International Journal of Agricultural Sciences and Natural Resources
2015; 2(4): 90-94
Published online July 20, 2015 (http://www.aascit.org/journal/ijasnr)
ISSN: 2375-3773

Keywords
Soybean,
Germination,
Storage Materials,
Environmental Condition

Received: June 20, 2015
Revised: July 2, 2015
Accepted: July 3, 2015

Effects of Storage Materials and Environmental Conditions on Germination Percentage of Soybean (*Glycine Max* (L.) Merr) Seeds in Yola Nigeria

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Citation
Tame V. T., Elam Y.. Effects of Storage Materials and Environmental Conditions on Germination Percentage of Soybean (*Glycine Max* (L.) Merr) Seeds in Yola Nigeria. *International Journal of Agricultural Sciences and Natural Resources.* Vol. 2, No. 4, 2015, pp. 90-94.

Abstract
The experiment was conducted between January 2007 and June 2008 at the Department of Crop Production and Horticulture, Federal University of Technology, Yola to study the effects of storage materials and environmental conditions on germination of soybean seed in the laboratory. The experiment was replicated three times in factorial design. The treatments were five storage materials (bottle, polythene bag, polythene sack, clay pot, and tin), three varieties of soybean (Samsoy II, TGX1019-2E and TGX1448-2E) and two environmental conditions (room and open air temperatures). Data collected were analyzed statistically using Generalized Linear Model (GLM) procedure of SAS and means that were significantly different were separated using Least Significant Difference (LSD). The result revealed highly significant differences ($P \leq 0.01$) among the storage materials on germination. Bottle maintained significantly higher germination with 71 % after 360 days in storage and declined to 66, 57 and 42 % at 420, 480 and 540 days in storage, respectively as compared to the rest of the storage materials. Samsoy II recorded significantly higher germination with 72% at 360 days in storage and declined to 58 and 42 % after 420 and 480 days in storage, compared to TGX1019-2E and TGX1448-2E. Room temperature recorded significantly higher germination percentage with 52 % after 420 days in storage as compared to open air temperature that had 39 %. From this study, it can be concluded there are variation among soybean varieties in storage in respect to germination. Also, bottle and polythene bag showed better result with higher germination percentage during storage.

1. Introduction

Seed germination is the resumption of active growth of the embryo that results in the rupture of the seed coat and the emergence of the young plant (Tame, 2011). Seed quality is affected during pre and post-harvest period (Walters *et al*., 2005). Soybean seed reaches its maximum potential for germination and vigour at physiological maturity. The germination potential is very short lived in soybean as compared to other oilseed crops and is often reduced prior to planting time (Agha *et al*., 2004). This loss of germination is much more acute under tropical conditions (Tatipata, 2009). These environmental conditions make maintenance of soybean seed viability during storage very difficult.

Such deteriorated seed is one of the basic reasons for low productivity in soybean (Adebisi *et al*., 2004).

Seed viability and the rate of seed deterioration have been extensively investigated (Kundu and Kachari, 2000; Walters *et al*., 2005). The goal was to develop a means of preserving and predicting seed quality during seed storage (Sajo and Tame, 2012). From a quantitative view point, seed deterioration can best be defined as an increased probability of death of an individual seed as deterioration proceeds (Tang *et al.*, 2000). Seed death is indicated by the failure to germinate and seed longevity is the period until seed death occurs (Hay *et al*., 2003; Mollah *et al.*, 2002; Sacande *et al*., 2000). In a research conducted by Mettananda *et al.* (2001), most seed lots failed to germinate when stored for about 5 – 6 months in woven polypropylene sacks (poly-sacks) at 12 % moisture level, which is the method mostly used by farmers. This has become constrain to increasing the crop production (Mettananda *et al.,* 2001). Thus, it is necessary to find alternate methods to store soybean seeds for a longer period without losing viability below the required minimum.

In a study conducted by Mettananda *et al.* (2001), well dried seeds were packed in poly–sack, clear and white polythene bags stored under open air conditions and in a cold room. Standard germination and field germination were tested every 30 days after starting the experiment. They found that seed stored in poly–sacks under room temperature had low viability after 4, 5 and 6 months respectively. Longest storability was recorded in cold room with all packaging used. They concluded that storage in poly–sacks was good only under cold room conditions, and seeds stored in polythene bag were superior in storability compared to those stored in poly-sacks in maintaining the germination level.

2. Materials and Methods

The experiment was conducted between January 2007 and June 2008 at the Department of Crop Production and Horticulture, Federal University of Technology, Yola. The soybean varieties were grown and harvested under rain fed in 2006 growing season on the Teaching and Research Farm of the Department. The experiment was conducted in the laboratory of the Department. Yola is located in Northern Guinea Savanna region of Nigeria between latitude 9^{o} 14^{1} N and longitude 12^{o} 31^{1} E, at an altitude of 158.5 m above sea level as reported by Tame and Mibzar (2010). It has an annual mean minimum temperature of 15.2 ^{o}C and mean maximum temperature of 39 ^{o}C. Rainfall ranges from 700 mm – 1000 mm per annum with the soil texturally classified as sandy loam (Tame and Mibzar). The experiment was replicated three times in factorial design. The treatments were five storage materials (bottle, polythene bag, polythene sack, clay pot, and tin), three varieties of soybean (Samsoy II, TGX1019-2E and TGX1448-2E) and two environmental conditions (room and open air temperatures).

Germination test was carried out according to International Seed Testing Association standard (ISTA, 2005). This was done by counting 25 soybean seeds from the pure seed by multi auto electric counter. The 25 pure seeds of each sample were placed in Petri dishes containing filter paper soaked with distilled water. Germination count was made every day up to the completion of germination at fifth day. A seed was considered to have germinated when the seed coat ruptured, plumule and radicle came out up to 2 mm length.

Germination percentage was calculated using the formula reported by Tame (2011)

$$\text{Germination percentage } (\%) = \frac{\text{Number of seeds germinated}}{\text{Number of seed tested}} \times 100\%$$

Data collected were analyzed statistically using Generalized Linear Model (GLM) procedure of SAS and means that were significantly different were separated using Least Significant Difference (LSD).

3. Results

The effects of the storage materials, varieties and environmental conditions on germination percentage of soybean seeds stored for 540 days are presented in Figures 1, 2 and 3, respectively. There were highly significant differences ($P \leq 0.01$) among the storage materials as well as among the varieties all through the storage period. Also, there were highly significant differences ($P \leq 0.01$) among the environmental conditions all through the storage period except 360 days in storage that significant differences were observed at $P \leq 0.05$ and from 180 to 300 days in storage that no significant difference ($P \leq 0.05$) was observed between room and open air storage.

For storage materials, at 120 days in storage, tin recorded the highest value for germination percentage with 78.1 % followed by bottle and clay pot with 71.7 and 70.1 %, respectively. These storage materials differed significantly ($P \leq 0.01$) from the rest of the storage materials which had 67.2 and 58.6 %, respectively. But at 240 days in storage, poly bag recorded the highest germination percentage with 93.6 % followed by tin and bottle with 83.3 and 82.5 %, respectively. These materials also differed significantly ($P \leq 0.01$) from the other storage materials which recorded lower percentage germination. The same trends were observed from 300 to 360 days in storage, while at 420 days in storage, seeds in bottle recorded 66.1 % which was the highest followed by those in poly bag and tin with 57.5 and 56.3 %, respectively, and these particular storage materials differed significantly ($P \leq 0.01$) from clay pot and sack which had 25.3 and 24.2 %, respectively. This trend was also observed at 480 to 540 days in storage. Generally, the storage materials reached their maximum percentage germination at 240 day in storage with 93.6, 83.3 and 82.3 % for poly bag, tin and bottle, respectively, while sack and clay pot attained 82.8 and 79.2 %, respectively at 300 days in storage (Figure 1).

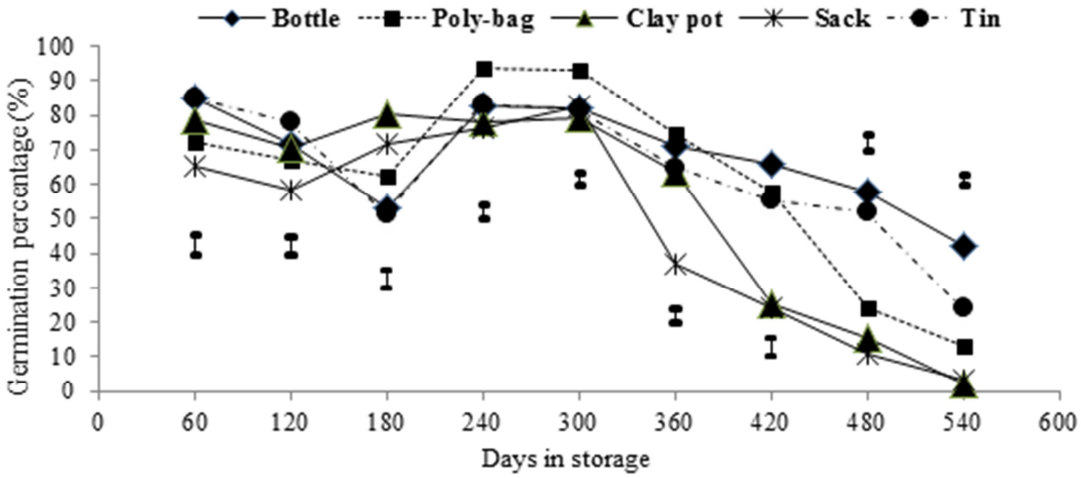

Fig. 1. *The effects of storage materials on germination percentage of soybean seeds under ambient conditions. I= LSD*

Incase of the varieties, at 120 days in storage, Samsoy II recorded the highest germination percentage with 82.3 %. This variety differed significantly ($P \leq 0.01$) from the other varieties which recorded 65.5 and 59.7 % for TGX1019-2E and TGX1448-2E, respectively. The same trends were observed all through the storage period, although Samsoy II reached its maximum percentage for germination at 240 days in storage with 94.1 %, while TGX1019-2E and TGX1448-2E had 81.0 and 77.8 %, respectively at 300 days in storage, after which the percentage germination decreased as storage time progressed (Figure 2).

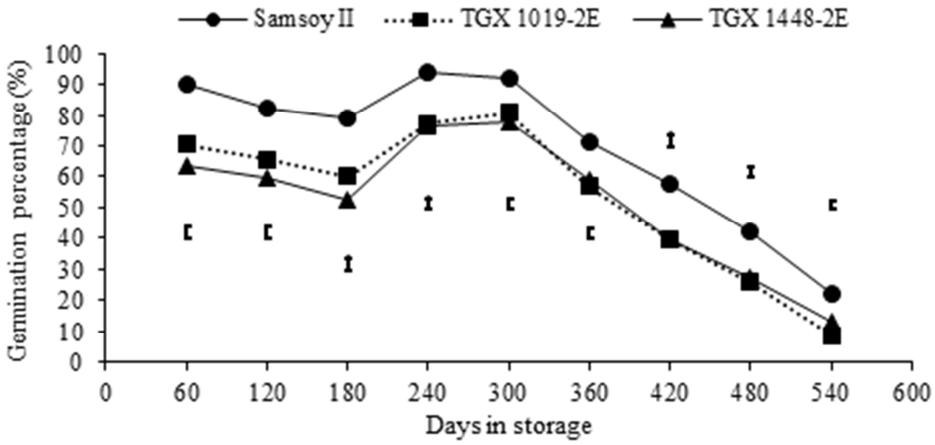

Fig. 2. *The effects of varieties on germination percentage of soybean seeds under ambient conditions. I= LSD*

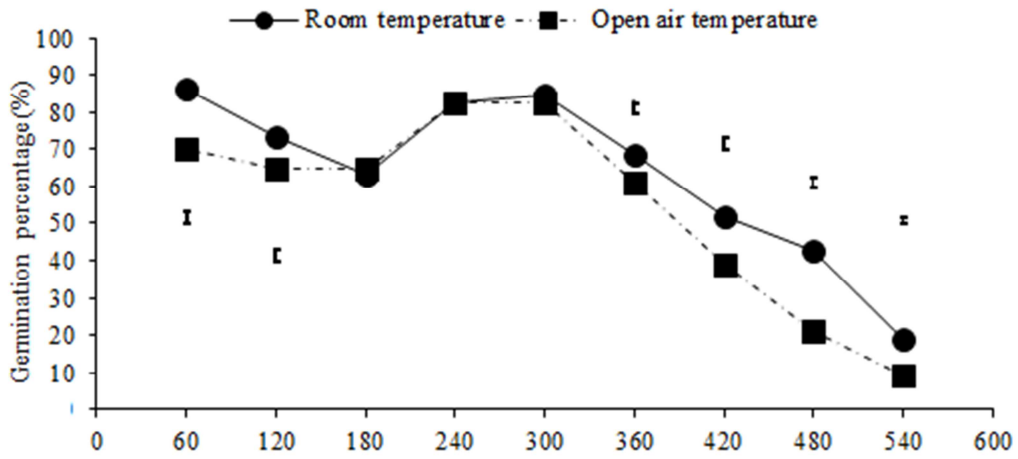

Fig. 3. *The effects of environmental conditions on germination percentage of soybean seeds under ambient conditions. I= LSD.*

In regards to environmental conditions, at 120 days in storage, room temperature recorded 73.3 % of germination percentage which differed significantly ($P \leq 0.01$) from the open air storage temperature with 65 %. The same trend was observed from 360 to 540 days in storage. But at 180 to 300 days in storage, no significant difference was observed ($P \leq 0.05$). Also, both room and open storage temperatures attained maximum percentage of germination at 300 days in storage with 84.6 and 82.8 %, respectively, after which it decreased as storage time progressed (Figure 3).

4. Discussion

Seed stored in bottle performed better in terms of germination as compared with other storage materials. However, result reported by Sajo and Tame (2012) that storage of soybean seed in poly bags preserved viability and reduced invasion by storage fungi compared with jute or cloth bags. It was further reported by Tame *et al.* (2013) that poly bag storage was the most efficient method of vegetable soybean seeds to maintain quality. Also, Mettananda *et al.* (2001) concluded that seeds stored in poly bags were superior in storability in maintaining the vigor. Similarly, Pessu *et al*. (2006) reported that polythene bag and metal tin were better storage containers than the bamboo bin and clay pot. They also found that soybean stored in polythene bag and metal tin maintained 58.7-86.0% germination means at the end of a 12-month period, unlike soybean stored in bamboo bin and clay pot where germination means dropped to zero after four months of storage.

The variation in germination percentage of soybean seed decreased with increase storage period which might be due to the deleterious effects of moisture which resulted from the storage materials and perhaps environmental conditions. This agrees with Tame (2011) who reported that germination percentage of onion seed decreased with increase in storage period.

The differences in performance among the environmental conditions on germination percentage in which room temperature performed better than open air storage might be due to differences in temperature and relative humidity. However, the germination percentage fluctuated over time of storage which might be attributed to changes in environmental conditions. This concurred with Tame *et al*. (2013) that the storage life of seeds varies with species and environmental conditions in which the seeds are stored. Furthermore, seeds must be stored under conditions which retard respiration, and enzymes activities within the seed. Also, Mollah *et al*., (2002) reported that the lower germination percentage recorded in the treatments might be associated with the presence of higher number of dead seeds which might be due to deterioration, thus contributed to poor seed germination.

Tame (2011) reported that decline in germination of soybean seeds stored in gunny bags was greater than those stored in gunny bags lined with polyethylene. Furthermore, Tame and Ayuba (2009) reported that re-absorption of moisture by seeds was high and rapid in some storage materials, seed being hygroscopic, absorbed moisture until vapour pressure of seed moisture or atmospheric moisture was in equilibrium. Higher moisture content might have increased respiratory activities of seeds and shortened the seeds live. The cellular membrane of short lived seeds became weaker.

5. Conclusion

From the results of this study, it can be concluded that germination was directly proportional to viable seeds and there are variations among storage materials as well as among varieties. Storage in bottle, poly bags and tin materials are the ideal for soybean seed to retain maximum viability for higher germination.

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