

Some Aspects of Ecological Characteristic of *Acacia tortilis* subsp. *raddiana*

Research Article

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Abstract

This study conducted during the season 2017 at Eldouim locality is in the northern White Nile State of the Sudan, where the main objective of the study was made that to address the occurrence, frequency and other characteristic of the *Acacia raddiana* sp. at different parts at in Eldouim locality. The researcher used the systematic circular sampling plots, established with a total number of 130 sample plots. The sample plots were circular in shape with a radius of 17.84 m (0.1 ha in area). In these sample plots, all trees with Diameter at Breast Height (dbh) equal to or greater than seven centimetres were measured in addition to use different parameters were obtained from the tree species were used for assessment of abundance, frequency, dominance, and importance value index for all the species by using the statistical formulas. The result shows the abundance of 78.5% and relative abundance 53.31% as higher abundance species compared to other species; the other hand ranking of the species into categories according to their abundance, *Acacia raddiana* dominate the first rank of 75.5%, while other species finds within the lower rank with a range of abundance 0.1-4.3%. The researcher recommends that FNC to improve the management program.

Keywords: White Nile State; Sudan; *Acacia* spp.; Forest; FNC

Introduction

Northern Sudan consists of different in its topography, climate, soil, and hydrology. These are reflected in its ecological habitats, vegetation zones and rich flora in natural forests. *Acacia tortilis* subsp. *raddiana* is one of the floras in natural stands. The genus *Acacia* belongs to the family *Fabaceae*, subfamily *Mimosaceae*. *Acacia tortilis* subsp. *raddiana* is synonyms *Acacia raddiana*. It is a gregarious tree and between 7 - 21 m in length. The soil habitats are loamy or gravely soils as was indicated by Elamin HM [1]. The known species of the Sudan is *Acacia raddiana* and the Arabic name of the tree is "sayyal" It occurs in the drier areas with exceptional case in the White Nile State. The tree cover in the White Nile State is the highest as it occurs

in different area at Eldouim locality. It is similar to what Barbour recorded *Acacia raddiana* tree is rarely found in pure location, but it is found with other species in arid and semiarid areas [2].

Acacia tortilis subsp. *raddiana* is used in the Sudan for different purposes. The wood of the species produces poles; its wood has high calorific value of 4400 kcal/kg making superior fuel wood and charcoal [3,4]. It burns slowly and makes little smoke when dry. It is one of the main fuel wood and charcoal sources in parts of Africa, e.g. around Khartoum. Nitrogen-fixing nodules are reported in South Africa and Zimbabwe [5].

Lamprey found in Tarangire Game Reserve in Tanzania, 7 percent germination was from seed collected from faecal pellets [6].

He obtained no germination of seed from fallen pods thus natural regeneration is very poor. Kirkpatrick, et al. it will help to protect the generic make-up of the bush on ones property and finally the role of natural regeneration in developing the natural forest as sign in livestock domestic or wild and the importance of which in sites ecology [7].

Acacia tree grows in the arid and semiarid areas, water found in areas with maximum average rain < 600 mm [8], it is difficult for other species to be available, with exception of *Acacia tortilis*, subsp. *tortilis*, *Balanites aegyptiaca*, *Leptadenia pyrotechnica*, *Capparis decidua*, *Ziziphus spina-christi* and *Acacia nubica*, which are in benefit in relation with *Acacia raddiana* [9-11]. Eventually, *Acacia raddiana* was considered as one of the most important species in arid and semiarid areas and used widely in all the zones where it is ecologically adapted. Gum from the tree is edible and can be used as Gum Arabic [12]. It can address in general way the problems of drought and desertification. But it should be an essentials component of any aiming to improve and protect the degraded environment of the zones of Sudan. During the dry season, camel nomads and cattle raiser using severe lopping to the tree. This happens because *Acacia raddiana* is an excellent browse in both pod and foliage, probably all natural different vegetation almost completely consumed by over grazing.

This behavior of nomads and cattle raiser misuse *Acacia raddiana* in the absence of sound forests media lead to severe deterioration that put the land under threat.

Study Area

Eldouim locality is in the northern White Nile State of the Sudan Republic, approximately between latitude 13°58' 13".6 N. and longitude 32°18' 11". 6 E. The average elevation of the study area is about 1246 m. above sea level. The study area lies on loamy and gravel soils along river, seasonal valleys and khors [1]. The climate is a typical tropical continental characterized by warm dry winters and hot rainy summers. The study area is generally characterized by high temperatures for most of the year, with means of 37 °C and 21 °C for maximum and minimum summer temperatures respectively. The rainy season extends from June to October and most of the rains fall during July to August. The average annual rain falls for Eldouim had declined from 330 mm (1920-1950) to 239 mm (1990-2012) (Eldouim Meteorological Station, 2012). The great variations in rain fall are characteristic of arid climates [13]. The mean relative humidity percentage is lowest in April (10%) and highest in August (67%) respectively.

The mean daily evaporation is highest in April (20.00 mm) and lowest in August (10.8 mm). This is to be expected since high temperatures coincide with lower R.H. in April, cooler and more humid conditions reduce evaporation.

The Winds at the study area prevail in different directions at different times of the year. The North -East or Northerly Trade Winds prevail during the winter, whereas the South and South-East Winds prevail during the autumn (is rainy season). The dust storms (haboobs) are common in the summer season. Clouds prevail almost 6 months in the year, whereas the mean sunshine was 3650 hours/year.

The main tribes living in the area are Hassania, Kawahalla, Hussunate, Kababish, Magadai, Sawarda and Galieen. The population of the area is about 49292 (2009 census).

Methodology

Lay out of sample plots

The systematic circular sampling plots were used in this study [14]. The area covered in this study was 258 hectares. 8 locations (camps) were selected and established with a total number of 130 sample plots. The sample plots were circular in shape with a radius of 17.84 m (0.1 ha in area).

Parameter assessment

In each sample plot trees were measured for different parameters. Data recorded for each tree included: tree species identified (type and number); tree height in meter, diameter at breast height (diameter Brest height (dbh)) in (cm) and crown diameter in meter. Data for each sample plot was recorded in a sheet. In each sample plot the natural regeneration was counted and recorded for each species. Further tree heights were classified into height classes. Diameters and crowns were also classified in to the diameter and crown classes.

Data analysis

Different parameters were obtained from the tree species were used for assessment of abundance, frequency, dominance, and importance value index for all the species by using the formulas:

- Abundance = % of Stem number of a given species
- Absolute abundance = Number of individuals per species.
- Relative abundance = Percentage of each species of the total stem number per ha.
- Frequency = Occurrence or absence of a given species in a sample plot.
- Absolute frequency = % of occurrence.
- Relative frequency = % of the total of the absolute frequencies.
- Dominance = Expression of the space that a given species occupies.
- Absolute dominance = the sum of the individual stem basal areas.
- Relative dominance = % of a given species of the total stem basal area measured.
- Importance value index = Sum of the relative abundance + relative frequency + relative dominance

The importance value index is a measure of ecological significance of a species in a certain forest type. It also expresses the dominance of a particular species in a stand [15,16].

Natural regeneration

For assessment of natural regeneration in the study area, where the plots need to be small. These may be based on separate sampling or sub plots within conventional forest inventory plots [17].

The regenerating species (R.S) were calculated as follows method formula:

$$R.S = \text{Number of seedlings} / \text{Number quadrates} \times \text{area (M)}$$

R.S: Regenerating Species

M: Mater

T-test is used for the regeneration of *Acacia raddiana* species.

Results and Discussion

Assessment of tree species

In the eight locations of the study area, tree species varies in the abundance. These *Acacia* individuals occupy 105 sample plots out of 130 frequencies with abundance of 78.5% and relative abundance 53.31% as higher abundance species compared to other species. When is ranking the species into categories according to their abundance, *Acacia raddiana* dominate the first rank of 75.5%, while other species finds within the lower rank with a range of abundance 0.1-4.3%. This is attributed to dominate distribution of *Acacia raddiana* on climate of arid and semi arid. Species in the study area are classed in two ranking limits either the first rank which dominated by only one species that is *Acacia raddiana*, other species occupying the lower rank with no species also in the medium ranks. Relative abundance followed the same trend of abundance, with higher % of *Acacia raddiana*, other species realized at low percentage.

A number 693 *Acacia raddiana* individuals were found to eight locations. The importance value index which is used as a measure of ecological significance of a species in a given forest type was found to be also the highest for *Acacia raddiana* (167.13). This index is used to express the dominance of a particular species in a certain location [15,16]. Importance value index of 184.8 for tree species in Jebel Marra was calculated by Khamis [18]. The number of tree species per hectare 113.44 and 80.8 % of the absolute frequency in eight locations (Table 1). The total number of 164.32 trees per hectare and 86.7% of the absolute frequency [19]. Elsefory mentioned that the wood species was 19.3 stem/ha and 24% of the absolute frequency in three sites at the same study area [20]. Goda calculated that the average of *Acacia albida* was about 11 trees/ha and 43% of the absolute frequency in four sites at the study area [21]. Also wickens reported that dominant trees in the same study area were *Acacia tortilis subsp. tortilis*, *Leptadenia pyrotechnica* and *Salvadora persica* [11]. The present study reported similar finding to those of wickens except that *Salvadora persica* has become a rare species, but above mentioned values are perceived as low as shown in (Table 1) [11]. Moreover, the present study revealed that some woody species are threatened as seen from their low abundance e.g. *Acacia laeta*, *Acacia nubica*, *Boscia senegalensis* and *Dobera glabra*. The threat is probably due to excessive use of over-grazing and illicit felling. *Acacia raddiana* shows deterioration of natural forest. This loss of species should be seriously and more attention than the saying in managerial measures.

Physical characteristics of *Acacia raddiana* at the eight locations

As shown in (Table 2) small basal area (3 m²/ha) were reflected in wood volume per hectare 8.7 m³. These influencing in the volume were

resulted through intermediate different in diameter classes. However, the range of Sudan zone (Sudano-Sahelian) is 5-20 m³ per hectare as reported by Shepherd [22]. The lowest and highest diameters recorded were 7-45 cm, the mean was 10.9 cm, the minimum and maximum height counted were 5-12 m, the mean 5.6 m; these results indicate the strong relationship between the diameter classes and the height classes and that means there are no significant difference in between. The mean crown diameter was 12.9 m² where as the lowest and highest crown diameter measured were 9.42 and 25.12 m² respectively; this has been reflected in the percentage coverage which is only 6.9%. According to the FAO Forest Resource Assessment 2000 the forest is defined as land with a tree canopy more than 10% and land area of more than 0.5 ha [23]. This realized as low coverage in the locations and classified as an open wooded grass land. Elsefory

Table 1: The results of species composition, Abundance (AB), Absolute Abundance (AAB), Relative Abundance (RAB), Frequency (FR), Relative Frequency (RFR), Dominance (BA), Relative Dominance (RBA), Importance Value Index (IVI) for trees with DBH ≤ 7 cm in *Acacia raddiana* locations.

Species	AAB	AB	RAB	FR	AFR	RFR	BA	RBA	IVI
<i>Acacia albida</i> (F. albida)	4	0.5	0.38	2	1.5	1.1	2.02	3.89	54
<i>Acacia laeta</i>	2	0.2	0.15	1	0.8	0.6	0.05	0.1	52.89
<i>Acacia mellifera</i>	31	3.5	2.39	8	6.2	4.7	40.7	1.32	59.12
<i>Acacia nilotica</i>	13	1.6	1.08	1	0.8	0.6	4.13	7.39	9.07
<i>Acacia nubica</i>	2	0.2	0.15	1	0.8	0.6	0.04	0.07	0.83
<i>Acacia senegal</i>	9	1.0	0.069	6	4.6	3.5	0.59	1.06	5.25
<i>Acacia seyal</i>	6	0.7	0.054	2	1.5	1.1	0.26	0.47	2.03
<i>Acacia tortilis subsp. tortilis</i>	19	2.2	0.17	6	4.6	3.5	0.57	0.11	5.07
<i>Acacia tortilis subsp. raddiana</i>	693	78.5	53.31	105	80.8	61.7	33.22	63.74	167.13
<i>Balanites aegyptiaca</i>	38	4.3	3.3	16	12.3	9.4	5.5	9.84	22.16
<i>Boscia angustifolia</i>	21	2.4	0.18	6	4.6	3.5	0.5	0.89	6.01
<i>Boscia senegalensis</i>	1	0.1	0.01	1	0.8	0.6	0.02	0.4	1.06
<i>Calotropis procera</i>	10	1.1	0.08	3	2.3	1.8	0.27	0.48	3.05
<i>Capparis deciduas</i>	3	0.3	0.23	2	1.5	1.1	0.09	0.16	1.49
<i>Commiphora africana</i>	5	0.6	0.39	1	0.8	0.6	0.41	0.73	1.72
<i>Dober40a glabra</i>	2	0.2	0.15	1	0.8	0.6	1.3	2.33	3.08
<i>Eucalyptus maiden</i>	7	0.9	0.62	1	0.8	0.6	0.21	0.21	53.1
<i>Hyphaene thebaica</i>	4	0.5	0.31	1	0.8	0.6	1.98	4.15	52.79
<i>Leptadenia pyrotechnica</i>	7	0.8	0.54	2	1.5	1.1	0.14	0.29	53.52
<i>Ziziphus spina-christi</i>	3	0.3	0.23	3	2.3	1.8	0.06	0.11	53.21
<i>Prosopis chilensis</i>	1	0.1	0.1	1	0.8	0.6	0.02	0.4	52.58
Total			113.44			131		52.1	

Table 2: Physical characteristics of *Acacia raddiana* at the eight locations.

Character	Min. value	Max. value	Mean value	Value
Height (m)	5 m	12 m	5.6 m	-
D.B.H (c m)	7 cm	45 cm	10.9 cm	-
Basal area (m)	0.02 m ²	0.64 m ²	0.1 m ²	-
Basal area per hectare (m)	-	-	-	3 m ²
Volume (m)	0.31 m ³	3.05 m ³	0.16 m ³	
Volume per hectare (m)	-	-	-	8.7 m ³
Crown diameter (m)	9.42 m ²	25.12 m ²	12.9 m ²	-
% Crown coverage	-	-	-	6.9

found the crown cover at the same study area to be 3.5% in three sites and classified the sites as wooded lands [20]. This low percentage of the crown cover is attributed to different lopping, felling of trees and the expansion in agriculture and urban activities. Field observations showed that some herbs and grasses had completely disappeared from the study area e.g. *Stipagrostis plumosa* this may be attributed mainly to overgrazing since this species is highly palatable. Observation also showed a greater number of ground vegetation occupied the locations e.g. *Panicum turgidum* and *Aristida adscensionis* which were dominated at the locations. This occupation is probably due to soil deterioration, soil seed bank and rainfall fluctuation.

Natural Regeneration of tree species among *Acacia raddiana* location

The eight locations under study showed no significant difference of natural regeneration of *Acacia raddiana*. The higher number of regeneration scored by “Waaara” taha Elbabonus location (one), while Elshegig location (eight) scored lower number by regeneration (Table 3 and Figure 1). According to Table 4 the natural regeneration is a process of nature in the locations, however natural regeneration seems to be obtained from ingested and dispersed seeds in waaara. *Acacia raddiana* dominates some sample plots in form of seedlings

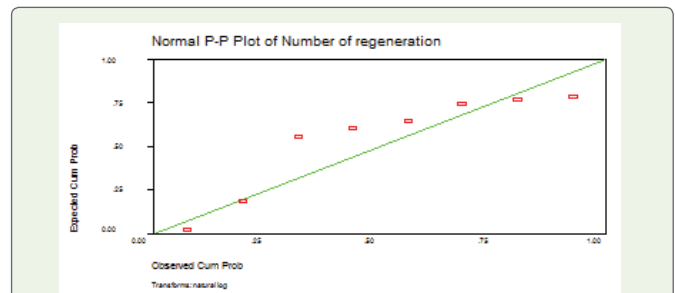


Figure 1: Normal distribution P-P plot of number of regeneration at eight locations.

Table 3: Analysis of Natural regeneration of *Acacia raddiana* in eight locations (One-Sample Test).

	Test Value = 9.13					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence interval of the Difference	
					Lower	Upper
Number of regeneration	-0.003	7	0.998	-5.000E-03	-4.2311	4.2211

T test at 5%= 1.451

abundance of 1738 seedlings per hectare; this represents 58.5%. These regenerations were not found under the shade of crown diameter of *Acacia raddiana*, it may be due to the shade of the flora that reduces the vitality of the natural regeneration of *Acacia* trees and it grows difficulty to mature trees. Regenerations of *Acacia tortilis subsp. tortilis*, *Balanites aegyptiaca* and *Ziziphus spina-christi* scored 138, 185 and 131 seedlings respectively that come on the second degree at locations (6.4%, 6.2% and 4.4%). *Faidherbia albida*, *Acacia laeta* and *Hyphaene thebaica* showed small number of wild seedlings which are 23, 15 and 62 respectively. Eventually the reasons behind the very low regeneration are over-grazing pressure, excessive use of the land, predation of young plants and urban activities. Also this difficulty is a sign that the species pods as a browse must pass through an animal for regeneration to take place.

Conclusion and Recommends

Conclusions

The study showed the flowing Conclusions:

Table 4: Natural regeneration of tree species in *Acacia raddiana* for all locations.

Species	Site1	Site2	Site3	Site4	Site5	Site6	Site7	Site8	Total	%	Per ha
<i>Acacia albida</i> (F. albida)	0	0	0	0	0	0	0	3	3	0.78	23
<i>Acacia leate</i>	2	0	0	0	0	0	0	0	2	0.50	15
<i>Acacia mellifera</i>	10	0	0	0	2	0	0	0	12	3.10	92
<i>Acacia nilotica</i>	0	0	0	0	0	0	3	0	3	0.70	23
<i>Acacia nubica</i>	1	0	5	3	0	0	0	0	9	2.30	69
<i>Acacia senegal</i>	0	0	0	0	0	0	5	0	5	1.30	38
<i>Acacia seyal</i>	0	0	0	6	0	0	0	0	6	1.60	46
<i>Acacia tortilis subsp. tortilis</i>	3	3	2	2	4	1	2	1	18	4.60	138
<i>Acacia tortilis subsp. raddiana</i>	43	41	39	31	29	24	19	0	226	58.6	1738
<i>Balanites aegyptiaca</i>	1	4	2	10	1	1	4	1	24	6.20	185
<i>Boscia angustifolia</i>	9	2	0	0	0	0	1	0	12	3.10	92
<i>Boscia senegalensis</i>	4	0	0	0	0	0	0	0	4	1.00	31
<i>Commiphora africana</i>	0	0	0	0	5	0	0	0	5	1.30	38
<i>Calotropis procera</i>	0	0	0	0	0	0	0	3	3	0.70	23
<i>Capparis deciduas</i>	0	5	0	0	0	0	0	0	5	1.30	38
<i>Dobera glabra</i>	2	0	0	0	0	0	0	0	2	0.50	15
<i>Eucalyptus maiden</i>	0	0	0	0	0	0	0	2	2	0.50	15
<i>Hyphaene thebaica</i>	0	0	0	0	0	0	0	8	8	2.10	62
<i>Leptadenia pyrotechnica</i>	0	2	0	0	1	0	0	11	14	3.60	108
<i>Ziziphus spina-christi</i>	1	1	2	8	1	1	1	2	17	4.40	131
<i>Prosopis chilensis</i>	0	0	6	0	0	0	0	0	6	2.00	46
Total	75	58	56	64	43	24	36	30	386	100	

- The highest number of trees at locations results to continuous presence of forest guards with their animals.
- *Acacia raddiana* was found to be dominant, frequent, and abundant and twenty one species were found to occur in association with *Acacia raddiana*.
- *Acacia raddiana* could regenerate naturally on area frequented by animals.
- Natural regeneration at sites of no animals and no guard is lacking.
- Some factors affecting regeneration are; trampling, rodents, children, fire regenerating and seeds harvesting by ants.

Recommendations

- Improving management program.
- There is a need for F.N.C. integrated with local Communities and United Nation to rehabilitate the study area and other degradation lands.
- There is a need for extension awareness programs considering the importance of the trees species at the study areas.
- Grazing and cultivation at *Acacia raddiana* locations should be banned or at least regulated.
- Improvement of rangeland records of livestock is important to find out the optimum carrying capacities.

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