is produced and the conditions of the storage environment are the three main factors that influence storage time [16]. Low seed moisture content (9-11%) and humidity below 75% can reduce the rate of decline in seed quality for 3 months of storage at room temperature. [17], reported that unfavorable storage conditions, especially air temperature and humidity, accelerate seed damage during storage. The results of [14] study showed that wheat seeds stored at 40°C had a greater decrease in germination and vigor compared to seeds stored at 25°C. Furthermore [7], reported the results of sorghum storage research that seeds stored at room temperature after 9 months had a low germination percentage (10.67 - 28%) except storage using aluminum cans (41.33%).



The results of storage research using plastic packaging and room temperature treatment were also carried out on pearl millet seeds and purple maize. The temperature and humidity of the storage room ranges from 59 - 75% and the temperature ranges from 27.7 - 30°C, while the initial moisture content of the storage period ranges from 11-12%. Storage of pearl millet seeds for a year shows viability and vigor that is still high. This is shown by the germination value above 90% and the rate of growth of seeds above 30% / etmal. This condition is not much different from Anoman, Bisma and Lamuru maize varieties so that during the storage period the rate of decline in seed quality can be suppressed.



Similar storage conditions were also observed for purple maize. Seed quality in term of germination and seed growth rate at the beginning of storage has decreased. Furthermore, germination percentage at the beginning of storage (storage period of 3 months) was 73.5% while the growth rate of seeds was 24.86% / etmal (Figure 7). Seeds with low viability and vigor when stored using room temperature will experience a rapid decline in seed quality. [12], reported that seeds stored at room temperature will reduce the viability rapidly. [6] and [13], also argued that inappropriate storage facility such as storage under room temperature often results in low seed germination, seed deterioration, and the decline of viability during seed storage.

During a longer period of storage i.e. 18 months, purple maize indicated very low germination of 42% and seed growth rate of 19.42% / etmal. [2] and [11] reported that seeds can generally be stored for a long time, depending on the quality of the initial seed, moisture content, and temperature conditioned for long-term storage.

4. Seed Quality During Low Temperature Storage

Storage of seeds under low temperatures can extend the life time use of maize seeds. High temperatures will accelerate respiration quickly so that the faster the changes in food reserves in the seeds that have an impact on the decrease in viability and vigor of the seeds. Low temperature and air humidity will limit the increase of seed moisture content and the rate of respiration of the seeds during the storage period.

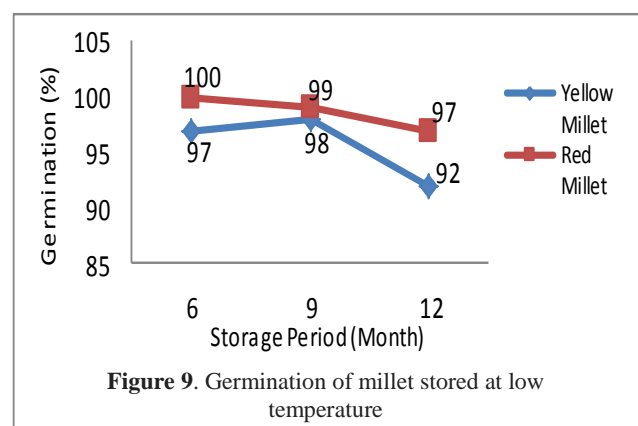
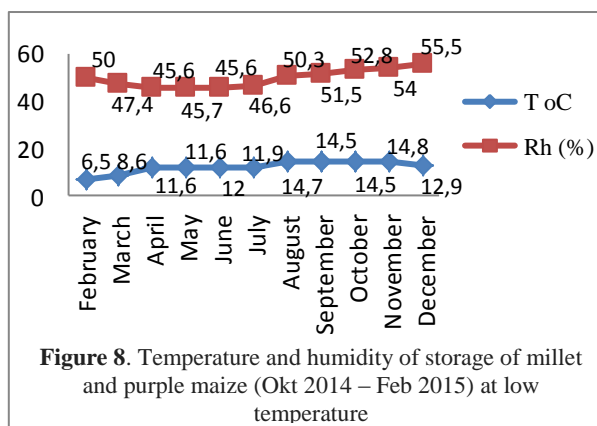
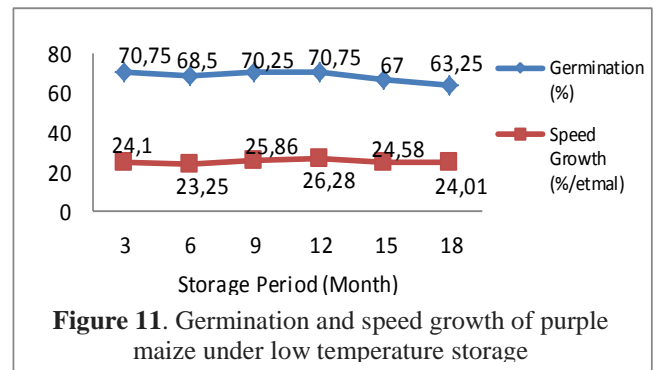
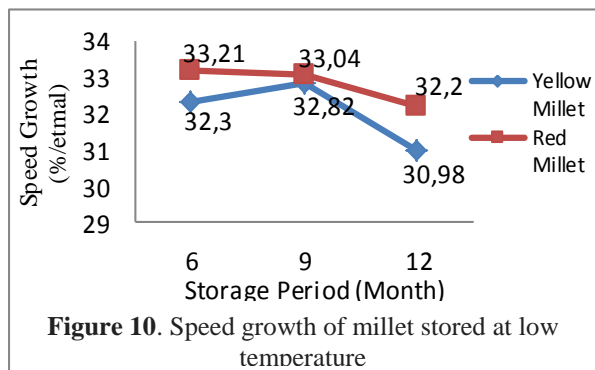


Figure 8 indicated the magnitude of air temperature and humidity of millet and purple maize stored at low temperatures. Air humidity storage varied from 45.6 to 55.5% and air temperature from 6.5 to 14.8°C. The results of the germination test indicated that during 12 months storage, millet seeds

had germination that was still above 90% and seedling growth rate was above 30% / etmal. Viability and vigor of millet seeds has not decreased dramatically.



The same phenomenon was also observed for purple maize seeds (Figure 11), even though at the beginning of seed storage (storage period of 3 months) the seed quality is low but low temperature storage can still maintain seed quality. The results of observation of the germination at an 18-month storage period showed a decrease but not drastically, even though the low germination power value was 63.25% and the seed growth rate was 24.01% / etmal.

Growing speed of seeds during the storing period is almost the same as the value for the 3-month storage period. [19], stated that several studies related to the influence of temperature and humidity on seed viability, and most of the studies proved that the treatment of temperature and low air humidity can prolong the shelf life of seeds. Furthermore [4], stated that soybean seeds which were given storage treatment had higher viability and vigor than soybean seeds which were not treated with low temperature and air humidity. Seeds stored at 15°C and 20°C have higher germination rates than seeds stored at room temperature.

5. Conclusion

Seed storage under different level of temperatures and humidity gives an effect on the seed quality during the storage period. Storage using room temperature is very crucial particularly seeds that indicating deterioration prior to storage, the rate of seed quality decline is quite drastic. The use of low temperature and air humidity can limit the decline in seed viability and vigor even though it has deteriorated. Thus, the quality of seeds during the storage period is strongly affected by the quality of the initial seed before storage, moisture content, temperature and humidity during the storage period.

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