

Effect of several type storage conditions and preservative seed vigor of selected *Acacia* species.

Mulik Abbaker Ibrahim^{*1,2}, Yan Rong Wang¹, Mohammed Abdelmanan², Salim Haroon Imam², Nasrladeen Adam Ali², Abdelrahim Omer Abdelrahim³

¹State Key Laboratory of Grassland Agro-ecosystems, College of Pastoral, Agricultural Sciences and Technology, Lanzhou University, P.R. China

²Department of Forestry, College of Forest Sciences, University of Zalingei, Sudan

³Department of Range, College of Forest Sciences, University of Zalingei, Sudan

Abstract

The current study was to assess the influence of a different type storage conditions and preservative seed vigor and temperature storage method in retaining the viability of seeds of *Acacia* species had been successfully prophesying germination demand in several threat categories and seeds were limited store-controlled conditions due to early damage. Seeds of four *A. species* were stored at room temperature stored, cold stored, Aerial and underground stored for a period of 0, 4, 8, 12, 16, 20 and 24 months. The results revealed that the degree of dormancy variation among the species, they were 81% for *A. nilotica*, 74% for *A. seyal*, 15% for *A. mellifera* and 5% for *A. senegal*. Further, the studies were exhibited germination affected by storage time. Room storage temperature presented significantly declined in germ inability. Even more, the cold, aerial and underground storage conditions indicated effective method for preservation of *A. seeds* and maintenance of seed viability and storability for 24 months of storage. However, there were very few differences in response to break dormancy treatments before and after 24 months storage. As the storage period advances, *A. seyal*, *A. mellifera* and *A. senegal* there were progressively reduction in hard seed percentage from the beginning of the 4 months of cold, aerial and underground storage. The different responses may be reasonable by the reduction of the seed degradation in breaking dormancy and germination behavior into the room, cold, aerial and underground storage conditions can be utilized how these species might respond to environmental change, and also, used for the formation of artificial seed banks of *A. species*. Therefore, the aerial seed storage affects germination behavior of small seeded halophytes, further, aerial seed storage may protect seeds from detrimental salinity effects, insects and fungal are the major causes for quantitative and qualitative losses.

Keywords: Storage types, *Acacia*, viability, temperature, cold, Aerial, underground, germination, dormancy.

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Introduction

Acacia species are growing natively in Savannah regions, there are more important sources recorded to be useful for timber, forage, gum, food, fuel, firewood, fiber, tannins, medicine, ornamentals, shade, shelter, domestic utensils, handicrafts, nitrogen fixing, soil stabilization, Agroforestry system, as well as environmental protection. *Acacia* seeds storage perhaps advantageous for good quality seed as well as can be harmful if the seed is of less quality, seeds will probably store for longer periods without deterioration if saved at low temperatures. The main objective of natural condition seed storage is to secure the support of good quality seed for planting and restoration programmers whenever requested. Several species produce seeds at long intervals, limiting from a few years to many years. To assure seed supply among the period between two good seed crops, a seed stock must be established [1]. Moisture content and temperature are particularly more important factors affecting the longevity of seeds and influencing the rate of deterioration [2]. The literature pertaining to the studies on effect of seed storage of *Acacias* is reviewed. There seems to be an association between plant ecology and seed storage behavior, it is evident that species that show recalcitrant seed storage behavior do not occur naturally in habitats that are deserted and savanna.

In some species, part of the seed with physical stored at room temperatures for several months or years becomes permeable [3,4]. Shields held at 20°C retain viability and remain soft for up to five years [5]. The evidence suggests that cold storage of 5°C is necessary to arrest the set of seed coat dormancy [6]. Long-term dry storage at room temperatures may promote the breaking of physical dormancy [7]. In these environments, the most of plant species indicated orthodox seed storage behavior, while a few indicated intermediate seed storage behavior [4]. The advantages of treating seeds before to storage it seems that, little to indicate the long period consequences of storing seeds for the non-dormant mean [8,9]. Seed conservation is ordinarily classified into two groups: *ex situ* and *in situ* [10]. *Ex situ* protection preserves the vegetal material exterior on the natural environment. *Ex situ* conservation way consists seed banks, *in vivo* banks and *in vitro* banks [11], ensuring its preservation in viable condition also saving it genetically completely for long term [12]. On the other hand, *in situ* method conserve the biological diversity when the management and preservation of species in the natural environment [13]. However, aerial seed storage are potentially the most important source of propagules for sexual regeneration in woody wetland plants, given that the seeds of woody wetland plants are often under-represented in

the seed storage of wetland sediments [14,15] and that aerial seed storage have been demonstrated to play a critical role in sexual recruitment of many taxa of woody plants in terrestrial forests [16,17]. Therefore, the role of seed storage in maintaining floristic diversity in freshwater wetlands has been examined in a very large number of studies [18,19]. Further, the underground-storage in perennials might be important for seed development [20]. Besides, there is an urgent need to explore and develop a use for deep-underground space due to the predicted exhaustion of resources in the shallow depths of the Earth's surface [21,22], When the seeds deteriorate during storage, they lose their vigor and become more susceptible to environmental stresses during germination and finally are not able to germinate. The aging speed is affected by genetic and environmental factors such as temperature, seed's moisture content and quality [23]. In other hand, the seed vigor reduces during maturity, harvesting and storage depending on temperature and moisture and gradually deteriorates [24]. The current paper describes and evaluates the impact of different types of storage condition and temperature for germination of selected *Acacia* seeds, in order to identify the longevity and storability in retaining the viability of seeds of *Acacia* species.

Materials and Methods

Seed collection

Seeds of *Acacia seyal*, *A. nilotica*, *A. senegal* and *A. mellifera*, were collected from Western Sudan and imported to the laboratory of the College of Pastoral Agricultural Sciences and Technology, Lanzhou University, China. During September 2016, Seeds were selected by sorting out the healthy, uninfected seeds of almost uniform size.

Room storage treatment

Selected seeds of *A. seyal*, *A. nilotica*, *A. senegal* and *A. mellifera* were stored at room, storage temperature at 20-25°C for 0, 4, 8, 12, 16, 20 and 24 months.

Cold storage treatment

The selected of *Acacia* seeds were stored at cool storage temperature at 4°C since 0, 4, 8, 12, 16, 20 and 24 months.

Aerial storage treatment

Seeds of *A. seyal*, *A. nilotica*, *A. senegal* and *A. mellifera* were stored at aerial storage temperature at 20-25 - 30°C for 0, 4, 8, 12, 16, 20 and 24 months.

Underground storage treatment

Seeds of *A. seyal*, *A. nilotica*, *A. senegal* and *A. mellifera* were stored at underground storage temperature at 15 - 20°C for 0, 4, 8, 12, 16, 20 and 24 months.

Influence of temperature on germination

Germination responses to temperature were examined for scarifying seeds incubated at five constant temperatures (15°C, 20°C, 25°C, 30°C and 35°C).

Seed germination test

Germination was carried out before and after the final of the storage experiment incubated at 20°C in incubator lighting

for 12 hours a period. Samples of four replicates of 50 seeds were used for each treatment in the experiment and placed on top of 2 layers of filter paper in 90 mm Petri dishes. A seed was considered to have germinated when the radical extension was at least 0.5cm. Seeds were evaluated according to the ISTA Rules. The experiments were laid out in a completely randomized design. Comparisons in germination performance across different seed pre-treatment methods. Were made using one-way ANOVA in SPSS version 19.0.

Results

Effect of room, cold, aerial and underground storage on seed germination and hard seed performance

Germination percentage affected by *A.* species differed significantly over a time of storage. In most of *A. senegal*, *A. mellifera* and *A. seyal* the germination percentage improved during cold, aerial and underground storage, treatment to the advancement of storage time up to 4 and 8 months of storage, which later decreased at the end of storage time 24 months (Tables 1,3 and 4). However, in *A. nilotica* the germination percentage decreased within first 4 months of cold, aerial and underground storage after that developed in progress among the cool, aerial and underground storage period (Table 2).

Table 1. Effect of room, cold, aerial and underground storage condition on seed germination of *A. seyal*, during 24 months.

Species	Room store	GP%	HS%	DS%	AS%	
<i>A.seyal</i>	Control	22.5 ^a	74 ^c	1 ^a	2.5 ^a	
	4 m	18 ^{ab}	76.5 ^b	1 ^a	4.5 ^a	
	8 m	17.5 ^{ab}	78 ^b	1.5 ^a	3 ^a	
	12 m	13.5 ^b	82.5 ^{ab}	1 ^a	3 ^a	
	16 m	13.5 ^b	83.5 ^{ab}	0 ^a	3 ^a	
	20 m	10.5 ^c	89 ^a	0.5 ^a	0 ^a	
	24 m	5 ^d	92 ^a	2 ^a	1 ^a	
	Cool store					
	4 m	28.5 ^a	69 ^c	0.5 ^a	2.5 ^a	
	8 m	22.5 ^{ab}	75 ^{bc}	0.5 ^a	2 ^a	
	12 m	18.5 ^{bc}	81.5 ^{ab}	0 ^a	0 ^a	
	16 m	14.5 ^c	83.5 ^a	0 ^a	2 ^a	
20 m	20 ^{bc}	78 ^b	0.5 ^a	1.5 ^a		
24 m	12 ^c	88 ^a	0 ^a	0 ^a		
Underground						
4 m	7.5 ^{bc}	86 ^{ab}	1.5 ^a	5 ^{ab}		
8 m	8 ^c	87 ^a	2 ^a	3 ^b		
12 m	12.5 ^a	84.5 ^{ab}	0 ^a	3 ^b		
16 m	11 ^{ab}	87.5 ^{ab}	0 ^a	1.5 ^b		
20 m	12 ^a	83.5 ^{ab}	0.5 ^a	3 ^b		
24 m	11.5 ^{ab}	84 ^{ab}	3 ^a	1.5 ^b		
Aerial store						
4 m	8 ^c	85 ^a	2.5 ^a	4.5 ^a		
8 m	10.5 ^b	87 ^a	1 ^{ab}	1.5 ^{ab}		
12 m	14 ^b	83.5 ^a	0 ^c	2.5 ^b		
16 m	14 ^b	85 ^a	0 ^c	1 ^b		
20 m	25 ^a	70 ^b	0.5 ^b	4.5 ^a		
24 m	17 ^{ab}	77.5 ^{ab}	2.5 ^a	3 ^a		

Means within a seed sample marked by different letters are significantly different at the 5%.

Table 2. Effect of room, cold, aerial and underground storage condition on seed germination of *A. nilotica* during 24 months.

Species	Room store	GP%	HS%	DS%	AS%	
<i>A. nilotica</i>	Control	10 ^{ab}	81 ^c	0.5 ^a	8.5 ^a	
	4 m	8.5 ^{bc}	86 ^{ab}	1 ^a	4.5 ^a	
	8 m	16.5 ^a	81.5 ^a 82.5 ^{ab}	1 ^a	1 ^a	
	12 m	11.5 ^c		1 ^a	3 ^a	
	16 m	12.5 ^a	83.5 ^{ab}	0 ^a	3 ^a	
	20 m	11 ^{ab}	79 ^a	0.5 ^a	0 ^a	
	24 m	5 ^d	72 ^a	2 ^a	1 ^a	
	Cool store					
	4 m	4.5 ^a	89 ^c	0.5 ^a	2.5 ^a	
	8 m	14.5 ^{ab}	85 ^{bc}	0.5 ^a	2 ^a	
12 m	18.5 ^{bc}	81.5 ^{ab}	0 ^a	0 ^a		
16 m	22 ^c	78 ^a	0 ^a	2 ^a		
20 m	20 ^{bc}	78 ^b	0.5 ^a	1.5 ^a		
24 m	12 ^c	88 ^a	0 ^a	0 ^a		
Underground						
4 m	9.5 ^{bc}	84 ^{ab}	1.5 ^a	5 ^{ab}		
8 m	7 ^c	89.5 ^a	0 ^a	3.5 ^b		
12 m	12.5 ^a	84.5 ^{ab}	0 ^a	3 ^b		
16 m	11 ^{ab}	86.5 ^{ab}	0 ^a	2.5 ^b		
20 m	12 ^a	83.5 ^{ab}	0.5 ^a	3 ^b		
24 m	12.5 ^{ab}	80 ^{ab}	3 ^a	4.5 ^b		
Aerial store						
4 m	4 ^c	89 ^a	2.5 ^a	4.5 ^a		
8 m	10.5 ^b	87 ^a	1 ^{ab}	1.5 ^{ab}		
12 m	14 ^b	83.5 ^a	0 ^c	2.5 ^b		
16 m	14 ^b	85 ^a	0 ^c	1 ^b		
20 m	30.5 ^a	64 ^b	1.5 ^b	4.5 ^a		
24 m	26 ^{ab}	67.5 ^{ab}	2.5 ^a	4 ^a		

Means within a seed sample marked by different letters are significantly different at the 5%.

In contrast, the germination percentage remarkable gradual declined in the whole of *A. senegal*, *A. mellifera*, *A. seyal* and *A. nilotica* at room, storage time (Table 1 and 4). Before starting storage, treatment, the seed of *A. seyal* and *A. nilotica* indicated no significant differences in seed viability. This may indicate that the of seed species were highly viable. Further, hard seed percentage as impacted by *A. species* differed significantly during storage time (Table 1 and 2). As the storage period advances, there were progressively reduction in hard seed percentage from the beginning of the 4 months of cold, aerial and underground storage seed of *A. senegal*, *A. seyal* and *A. mellifera*. As well as, the hard seed percentage of *A. nilotica* was increased in the first 4 months and then declined advanced during at end of cool storage (Table 1). The death seed percentage of those *A. species* effected by differed significantly above the period of 24 months of cold, aerial and underground storage. Since, storage time advances, the significant increasing in the dead seed percentage recorded in *A. senegal* and *A. mellifera* exhibited decline. Furthermore, the dead seed percentage was highest at the roomy storage as compared to cold, aerial and underground storage at the end of 24 months of storage time (Tables 3 and 4). The abnormal seed percentage of those *A. species* influenced by differed significantly during the period of 24 months of cold,

Table 3. Effect of room, cold, aerial and underground storage condition on seed germination of *A. mellifera* during 24 months.

Species	Room store	GP%	HS%	DS%	AS%	
<i>A. mellifera</i>	Control	80.5 ^a	15 ^c	2 ^a	2.5 ^a	
	4 m	81 ^{ab}	6.5 ^b	5 ^a	4.5 ^a	
	8 m	77.5 ^{ab}	5 ^b	7 ^a	3 ^a	
	12 m	71.5 ^b	4.5 ^{ab}	11 ^a	3 ^a	
	16 m	53.5 ^b	4.5 ^{ab}	15 ^a	3 ^a	
	20 m	60.5 ^c	5 ^a	18 ^a	0 ^a	
	24 m	45 ^d	7 ^a	16 ^a	26 ^a	
	Cool store					
	4 m	88.5 ^a	2 ^c	6.5 ^a	3 ^a	
	8 m	82.5 ^{ab}	4.5 ^{bc}	10 ^a	3 ^a	
	12 m	78 ^{bc}	5 ^{ab}	15 ^a	2 ^a	
	16 m	75 ^c	7 ^a	14 ^a	4 ^a	
	20 m	70 ^{bc}	8 ^b	15 ^a	7 ^a	
	24 m	63 ^c	10 ^a	17 ^a	10 ^a	
	Underground					
	4 m	87 ^{bc}	7 ^{ab}	1 ^a	5 ^{ab}	
	8 m	88 ^c	6.5 ^a	2 ^a	3.5 ^b	
	12 m	92 ^a	5 ^{ab}	0 ^a	3 ^b	
	16 m	90 ^{ab}	8.5 ^{ab}	0 ^a	1.5 ^b	
	20 m	92 ^a	5.5 ^{ab}	0.5 ^a	2 ^b	
	24 m	90 ^{ab}	4 ^{ab}	3 ^a	3 ^b	
	Aerial store					
	4 m	90 ^c	3 ^a	2.5 ^a	4.5 ^a	
	8 m	87.5 ^b	10 ^a	1 ^{ab}	1.5 ^{ab}	
12 m	84 ^b	13.5 ^a	0 ^c	2.5 ^b		
16 m	80 ^b	19 ^a	0 ^c	1 ^b		
20 m	77 ^a	18 ^b	0.5 ^b	4.5 ^a		
24 m	70 ^{ab}	24 ^{ab}	2 ^a	4 ^a		

Means within a seed sample marked by different letters are significantly different at the 5%.

aerial and underground storage. At the storage time advances there was a significant increase in the abnormal seed percentage of *A. senegal* and *A. mellifera* (Tables 3 and Table 4). Even more, the abnormal seed percentage was decreased at cold, aerial and underground storage for *A. senegal*, *A. nilotica* and *A. mellifera* among the end of the 24 months of storage time (Tables 1-4).

Impact of temperature on seed germination performance

The temperature had significant effects on the percentage and germination rate (1/T50) of each species ($P < 0.05$). Germination percentage of *A. mellifera* and *A. senegal* permeable seed dormancy was resulted in high germination at 20°C, 75%, 84.5 % and 25°C, 80%, 88.5%, respectively. Moreover, significantly decreased by 30°C 15.5%, 11% and 35°C, 13%, 8%. Germination percentages of *A. seyal* and *A. nilotica* impermeable seed dormancy were shown germination at 20°C, 18.5%, 12.5 % and 25°C, 20.5%, 14.5%, respectively. Further, significantly diminished by 30°C and 35°C. Germination rates generally improved as temperature increased and then decreased as temperature increased. Germination rate usually improving linearly with increased temperature up to an optimum point, after that, diminished linearly to a ceiling temperature (Figure 1).

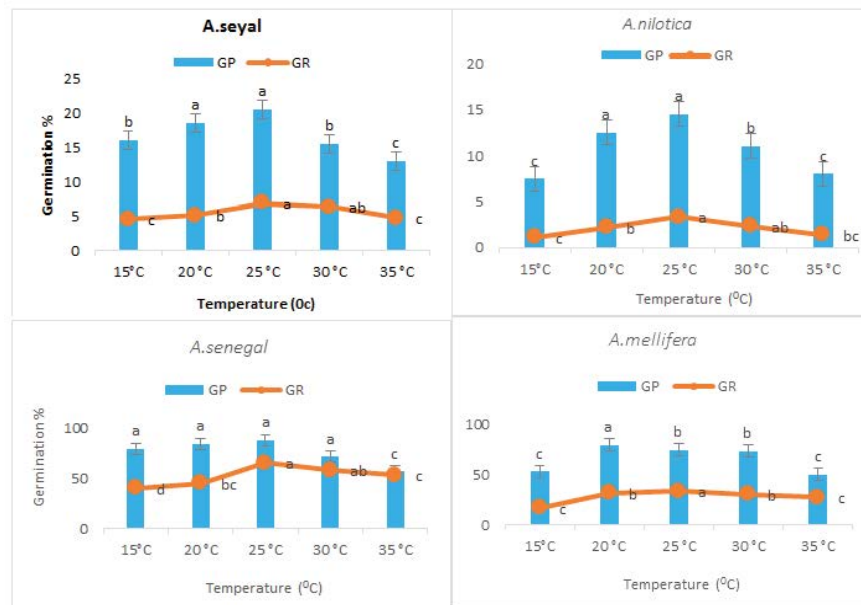


Figure 1. Seed germination percentage and rate of *Acacia* species at different temperature ranges.

Table 4. Effect of room, cold, aerial and underground storage condition on seed germination of *A. senegal* during 24 months.

Species	Room store	GP%	HS%	DS%	AS%
<i>A.senegal</i>	Control	83.5 ^a	13 ^c	1 ^a	2.5 ^a
	4 m	80 ^{ab}	14 ^b	1 ^a	4.5 ^a
	8 m	78.5 ^{ab}	17 ^b	1.5 ^a	3 ^a
	12 m	75.5 ^b	21 ^{ab}	1 ^a	3 ^a
	16 m	70.5 ^b	26.5 ^{ab}	0 ^a	3 ^a
	20 m	60.5 ^c	40 ^a	0.5 ^a	0 ^a
	24 m	55 ^d	47 ^a	2 ^a	1 ^a
	Cool store				
4 m	91 ^a	6 ^c	0.5 ^a	2.5 ^a	
8 m	90 ^a	8 ^{bc}	0.5 ^a	2 ^a	
12 m	85 ^{bc}	15 ^{ab}	0 ^a	0 ^a	
16 m	84 ^c	14 ^a	0 ^a	2 ^a	
20 m	81 ^{bc}	17 ^b	0.5 ^a	1.5 ^a	
24 m	82 ^c	18 ^a	0 ^a	0 ^a	
Underground					
4 m	85 ^{ab}	9 ^{ab}	1 ^a	5 ^{ab}	
8 m	84 ^c	12.5 ^a	0 ^a	3.5 ^b	
12 m	90 ^a	7 ^b	0 ^a	3 ^b	
16 m	85 ^{ab}	13.5 ^a	0 ^a	1.5 ^b	
20 m	88 ^a	9 ^{ab}	0.5 ^a	3 ^b	
24 m	85 ^{ab}	11 ^{ab}	3 ^a	1 ^b	
Aerial store					
4 m	93 ^a	6 ^b	0.5 ^a	0.5 ^b	
8 m	90.5 ^a	7 ^b	1 ^a	1.5 ^b	
12 m	84 ^{ab}	6 ^b	5 ^a	5 ^b	
16 m	84 ^{ab}	6 ^b	5 ^a	5 ^b	
20 m	80 ^b	10 ^{ab}	5.5 ^a	4.5 ^b	
24 m	75 ^c	12 ^a	5 ^a	8 ^a	

Means within a seed sample marked by different letters are significantly different at the 5%.

Discussion

For all species evaluated in this study, whole preserved high

germination under the different condition's storage tested, and germination after 24 months storage. The recorded, evidently performance the existence of room, cold, aerial and underground storage condition correlated variation in the seed germination behavior of those *A.* species and a significant influence of period of room, cold, aerial and underground storage on germination. Dormancy has broken within the room; cold, aerial and underground storage exposed two main groups of species, indicating contrasting germination behavior in decreased or increased germ inability. In the whole two comparisons depicted the storage condition may strongly influence seed germination. The distribution of seed germination percentages revealed that the cold, aerial and underground storage is the more effective condition for dormancy broken compared to the room storage condition duration of seed storage. Seeds by deep and no deep physical dormancy was stored below room, cold, aerial and underground store conditions, timing of sowing, there were three stages to consider. Firstly, dormancy loss can exist room and cold storage, but it can not to be complete, some of the seeds can change non-dormant and remain dormant. Secondly, the rate of dormancy broken becomes different between the species. Thirdly, several seeds can lose viability within the room and cool storage, also again we had shown that can vary among the species and collection area. Furthermore, the moisture content of the seeds is one of the most important factors determining seed longevity during storage [25,26,1]. Seed survival during the period of longevity varies greatly within species. It can also vary between accessions among a species due to differences in genotype and location. Affected by the area in potential longevity recorded from the environment during seed harvesting, maturation, duration of drying, time of seed harvest, pre-storage environment and the period of seed storage [27-30]. Besides, studies about the long-term viability are requested for the storability of those *Acacia* seeds in the gene bank. The different storage conditions response may have affected by many factors, including seeds structure, intrinsic physiological characters of each species and environmental factors such as temperature, moisture content and humidity [31,32]. Therefore,

the temperature responses of the plants to view the environments which they are adaptable. Even more, differences within the species have substantial ecological significance [33]. Species from tropical regions ordinarily require high-level temperature for germination in temperate species. The optimal temperature for germination of four *Banksia* species has been positively correlated together with mean annual temperature in the area of seed originates [34]. For the current study the seed germination of *Acacia* species completely more tolerant of low temperature. In conclusion, the cold, aerial and underground conditions of seed storage for *A. nilotica*, *A. senegal*, *A. mellifera* and *A. seyal* remained completely viable among 24 months of storage. However, the room, storage condition gradually declined seed viability during 24 months of storage and did not maintain seed viability. The variation within cold, room, aerial and underground storage may be due to differences in the storage conditions, temperature and moisture content. There were very few differences in response to break dormancy treatments before and after 24 months storage. According to these findings, storing seeds of a permeable seed's dormancy of *A. senegal* and *A. mellifera*, revealed does not change germination and this fascinates significant interest to the current seed-based restoration programs and promoted seed use effectiveness. The potential of dormancy broken to find among cold, room, aerial and underground storage must be considered when examined on initial seed dormancy were conducted maybe when seeds from different locations were stored before to propagating plants. It is to suggest that fresh seeds must be used after collection before proceeding for experimentation. Although, the aerial seed storage protects seeds against granivores, help seed dispersal over time and maintain seeds in a favorable microhabitat.

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***Correspondence to:**

Mulik Abbaker Ibrahim
Department of Range
College of Forest Sciences
University of Zalingei
Sudan
E-mail: mulikabaker@yahoo.com