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(RESEARCH ARTICLE)

A study on the soil seed bank of Nyala area, south Darfur, Sudan

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Abstract

This research is an ecological study on the vegetation of Nyala area, South Darfur State, Sudan. The main objectives of this research is determination of soil seed bank of species in the study area. The collected plant species were identified checked via the aid of the herbarium of the Department of Botany, Faculty of Science, University of Khartoum. Twenty-seven plant species have been identified from the study of soil seed bank. The most dominant of these species were *Euphorbia aegyptiaca, Dactyloctenium eagypticum, Eragrostis tenella*, *Corchorus trilocularis* and *Amaranthus graecizans*. The number of dead seeds/m2 on the upper soil surface layer (0-5 cm) was 12150, while that of live seeds was 5560. The number of dead seeds/m2 for the lower soil depth (5-10 cm) was 9707 and that of live seeds was 3254 seeds/m2. Statistical analysis of the data of the soil seed bank showed that there were statistically significant differences between the number of dead and live seeds/m2 at the same soil depth and among different soil depths.

Keywords: Soil seed bank; Vegetation; Ecological study; Nyala area- South Darfur- Sudan

1. Introduction

Soil seed banks are important components of vegetation dynamics affecting both ecosystem resistance and resilience. The soil seed bank is a vital resource for the resilience and restoration of disturbed ecosystems. Buisson et al. [1]. The preservation of mature dominant tree species is essential for ecological stability and the possible restoration of degraded semi-arid savannas in light of the changing climate and effects of global warming. Tessema et al. [2]. The species diversity and abundance of the soil seed bank were estimated after soil samples were brought to germination [3]. In terms of seed bank density, there was no significant variation between sites, with an average mean density of 87.6 seed m^{-2}. However, floristic compositions varied significantly from site to site [4]. Sousa et al. [5] recommended that the zone of the woodland parts influences the measure and composition of the soil seed bank, and can altogether impact the potential strength and recovery of these locales within the occasion of normal or human-centered unsettling influence.The dormancy of the collected seeds was lifted by germination tests after treatment with sulfuric corrosive (H_2SO_4), in an broiler at 140 °C and within the bubbling water [6]. In arid ecosystems seeds are characterized by high spatial and temporal variability and are particularly affected by spatial pattern of vegetation. Rainfall unpredictability is the lying under factor causing the huge soil seed banks found in arid environments [7]. The techniques for estimating the population of the soil seed bank (live and dead seeds) can be grouped. These involve sieving, flotation and subsequent viability determination on one side and those that rely on direct assessment of seedlings arising from soil samples on the other side [8]. Pruestey [9] defined seed bank as the number of seeds present in soil, which come from either plant species in the site or seeds transferred from elsewhere through dispersal or other means. Levels of seed reserves depend on the level of seed input from the swards, rate of seed loss by predictions or any other means such as incidence of germination and probability of successful establishment. According to Roberts [10], the term soil seed bank has been used to designate the live seed reservoir present in a soil. The persistence of seeds in the soil is a major component of plant succession and plays a substantial role in the evolution of plant communities [10].Aljandro and Aide [11] claimed that the soil seed banks were composed of higher densities near the canopy's edge, which decrease as one

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gets farther away from the edge of the canopy. This pattern of densities was observed in these two areas until the end of spring, after which there was an increase with the arrival of summer until autumn, when the drought season was prolonged and the highest level reached. In addition to spatial variability, there was also seasonal variability. Elbarasi and Buhwarish [12] reported that the percentage of seeds/m^2 in the autumn season was 65% followed by 17% in the fall-winter season, then 7% in spring and 11% in the summer. The highest seed density (HSD) was 1050 seeds/ m^2 and the lowest was 533 seeds /m2. El-Safory [7] reported that in the depth (0-5 cm), the density of live seeds was 5829 seed/ m^2 whereas the dead seeds recorded a density of 8715 seeds/ m^2. In the depth (5-10 cm), the density of live seeds was 2286 seeds/ m^2 as compared to a density of 4699 seeds/ m^2 for the dead seeds. In the depth (10-15 cm) the density of live seeds was 986 seeds/ m^2 while that of the dead seeds was 2872 seeds/ m^2. Abdallah [13] and Mohamed [14] found that number of seeds/ m^2 for viable seeds on the top soil (0- 5 cm) was 7524 and that for dead seeds/ m^2 was 19700. Similarly 3104 viable seeds/ m^2 and 5333 dead seeds/ m^2 were obtained on the second soil depth (5-10 cm). The number of dead seeds/ m^2 exceeds that of viable seeds on the two depths of soil. The density of dead and viable seeds decreased with increased soil depths. The high number of dead seeds may be due to many reasons the most important of which is that some species shed their seeds before maturity in addition to over stocking. Location of the study area Nyala town the capital of both Nyala province and south Darfur state in western Sudan. It lies just east of longitude 23º53 east and latitude12º04 north. It is about 900 km south west of Khartoum and 250 km east of the borders with the Republic of Chad [15]. This study was conducted to determine the soil seed bank of Nyala area, South Darfur, Sudan.

2. Material and methods

Ninety soil samples (10 x 10 cm) were taken from Mosei (lowlands), Wadi Nyala (khor area), and Jabal Nyala (highlands) of Nyala area, South Darfur, Sudan. The soil samples were taken from two depths (0-5 cm) and (5-10 cm) and put into plastic bags. The samples from each depth were thoroughly mixed and then sub-samples of 250 g were prepared from the mixed soil samples. The sub-soil samples were placed in a set of sieves with pores of 0.5 mm, 0.25 mm, and 0.01 mm, respectively, and then washed for 10-15 minutes under continuous flow of water in order to wash away the soil leaving only the seeds. The seeds were transferred to a 500 ml beaker and water was added and the dead seeds were observed to float. The floating dead seeds were immediately filtered leaving a residue of live seeds at the bottom of the beaker. The dead seeds were air –dried. The live seeds at bottom of the beaker were extracted as follow. A weigh of 1.5 g of $CaCl_2$ was accurately weighed and dissolved in 250 ml of water. The solution was added to live seeds in the beaker and left for 40 minutes. The live seeds were observed to float in the $CaCl_2$ solution. These were then filtered and air dried. The number of seeds per unit area (N.S)/ (m2) is calculated by the following equation:

$$\mathrm{N.S} = \frac{\text{Number of seeds per depth x2 x100 x 100}}{\text{Quadrate area x number of quadrates per depth}}$$

The extracted seeds were identified by comparison with reference seed samples collected from plants growing in the study area. Magnifying lenses and Mbc-10, dissection microscopes were used for seed identification.

3. Results

Ninety soil samples were taken from three areas: Mosei, Wadi and Jabal at two depths: 0-5 and 5-10 cm. The seeds were identified for each soil area and seed densities and the number of live and dead seeds were determined for each depth.

Table 1 Soil seed bank at Mosei area

Species	0 – 5 cm		5 – 10 cm		Total	
	Live	Dead	Live	Dead	Live	Dead
Acanthospermum hispidum DC.	-	-	-	-	-	-
Achyranthes aspera L.	22	52	15	38	37	90
Amaranthus graecizans L.	6	14	-	15	6	29
Amaranthus viridis L.	22	26	6	13	28	39
Senna obtusifolia L.	-	1	1	1	1	2
Cenchrus biflorus Roxb.	23	36	5	9	28	45

Cenchrus setigerus Vahl	-	-	-	-	-	-
Cleome gynandra L.	26	12	2	11	28	23
Abutilon pannosum (Forst f.) Schlecht.	25	58	15	26	40	84
Dactyloctenium aegyptium L.	29	71	40	30	69	101
Echinochloa colona (L.) Linx.	33	33	9	24	42	57
Eragrostis tennella L.	2	28	-	16	2	44
Euphorbia aegyptica Bioss.	50	48	19	95	69	143
Euphorbia granulata Forssk.	2	6	-	2	2	8
Faidherbia albida Del.	-	-	-	-	-	-
Indigofera stenophylla Gill and Perr.	6	5	2	2	8	7
Leonotis nepetifolia (L.) Ait. f.	8	4	8	5	16	9
Ocimum brasilicum L.	5	6	-	4	5	10
Ricinus communis L.	1	1	1	-	2	1
Rogeria adenophylla Gay	-	1	-	-	-	1
Schoenfeldia gracilis Kunth.	25		54		36	
Sesbania sesban L.	8		9		1	
Setaria sphacelata (Schumach) Staph and Hubbard	3	2	2	-	5	2
Setaria verticillata L.	15	34	4	18	19	52
Solanum dubium L.	12	22	4	20	16	42
Tribulus terestris L.	1	1	-	2	1	3
Xanthium brasilicum Wallr.	-	2	-	-	-	2
Total	324	526	170	371	494	879

The number of seeds/m^2 was calculated by the following equation:

$$\text{Number of seed/ m}^2\ \frac{\text{No. of seeds/depths x 2 x100x 100}}{\text{Quadrate area (m2) x No. of quadrat/depth}}$$

Depth 0-5:

$$\text{Number of live seed/m}^2 = \frac{324x2x10000}{100x15} = 4320$$

$$\text{Number of dead seeds/m}^2 = \frac{526x2x10000}{100x15} = 7013$$

Depath 5-10:

$$\text{Number of live seed/m}^2 = \frac{170x2x10000}{100x15} = 2267$$

$$\text{Number of dead seeds/m}^2 = \frac{371x2x10000}{100x15} = 4947$$

Table 2 The soil seed bank at Wadi area

Species	0 – 5 cm		5 – 10 cm		Total	
	Live	Dead	Live	Dead	Live	Dead
Acanthospermum hispidum DC.	-	-	-	-	-	-
Achyranthes aspera L.	-	-	-	-	-	-
Amaranthus graecizans L.	3	5	1	9	4	14
Amaranthus viridis L.	-	-	-	-	-	-
Senna obtusifolia L.	-	-	1	-	1	-
Cenchrus biflorus Roxb.	9	3	6	1	15	4
Cenchrus setigerus Vahl	1	10	5	6	6	16
Cleome gynandra L.	-	-	-	-	-	-
Abutilon pannosum (Forst. f.) Schlecht.	1	1	-	3	1	4
Dactyloctenium aegypticum L.	1	7	1	12	2	19
Echinochloa colana (L.) Linx.	-	-	-	-	-	-
Eragrostis tennella L.	8	5	3	6	11	11
Euphorbia aegyptica Bioss.	-	-	-	-	-	-
Euphorbia granulata Forssk.	-	3	1	2	1	5
Faidherbia albida Del.	-	-	-	-	-	-
Indigofera stenophylla Gill. and Perr.	-	4	-	1	-	5
Leonotis nepetifolia (L.) Ait. f.	1	6	1	9	2	15
Ocimum brsilicum L.	-	-	-	2	-	2
Ricinus communis L.	-	-	-	-	-	-
Rogeria adenophylla Gay	-	-	-	-	-	-
Schoenefeldia gracilis Kunth.	6	18	-	12	6	30
Sesbania sesban L.	-	3	-	-	-	3
Setaria sphacelata (Schunach) Staph and Hubbard	-	-	1	2	1	2
Setaria verticillata L.	-	-	-	-	-	-
Solanum dubium L.	-	5	-	2	-	7
Tribulus terestris L.	-	-	-	-	-	-
Xanthium brasilicum Wallr.	-	-	-	-	-	-
Total	30	70	20	67	50	137

Depth 0-5:

$$\text{Number of live seeds/m}^2 = \frac{30x2x10000}{100x15} = 400$$

$$\text{Number of dead seeds/ m}^2 = \frac{70x2x10000}{100x15} = 933$$

Depath 5-10:

$$\text{Number of live seeds/ m}^2 = \frac{20x2x10000}{100x15} = 267$$

$$\text{Number of dead seeds/ m}^2 = \frac{67x2x10000}{100x15} = 893$$

Table 3 Soil seed bank at Jabal Nyala area

Species	0 – 5 cm		5 – 10 cm		Total	
	Live	Dead	Live	Dead	Live	Dead
Cenchrus biflorus Roxb.	-	-	-	-	-	-
Cenchrus setigerus Vahl.	-	2	-	-	-	2
Cleome gynandra L.	11	84	4	126	15	210
Abutilon pannosum (Forst. f.) Schlecht	1	22	-	2	1	24
Dactyloctenium aegyptium L.	2	11	-	10	2	21
Echinochloa colana (L.) Linx.	-	4	3	13	3	17
Eragrostis tennella L.	-	-	-	-	-	-
Euphorbia aegyptica Bioss.	-	-	-	5	-	5
Euphorbia granulata Forssk.	2	10	1	8	3	18
Faidherbia albida Del.	-	1	-	7	-	8
Indigofera stenophylla Gill. and Perr.	3	14	-	9	3	23
Leonotis nepetifolia (L.) Ait f.	4	-	2	16	6	16
Ocimum brsilicum L.	-	-	-	-	-	-
Ricinus communis L.	8	18	23	5	31	23
Rogeria adenophylla Gay	2	-	-	-	2	-
Schoenefeldia gracilis Kunth	18	15	11	11	29	26
Sesbania sesban L.	2	1	2	-	4	1
Setaria sphacelata (Schunach) Staph and Hubbard.	-	-	-	-	-	-
Cenchrus biflorus Roxb.	-	4	-	2	-	6
Cenchrus setigerus Vahl.	-	-	-	-	-	-
Cleome gynandra L.	4	2	-	4	4	6
Abutilon pannosum (Forst. f.) Schlecht.	2	18	6	14	8	32
Dactyloctenium aegyptica L.	-	-	-	-	-	-
Setaria verticillata L.	-	54	-	1	-	55
Solanum dubium L.	4	100	-	57	4	157
Tribulus terestris L.	-	-	2	-	2	-
Xanthium brasilicum Wallr.	-	-	-	-	-	-
Total	63	360	54	290	117	650

Depth 0-5:

$$\text{Number of live seeds/m}^2 = \frac{63x2x10000}{100x15} = 840$$

$$\text{Number of dead seeds/ m}^2 = \frac{360x2x10000}{100x15} = 4800$$

Depath 5-10:

$$\text{Number of live seeds/ m}^2 = \frac{54x2x10000}{100x15} = 720$$

$$\text{Number of dead seeds/ m}^2 = \frac{290x2x10000}{100x15} = 3867$$

4. Discussion

The species composition was determined for each of the three sites in the study and area 27 species were identified from the live and dead seeds (Table 1, 2, 3). In depth 0-5 cm, at the three sites the density of live seeds was 5560 seeds/m^2 whereas the dead seeds density was 12150 seeds/m^2. In the depth 5-10 cm, at the tree sites the density of live seeds was 3254 seeds/m^2 as compared to the density of 9707 seeds/ m^2 for the dead seeds. Douh,et al. [3] found that the most elevated species lavishness were gotten within the to begin with two soil layers (0–10 cm profundity) whereas 21.8% and 21.4% of the species were only found within the most profound layer (10–20 cm) within the Celtis timberland and the Manilkara timberland, individually. .From these results the vertical distribution and soil seeds density were higher in upper layers and this agreed with El-Safouri [7] and Mohamed [14]and agreed with which was found by Clement and Bentiot [16] and Dessint et al. [17]. The study also showed that the percentage of dead seeds was higher as compared to that of live seeds this agreed with Roberts and Stokes [18]. The non-viability of seeds may be attributed to suffocation resulting from water logging, shedding of seeds before maturity and high temperature. This agreed with that reported by Mohamed [13] Abdallah [14]. The number of live and dead seeds varies among the sites in Mosei, Wadi, and Jabal, according to the results. This suggests that the vegetation varies among the sites, and it could be caused by topography, various ecological factors, including grazing, human activity, land clearance for agriculture, and the production of charcoal [19, 20].

5. Conclusion

In depth 0-5 cm, the density of live seeds was 5560 seeds/m^2 whereas the dead seeds density was 12150 seeds/m^2. In depth 5-10 cm, the density of live seeds was 3254 seeds/m^2 as compared to density of 9707 seeds/m^2 for the dead seeds. Distribution of soil seed bank showed a high density in upper soil layer. The study recommended more research work is needed to document and highlight the effects of grazing and other activities on soil seed bank so as to help the rangeland managers and decision makers.

Compliance with ethical standards

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