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(RESEARCH ARTICLE)

Effects of period and type of storage on germination test of *Acacia polycantha* seeds in South Kordofan State, Sudan

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Abstract

The study aimed to investigate the effect of storage type and period of Acacia polycantha (Kakamout) on seeds germination and to attain an appropriate method of seed storage. The experiment was conducted at the Regional Tree Seed Centre-Elobied during the year 2016, and the seeds were collected from Kadugli site. Some tests were applied (purity, number of seeds/kg, moisture content, germination, viability) on seeds before and after their storage in three stores under different status (normal, cold and deep) and in four periods of time (3, 6, 9 and 12 months) for each sample. Experiment design by Randomized Complete Block Design (RCBD) with three replicates in storages by repeating three samples. The experiment used the Randomized Complete Block Design (RCBD) with three replicates in storages by repeating three samples. The data was analyzed by SAS software using ANOVA table, while LSD test used for means separation. The results showed a significant differences ($\alpha = 0.05$) in the normal store and high significant difference ($p< 0.0001$) in the deep store. Also, seeds revealed a decrease in the moisture content of the deep store by 4%, and a decrease in the number of seeds by11747 seeds for the cold store in the fourth period resulting in the weight gain of the seeds and the decrease in the number of seeds/kg. The study recommends the storage of Acacia polycantha seeds in deep, cool and normal storage at any period of the year.

Keywords: Seed storage; Kakamout; Germination; Storage period

1 Introduction

The *Acacia polycantha (Kakamout)* is found in woody grasslands, deciduous and jungle lands, groundwater forests and rivers at elevations between sea level and 1800 m. It prefers sites with high groundwater levels, indicating a preference for nutrients and good soil. It sometimes thrives on stony slopes and compact soil. In Kenya, it can be found on the coast, in the middle of the highlands and the lake region in Sudan. It is found in the highlands, in the foothills and on the slopes. Rainfall rates are between (300 - 1000) mm (1).

Seed storage is the preservation of seeds under controlled environmental conditions to maintain seed viability (germination and vigour) for long periods. The entire storage period comprises several processes and sites. In the broadest sense, storage begins at physiological maturity and ends with germination in the field (2).

There is a desire to plant seeds annually, while we find that the trees belonging to most of the species desired from the point of view of man produce irregularly and over long periods and storage in this case is necessary and must collect large and sufficient quantities in the years with a good stock of seeds so that they can meet the needs during the years without seeds. The problem is the encountered of storage process for some species may be the limiting factor where it is not economically and naturally feasible to store seeds of certain species for a sufficient period so that we can give the production of low years (2). Seeds differ in terms of sensitivity to drying and temperature; some seeds lose their viability once they reach a certain level of moisture content. Seed moisture is a critical factor determining the viability and

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longevity of all seed types. For this reason, it is fundamental to identify the seed type before considering the method of storage. In terms of seed longevity, effects of drying and storage on germination, there are different seed categories such as kept in cool places for storage (3). Good buildings that do not differ in temperature have a gradual rise and fall with different seasons. The seeds can be kept in such places for a period of one year without much damage or more than a year and to store them for a longer period in low temperature (4).

The amount of moisture in the seeds is perhaps the most important factor influencing their viability during storage. Moisture content is the root of many storage problems - increased metabolic activity, higher respiration, fungus attack, heating and weakness - ultimately leads to seed death(5). If the moisture content of the seeds increases, this may encourage the growth of fungi and attack insect pests; generally, seeds deteriorate quickly when moisture content exceeds 20%. (5) Too low moisture content also harms seed quality, as the seed becomes vulnerable to mechanical damage, resulting in the breakage or cracking of the basic seed parts, rendering the seed vulnerable to damage and fungal attack. Moisture content is the basis of one of Harrington's basic rules: "For everyone low seed moisture content by 1%, the seed doubles life." However, this rule is applicable in the range (5-14%), because 5% causes physiochemical changes in the seeds, and more than 14% exposes the seeds to insects and fungal attack (5).

It has been proven from these studies that reducing moisture content facilitates the possibility of longer storage and better germination, and temperature was the main factor that played an important role in controlling seed degradation(6).

Storage of seeds under different levels of temperature and moisture affects the quality of seeds during the storage period and thus, the quality of seeds during the storage period is strongly affected by the quality of the initial seeds before storage, the moisture content, temperature and moisture during the storage period (7). There are two main methods of storage, determined by the class of seed that has to be stored. Most species have seeds that store best when dry ('orthodox' seed), but some species have seed that will lose viability if dried and must therefore be kept moist during storage ('recalcitrant' seed) (8). The paper aimed to study the effect of period storage and on germination of *Acacia polycantha* seeds.

2 Material and methods

2.1 Seeds collection

The seed collected from South Kordofan State, in Kadugli locality, in an area located between latitudes (50° and 12° N) and longitudes (27° 05" and 32° E). It covered an area of about 135,000 km^2, and has an average altitude of 600 meters above sea level. The seeds were collected during the seed collection period from November and December 2015 by the technical group.

2.2 The seeds processing

The maturity fruits were collected and placed in the drying and cleaning yard, where seeds were extracted from the capsule and these seeds were placed in bagges of burlap, and then some tests were performed on them.

2.3 The seeds storage

The tests were applied (purity, number of seeds/kg, moisture content, germination, viability) before seed and after storage in three different stores (normal, cold and deep), where the tests were conducted after 3, 6, 9, 12 months for each sample. The seeds were divided into three groups, then each seed group was stored.. Experiment design by Randomized Complete Block Design (RCBD) with three replicates in storages with three replicates was conducted.

2.4 Storage types

2.4.1 Normal store

It is a room prepared for normal storage conditions and a normal temperature similar to the normal room temperature (25-30) ^{0}C. It increases and decreases according to the general air (9) (Abutaba *et al.,* 2015).

2.4.2 Cool store

It is a temperature-controlled windowed room where it is cooled to (1-12) O C. And with a regulator to adjust the temperature until the required degree is controlled (9)(Abutaba *et al.*, 2015).

2.4.3 Deep store

A deep freezer is to cool to (10-20) ° C below zero (9) (Abutaba *et al*., 2015).

2.4.4 The seeds characteristics

- Purity test
- Number of seed per kg.
- Moisture content.
- Germination test
- Viability (seed cutting).

2.5 Data analysis

The data analyzed by SAS statistical software version 6.12 (10) (SAS Institute Inc., 1996) for ANOVA table, while LSD test used for means separated for the results.

3 Results

Table (1), showed the analysis of variance for germination test of seeds, which were stored in three different storages (deep, cold and normal), which showed significant differences with a significant level ($\alpha = 0.05$) in each of normal storage and high significant differences in deep storage ($p< 0.0001$) with no significant different in seeds stored in cold storage for mean germination of seeds. The analysis of variance to viability test of seeds for seeds in the three different storages indicated no significant differences (0.05) in all three storages (deep, cold and normal) (Table 2).

Table (3), showed a variation of mean moisture content and number of seeds/kg for seeds, which were stored in three different storages and underwent moisture content tests in four periods, the first period, is standard of three stores, whose results appeared (4%). Deep storage showed an increase in second and third periods (9% and 10%), respectively, and then a clear decrease in fourth period (4%) in which decrease is clearly visible for seeds (Figure . 1).

The deep storage of number of seeds/kg of seeds, which were stored in three different storages with four tests for different periods, and first standard period (13067) showed results of a decrease in number of seeds in different periods and was less in fourth period (11764) (Table 3) and (Figure 4).

In cool storage, the mean number of seeds/kg significantly decrease in number of seeds in second period (12000) and third period (11800) and less in fourth (11747) (Table 3) and (Figure 5).

In normal storage for mean number of seeds/kg, there was a noticeable variation in number of seeds for seeds from first standard period (13067) and decreased in second by number (12800), third (11461) and last fourth (11111), (Table 3) and (Figure 6).

Table (4) showed the analysis of variance of moisture content of seeds in different storages after 12 months in presence of significant differences ($p = 0.005$) between different storages, where normal and cool storage showed mean moisture content (10%), while the deep storage recorded lowest mean moisture content (4%), Table (5) and Fig. (7).

Table 1 The ANOVA table shows germination testing of *Acacia polycantha* seeds were stored in three different storages

Sources	**Df**	**Normal storage**			**Cold storage**			**Deep storage**		
		Ss	**F value**	**Ss**	**Ss**	**Fvalue**	**Ss**	**Ss**	**F value**	**Ss**
Period	3	767.04	255.68	0.0262*	106.12	35.37	0.13n	222.92	74.30	0.0012**

*significant. **high significant and ns no significant

Table 2 The ANOVA table shows viability testing of *Acacia polycantha* seeds were stored in three different storages

Sources	Df	Normal storage			Cold storage			Deep storage		
		Ss	F value	Ss	Ss	F value	Ss	Ss	F value	Ss
Period	3	0.25	0.08	1n	0	0	1n	0	0	1n

Table 3 The mean moisture content and number of seeds/kg of *Acacia polycantha* stored in three different storages

Period (Every three months)	The test		
	Normal storage(%)	Cool storage (%)	Deep storage (%)
The first	4	4	4
The second	5	5	9
The third	5	5	10
Fourth	10	10	4
The mean number of seeds/kg			
The first	13067	13067	13067
The second	12800	12000	11850
The third	11461	11800	11780

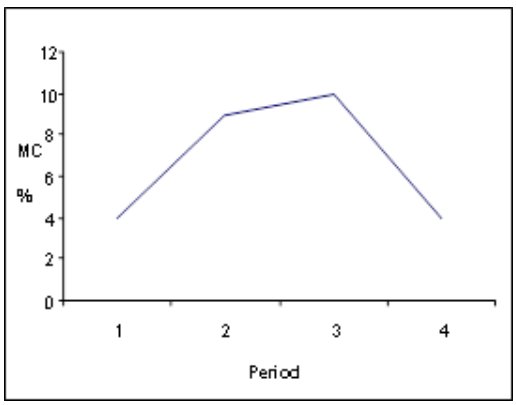

Figure 1 Mean moisture% in deep storage

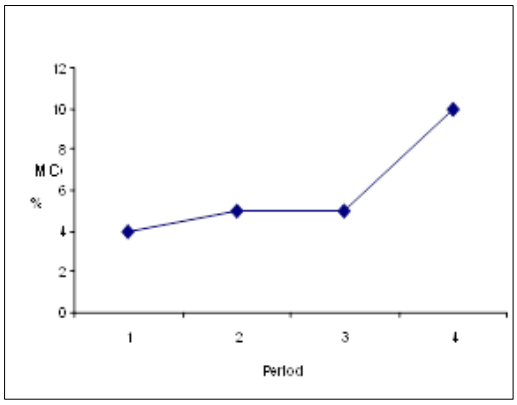

Figure 2 Mean moisture% in cold storage

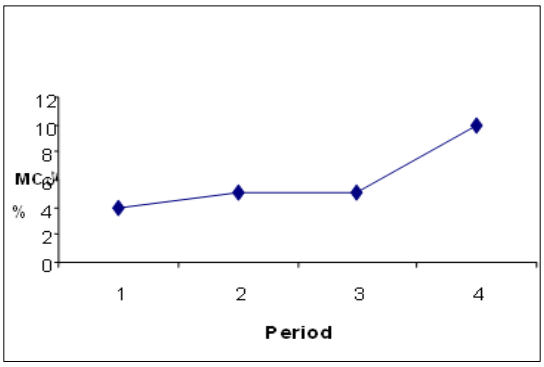

Figure 3 Mean moisture% in normal storage

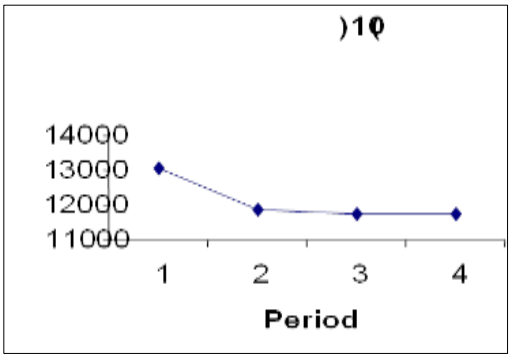

Figure 4 Mean number of seeds/kg in deep storage

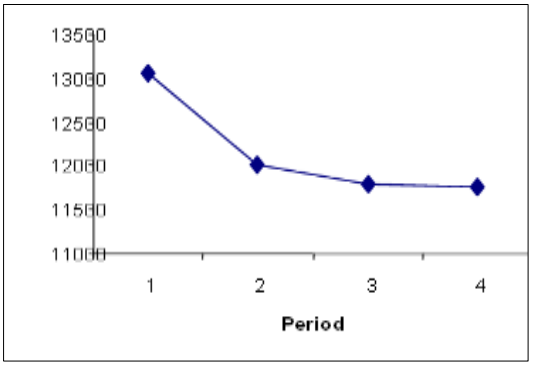

Figure 5 Mean number of seeds/kg in cold storage

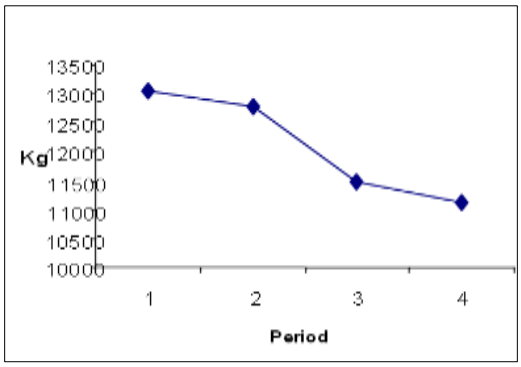

Figure 6 Mean number of seeds/kg in normal storage

Table 4 The ANOVA table shows moisture content of *Acacia polycantha* seeds stored in three different storages after (12 month)

Source	DF	SS	MS	F value
Storage	2	72	36	12*

Table 5 The moisture content of *Acacia polycantha* seeds were stored in three different storages after (12 month)

Storage	Moisture content (%)
Normal	10^{A}
Cool	10^{A}
Deep	4^{B}

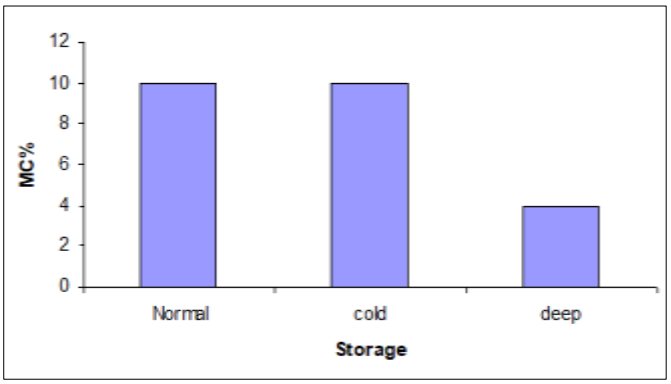

Figure 7 Moisture content of seeds stroredin the three different stor age

4 Discussion

Acacia polycantha seeds, which are important in the production of these trees from gums, It has direct contributions to increasing local and national income, and which show their importance in that, but they are repeatedly produced from seeds in different periods known as (Seed years), which are stored in storages for use in different periods. Trees compete with gum Arabic.

The seeds contain different factors and places of storage, some of them are stored in storages with normal temperatures, some are stored in refrigerated storages, and others are known in depth for many years.

The results of the variation in the presence of significant differences between seeds in different stores (deep and normal) which were subjected to germination test and no significant differences for cold storage, as well as for viability test, which was the result of the absence of significant differences.

The deep, cool and natural buffer is suitable for *Acacia polycantha* seeds in all storage periods (12 months), which means the seeds can be stored in them and this agrees with (10). The higher the moisture content in the seeds, the more negatively they will be affected by high temperatures, and therefore the seeds should be stored in a cool place. Harrington again suggests that for every 5 ° C decrease in storage temperature, the seed life doubles. The change of oxygen and removal of toxic gases produced during the metabolism process must be taken into consideration when determining storage conditions, especially long-term storage (11). This proved that reduced moisture content facilitates the possibility of longer storage and better germination, and temperature was the main factor that played an important role in controlling seed degradation (6).

5 Conclusion

Deep, cool and natural storage, although there is a marked increase, but within reasonable limits, in the moisture content of the seeds. Therefore, *Acacia polycantha* seeds can be stored in deep, cold and natural storage at any period of the year and can give good results upon germination.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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