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ASSESSMENT OF SOIL SEED BANKS IN SEMI-ARID REGIONS, SUDAN

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ABSTRACT
This study was conducted at Getaina locality in White Nile state. It lies between latitudes 15°: 13" N- 13°: 30"N and longitudes 32°: E- 33°E. The objective of this study was to investigate the soil seed bank under different conditions and practices in the study area. The soil seed bank was analyzed for the number of live and dead seeds at three depths in two types of soils within the study area. The study showed that 13 species were found in site (A) and 12 species in site (B), clay and sand soil respectively. The analysis showed the following results: the seed bank density was higher in upper soil depths as compared to the lower levels for both types of soils. It was also found that the seed density decrease with increasing depth. The live seed density ranges from 789- 7150 seed/m² where as the density of the dead seed s ranges from 2410-12150 seeds /m².The plant species to which the live seeds belong were *Chloris gayana, Panicum turgidum, Aristida adscensionis, Tribulus terrestris, Cenchrus ciliaris, Schoenfeldia gracilis, Indigofera spp, Eragrostis tenella, Achyranthus aspera, Barchiaria mutica, Cenchrus biflorus, Corchorus spp.* and *Dactyloctenium aegyptium*,The plant species to which the dead seeds belong were *Chloris gayana, Panicum turgidum, Aristida adscensionis, Tribulus terrestris, Cenchrus ciliaris, Schoenfeldia gracilis, Indigofera spp, Eragrostis tenella, Achyranthus aspera, Brachiaria mutica, Cenchrus biflorus, Corchorus spp* and *Dactyloctenium aegyptium.* ANOVA results showed that there were high significant differences in the number and density of live and dead seeds within depth and species in the study area.

KEY WORDS: Soil seed bank, live seeds, dead seeds, density, species composition, semi-arid

INTRODUCTION
Sudan is the largest country in Africa and the ninth largest in the world with an area of about 2.5 km², which constitutes 8.3 % of the land area of Africa. It exhibits a wide range of variation in its topography, climate, soil and hydrology. These variables characteristics are reflected in diversified ecological habitats and vegetation zones. It is a country of fragile ecosystems and frequent droughts. Examination of Sudan's ecological zones indicates that the majority of its land is quite vulnerable to changes. According to the diverse ecological zones more than half the country can be classified as desert or semi-desert with another quarter, arid savannah. Changes in temperature and rainfall are likely to lead to desertification in some regions (IFAD, 2006).The vegetation composition is a result of interaction of species with varying ecological tolerances and vegetation requirements. The change in the physical or biotic environment leads to the disturbance of interaction which causes changes in vegetation over-time. Other factors which also cause vegetation change include intensity of grazing and climatic variations (IFAD, 2006). The country is rich in its natural resources, among them are vast rangelands which are used for both livestock and crops production, that plays a vital role in the economy and welfare of rural people. Within the traditional agricultural systems of Geteina, number of components is involved with varying levels of importance. The human pressure on the rangeland manifests the demand for cropland, grazing land and forest products. It is imperative that this demand can be accommodated as practicable in orders to obtain the cooperation of the sedentary and nomadic rural population in the protection and management of the rangeland. (IFAD, 2006) Soil seed bank is a very important factor in rangeland vegetation management that can sustain vegetation regeneration; moreover soil seed bank can play an important role in the conservation and protection of plant communities. Soil seed bank can be affected by many factors such as environment, human activities, as well as biological factors. One of the major factors effecting soil seed bank in Getaina rangeland is overgrazing. Large number of different types of animals is grazing on natural vegetation. Ibrahim (2005) reported the density of about 19700 seeds/m^2 dead seeds and 7238 seeds/m^2 of live seed in the low Rainfall. Elsafori (2006) found that the average seed bank size of live seeds was 3193 seeds/m^2 and 5086 seeds/m^2 found dead in the semi-arid land.

MATERIALS & METHODS
The area under study falls within the semi-desert region. Direct observation and primary surveying were used to assess environmental condition and plant community types. The global positioning system (GPS) was used to determine the images of the study area and sample plots.

Collection of soil samples
The study area was divided in to two sites (sand and clay soil). Within each site two transects were demarcated. A total of 25 samples plots were assigned a long each transect. The distance between the sample plots was 4 km. Soil samples were taken from three depths (0-5, 5-10, 10-

15 cm) in each sample plot. The total numbers of soil samples taken per soil depth and per sample plot are 75.The samples mixed thoroughly and then sub-samples of 250g from mixed samples were prepared for physical extraction. These sub-soil samples were placed in a set of sieves with pores of 0.06m and 0.03m respectively, and then were washed for 10-15min under continuous flow of water. The soil was washed away leaving only the seeds. The seed were transferred to a 500ml beaker and water was added, the dead seeds were observed to float. The water containing the floating dead seeds was immediately filtered in a Bunchner funnel. The residue (dead seeds) was air –dried. The live seeds at bottom of the beaker were extracted as follows: A weigh of 1.5 of $CaCl_2$ was accurately weighed and dissolved in 250ml of distillated water. The solution was added to live seed in the beaker and left for 40 minutes. The live seeds were observed to float in the Cacl**2** solution. These were then filtered in a Buchner funnel and the residue (live seeds) was air-dried. The density of seed was determined by the following formula:

$$D = \frac{\text{Number of seeds / soil depth } \times 2 \times 10000}{\text{Quadrate area } \times \text{ Number of Quadrate / soil depth}}$$

The data was analyzed by (SAS) program.

RESULTS & DISSCUSION

The results (Table 1,2) indicated high significant differences in plant species number within different depths, generally the upper depths with high plant species than lower depths.

TABLE 1: Soil seed bank at site (A):

	0-5/ cm		5-10/ cm		10-15/cm		Total	
Species	live	Dead	live	dead	live	dead	live	dead
Chloris gayana	110	185	12	52	05	05	127	240
Panicum turgidum	13	13	07	07	-	-	20	20
Aristida adscensionis	21	46	08	17	11	08	40	71
Tribulus terestris	02	07	-	04	-	-	02	11
Cenchrus ciliaris	03	31	01	10	-	-	04	41
Schoenfeldia gracilis	39	40	04	10	3	09	46	59
Indigofera spp	01	06	-	17	-	-	01	23
Eragrostis tenella	-	02	-	-	-	-	-	02
Achyranthus aspera	-	-	-	-	-	-	-	-
Barchiaria mutica	-	06	2	-	-	-	02	06
Cenchrus bilforus	1	02	-	02	-	07	01	11
Corchorus spp	-	01	-	-	-	-	-	01
Dactyloctenium aegyptium	-	-	-	-	-	-	-	-
Total	190	339	34	119	19	29	243	487

TABLE 2: Soil seed bank at site (B)

	0-5/ cm		5-10/ cm		10-15/cm		Total	
Species	live	Dead	live	dead	Live	dead	Live	dead
Chloris gayana	22	31	10	118	02	19	34	168
Panicum turgidum	37	11	17	20	-	15	54	46
Aristida adscensionis	22	17	09	28	01	02	32	47
Tribulus terestris	-	13	-	04	-	-	-	17
Cenchrus ciliaris	05	54	03	21	-	03	08	78
Schoenfeldia gracilis	22	62	23	30	-	11	45	103
Indigofera spp	18	03	-	08	-	06	18	17
Eragrostis tenella	-	-	-	-	-	-	-	-
Achyranthus aspera	01	02	01	-	-	-	02	02
Barchiaria mutica	-	01	-	01	-	-	-	02
Cenchrus biflorus	02	02	-	-	-	-	02	02
Corchorus spp	-	-	-	03	-	-	-	03
Dactyloctenium aegyptium	-	-	02	-	-	-	-	02
Total	129	196	65	233	03	56	195	487

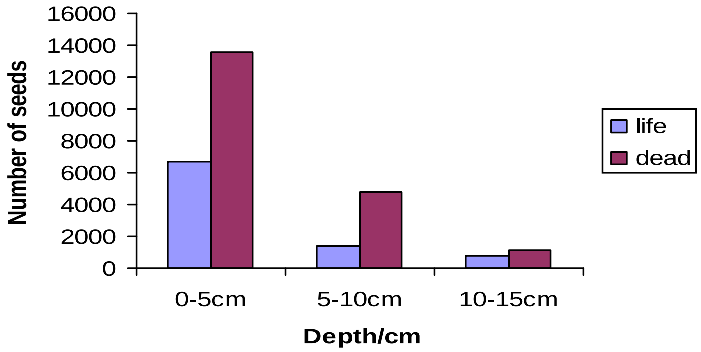

FIGURE 1: Histogram showing the number of live and dead seeds at each soil depth for site (A)

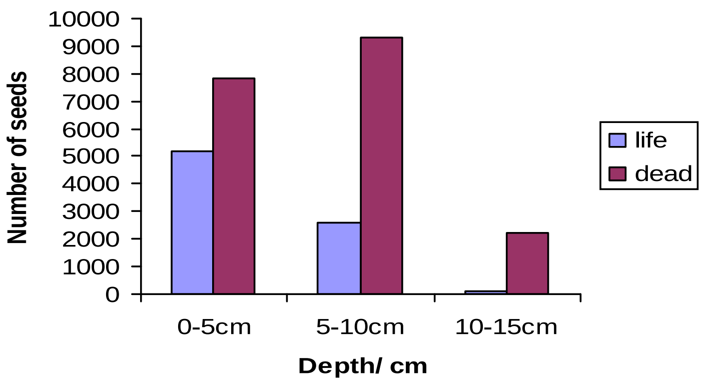

FIGURE 2: Histogram showing the number of live and dead seeds at each soil depth for site (B).

The density of seeds according to the depths

In depth (0-5 cm,) the density of live seeds was 7150 seeds /m² whereas the dead seeds density was 12150 seeds /m². In the depth (5-10), the density of live seeds was 2440-seeds /m² as compared to the density of 6657 seeds /m² for the dead seeds. In the depths (10-15cm), the density of live seeds was 789 seeds /m² while that of dead seeds was 2410 seeds /m².

From these results the vertical distribution and soil seeds density were higher in upper layers and that both vertical distribution and soil seed density decreases with increasing depths. These results are in agreement with results found by Clement and Bentiot (1996) and Dessint *et al*. (1991).

The density of live seed was low in the study area as compared with Roberts and Stodes (1996).This may probably be due to site condition and environmental factors. The study also showed that the percentage of dead seeds was higher as compared to that of live seeds. This may be attributed to suffocation resulting from water logging, shedding of seeds before maturity and high temperature.

The study also revealed that the live seeds in depth (0-5cm) belong to (9) species while the dead seeds belong to (11) species. The depth (5-10cm), the live seed belong to (9) species and the dead seeds belong to (11) species. However, in the depth (10-15cm) the live seeds belong to (7) species and the dead seed belong to (8) species. The number of the species decreases with increasing depth.

The dominant seeds flora at site (A) was *Chloris gayana, Aristida adscensionis, Scheonefeldia gracilis, Panicum turgidum and Cenchrus ciliaris*. The dominate seeds flora at site (B) *Indigofera spp*, *Scheonofeldia gracilis*, *Aristida adscensionis*, *Panicum turgidum, Chloris gayan and, Cenchrus ciliaris*. Dominate of the above mention species in the soil seed bank in two site may be attributed to there prolific seeding and good growth and establishment. Moreover, these species are resistant to decay protected from predictors and tolerate adverse climatic conditions.

There were differences among dominate in the percentage of the total live seeds, the frequencies of the total live seeds for - *Scheonofeldia gracilis*, *Aristida adscensionis*, *Panicum turgidum* and *Chloris gayan*, were 23.69%, 23.49%, 20.9% and 17.2% respectively. From filed observation and soil seed bank identification at the study area, it was found that some grasses and herbs were dominated and this is found in line with Hafliges (1990). This indicate that some of the dominate species have different seed production capacities at different site and climatic condition.

The percentage of the total number of dead seeds was as follows: *Chloris gayana* 26.8%, *Aristida adscensionis* 20.4%, *Scheonofeldia gracilis* 16.3% *and Indigofera spp*.12.3%. This may be due to adverse climatic condition, suffocation and decay besides the shedding of seeds before maturity.

The soil seed bank data was statistically analyzed by (SAS) program, table (3&4) for live and dead seeds within the two sites of the study area a very highly significant difference was found from the live seeds in site (B) and significant difference was found at site (A). The very highly significant difference of live seeds at site (B) may probably due to site condition and diversity of species, prolific seeding. As for the dead seeds at the two sites, a very high significant difference was found at site (B) and highly significant differences found at site (A), was probably due to the site conditions and floristic composition.

The soil seed bank analysis had also shown that the less palatable species were dominated. This agrees with O'conner and Picket (1992) who reported that heavy grazing results in the dominance of less palatable species.

TABLE 3: Soil seed bank analysis for species of live seeds at the study area

Site	Source	D F	Means	F. Ratio	P
A	Depth	2	822.1666	4.81	0.0114
	Species	12	374.790	2.19	0.0227
B	Depth	2	1081.166	9.35	0.0003
	Species	12	465.87	4.03	0.0001

TABLE 4: Soil seed bank analysis for species of dead seeds at the study area:

Site	Source	D F	Means	F. Ratio	P
A	Depth	2	3186.551	5.84	0.0047
	Species	12	1767.000	3.24	0.0011
B	Depth	2	1545.24	4.84	0.0111
	Species	12	1287.62	4.03	0.0001

Variances of live and dead seeds within different depths

The results (Table 5) shows that there were a high significant differences in the dead seeds number within species and depth, this provide evidence of a stronger effect of grazing on both soil seeds bank and standing vegetation composition. Also this effect may be due to environmental and physical factors.

TABLE 5: ANOVA table for the dead soil seed bank in the study area:

source	DF	M. Square	F. value	P R>F
Soil	1	174.51923077	0.44	0.5096
Depth	2	4584.79487179	11.48	0.0001
Species	12	2962.6859744	7.42	0.0001

Sig ***

TABLE 6: ANOVA table for the live seed bank in the study area:

source	DF	M. Square	F. value	P R>F
Soil	1	16.02564103	0.12	0.7313
Depth	2	1893	13.98	0.0001
Species	12	767.83	5.67	0.0001

Sig ***

In table (6) there were high significant differences in live seeds within species and depths, these attributed to site conditions, diversity of species, seeds and prolific seeding. The soil seed bank of the study area was quantitatively determined at each site The herbs and grasses recorded the highest number of seed as compared to the other live forms in the study area.

The woody species seeds not reported, this is in line with which found by Mustafa (1999), Tybrik *et al*. (1994) and Kaarokc (1996).This may be attributed to land over-use through a number of practices including excessive felling of trees, the use of fruits as large marketing of seeds, predictors, pathogens, seed suffocation in water – logged areas and wild fires used in land clearance.

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