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Variation of Soil Seeds Bank in Natural Rangeland of Wad Omer Agricultural Scheme, West Omdurman, Sudan

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Abstract:

The study was conducted in Omdurman locality which is located in Khartoum state, at the end of rainy season of two seasons, 2017and 2018. The aim of the study was to estimate soil seed bank in the natural rangeland so as to use them to develop the proper management plans. Stratified sample was done according to the specific variation of soil seed bank, divided the range sites into two sites, namely, rock soil and sandy soil. About 30 samples were taken systematically a long line transect, 15 soil sample for each site, all samples collected from the three soil depth (0-10, 11-20 and 21-30cm),were placed in plastic bags. All samples of the same depth were mixed of sub-samples of 250g, washed in water and $CaCl_2$ solution to extract the live and dead seeds. Computer and micro capture device were used to identify the seed species, according to the reference seeds. The study showed that, the seeds bank density decreases with the increase of soil depth and the lowest seed number in sandy soil. The five dominant seed bank in terms of the live seed density at the upper depth in the sandy soil range site, were, *Indigofera spp*, Dactyloctenium *aegyptium*, *Schoenfeldia gracilis*, *Amaranthus graecizans* and *Corchorus spp* respectively. The three dominant seeds bank in terms of highest botanical composition in the rocky soil range site, were *Dactyloctenium aegyptium*, Corchorus *spp* and *Schoenfeldia gracilis*, for all live and dead seeds, respectively in the upper soil depth. The study concluded that, the soil depth had a clear effect on the soil seed bank, and the rocky soil range site was better in seed bank density.

Key Words: soil seed bank, vegetation, organic matter**,** sandy soil, rocky soil

Introduction:

The rangeland of the Sudan is a land that is dominated by grasses and forbs managed as a natural ecosystem, (Mohammed, 2011). Rangeland livestock production is an important form of diversified agriculture, (Sayre, et al, 2012). About 70% of livestock in Sudan depends on natural rangeland in their feeding, these rangeland vegetation had different and varied environments which required different levels of management and utilization that fit the elements of each environment. The rangelands are heavily influenced by environmental factors such as drought, where periods vary, especially in rangeland vegetation in terms of quantity and quality. Seasonal fires, especially in semi-arid areas, have high rates of pasture and seed stock in the soil (about 33% of annual production), (El-Wakeel,. (2003). The impact of environmental and biological factors on rangeland resources is reflected in the degradation of these resources. This degradation extends to the soil through its low fertility and reduced soil seed bank, affecting the re-growth of rangeland vegetation after grazing utilization. The soil seed bank plays a vital role in the natural environment and ecosystem (Matthew, and Robert, (1993). The intensity of the stock of rangeland plant seeds differs greatly from one region to another and depends on many factors, such as soil type and previous crops. The soil

seed bank has a great benefit in knowledge of plant communities and to predict invasive plants, (Ministry of Information, 2011). Soil organic matter is one of the main soil constituents and has high influence on the chemical and physical properties of soil. The study aimed was to estimate the soil seed bank and the organic matter in the natural rangeland so as to use them to develop the proper management plans for the purpose of improving and developing rangeland and raising their efficiency.

Material and methods:

Study Area:

The study area is located in Khartoum state and occurs on the northern part of Omdurman (at Elkilo 84, Khartoum – Dongla highway), which is located between 16º 19′ 37″ -16º 27′ N and 31º 43′- 31º 47′ E, (Ministry of Agriculture, Khartoum State, 2012). The total area of the Wad Omer Agricutural Scheme is about (840 hectares), just 25% covered by Scheme activities (210 hectares). Wad Omer village surrounded with a sough village at North (Farah, 2008). Wad Omer Agricultural Scheme is a partnership between FAO and Ministry of Agriculture, Livestock and Irrigation, Khartoum State, (Ministry of Agriculture, 2008).

The concept of this study was to identify the different types of soil seed bank in two sites in the Wad Omer area to use their information for rangeland management and to help the range managers for sound decisions which lead to range resources sustainability.

The Objective:

Soil Sampling and Preparation:

Soil seed bank is a good indicator for assessing the accumulative effect of plant establishment along more than one year. To assess seed bank 30 soil samples from two sites (10cmx10) with depths 0-30, 30-60 and 60-90cm, were taken within each site randomly, and put them in paper bags. The soil samples collected at the end of rainy season, October 2018. The soil was mixed and sub-sampled of 250/gm, and then were prepared for washing and extraction.

The sub-samples of 250g with pores of soil samples were washed using three sieves of (1.0-0.5 and 0.25mm) put under each other, at the laboratories of the Higher Council Environment and Promotion, to extract the seeds from soil samples. After seed extraction,was floated into 250mm water for 45 minutes, until the dead seed float in the water surface, and then filtered by using filter papers. The live seed, which were sec in the bottom of the beaker,was floated in Calcium Chloride $CaCl_2$ 12g/ml solution for live seed extraction, and was put in filter papers for drying.

Seeds of the different species were identified under the microscope MBC Anatomy -10 by comparing them with a previously prepared colored image of seeds collected from the plants of study sites, and then the percentages of live and dead seeds were calculated according to the following equation:

Percentage of live seeds $= \frac{The\ Number\ of\ Live\ Seeds}{All\ Seeds\ Number} X100\%.$

Percentage of dead seeds $= \frac{The\ Number\ of\ Dead\ Seeds}{All\ Seeds\ Number} X100\%.$

Reference seed samples were used to identify the seed types in the studied samples and a magnifying glass and computer were used to identify seed species in the soil. The seed density was determined per square meter using the following equation:

Seed density $= \frac{Number\ of seeds\ of\ depth*2*10000}{Quadrate\ a[rea*number\ of quadrate\ of\ soil\ depth}$. (Fernandez-Quintanilla *et al.,*1991).

To find out the contribution of seed plant species in the soil seed bank, the following formula was used:

Percentage of seed plant species$= \frac{Number\ of\ seed\ plant\ species}{All\ number\ of\ seeds} X100\%.$

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Data Analysis:

Data obtained from this study were organized and analyzed by using and SAS statistical program, Duncan multiple range test and t test.

Results and Discussion:

Seed Bank Density at the Study Area:

The results represented in table (1) showed that, the soil types had no significan affected on the seed density in the Wad Omer area. On the other hand, soil depth had a significant effect on seed density in the soil. The depth of 0-1 0 cm was the highest seed density per square meter in both soil types of live and dead seeds, followed by the depth 11-20 cm, while the depth 21-30 cm recorded less seed density, see table (2 and 3). These results agree with Abdelsalam et al (2017), who stated that the soil depth had a highly significant effect on the seed density, while the seed density was not affected by the soil types. The high variability of the seed density among the soil depth reflects the occurrence of these seed in the different soil depths. The occurrence of the majority of the seed in the upper layer of the soil makes them able to grow the next growing season. Generally the seed density decreas with the increasing of the soil depth, this agrees with Elsafori and Abdallah, (2014), who found that the seed density decrease according to soil depth increasing.

As compared to the soil types the study explained in table (2 and 3) that the rocky soil range site had a high number of live seeds (188/m^2, 140m^2 and 68 m^2) than the sandy soil range site which had (168 m^2, 100 m^2 and 44 m^2), in all soil depths. This result demonstrates that the seeds in the rocky soil range site were more able to regenerate the rangelands next years. The lowest seed number in sandy soil may be due to the grazing rangeland, because this range site affected by the early grazing in rainy season. Abdelsalam, et al, (2017), reported that, the early grazing affected the soil seed bank under the heavy grazing.

The higher number of plant species found at the upper layer of the soil into two range sites, which were 10 species in all, and it decreased with the increase of soil depth. Through the results presented in Table (2). there are about five more dominant plant species in terms of live seed density at the upper depth in the sandy soil range site, including, *Indigofera spp*, *Dactyloctenium aegyptium*, *Schoenfeldia gracilis*, *Amaranthus graecizans* and *Corchorus spp* respectively. The results shown in Table (3) indicated that, there were six plant species that were more dense of live seeds than all the plants in the rocky soil range site at the upper depth these were, *Dactyloctenium aegyptium*, *Corchorus spp*, *Schoenfeldia gracilis*, *Panicum turgidum*, *Aristida spp* and *Amaranthus graecizans* sequentially. Among these plant species there were three species found in the two range sites (*Dactyloctenium aegyptium*, *Schoenfeldia gracilis* and *Amaranthus graecizans*), this indicates the widespread spread of these species and their ability to adapt to different soil types. The presence of plant diversity in the study area and differences in seed density may be due to some environmental factors in the area. Fernanda, et al (2004), reported that the soil properties have a clear effect on the soil seed bank. Generally, the density of plant species decreases as the depth of the soil increases, in both range sites. All the plants found in the study area were annual plants, including forbs and grasses except *Panicum turgidum*. Therefore, these rangelands need improvement interventions by introducing some seeds of perennial plants for the sustainability of range and soil conservation. As for the density of dead seeds, there was a clear difference between the range sites, where the *Indigofera spp* and *Amaranthus graecizans* had the highest plant density on the sandy soil range site, while the *Dactyloctenium aegyptium* and *Corchorus spp* were the highest density in the rocky soil range site, in the different soil depths.

Table (1). Effect of soil types and depth on the variation of soil seed bank density.

Source	DF	Mean Squire	F. Value	Pr ≥F
Soil	1	261.3	0.22	0.65NS
Depth	2	12785.3	10.72	0.005**

NS: no significant differences, **: High significant differences at alpha ≥ 0.05

Table (2). Seed density (seed/m^2) at the sandy soil range site.

	Depth 0-10 cm		
Botanical Name	Local Name	Live Seed/m^2	Dead Seed/m^2
Indigofera spp	Sharaya	36	68
Dactyloctenium aegyptium	Abu asabe	32	8
Schoenfeldia gracilis	Danab elnaga	28	12
Amaranthus graecizans	Lessan altir	24	36
Corchorus spp	Khudra bareya	24	12
Panicum turgidum	Tumam	8	8
Tribulus terrestris	Dressa	8	4
Crotalaria senegalensis	Safari	4	4
Ipomoea cordofana	Tabar	4	0
Eragrostis termula	Bano	0	12
Total		**168**	**164**
	Depth 11-20 cm		
Indigofera spp	Sharaya	24	48
Dactyloctenium aegyptium	Abu asabe	24	12
Schoenfeldia gracilis	Danab elnaga	16	8
Amaranthus graecizans	Lessan eltair	16	20
Corchorus spp	Khudra bareya	16	8
Panicum turgidum	Tumam	4	8
Sarcopterium spinosum	Natash	0	4
Total		**100**	**108**
	Depth 21-30 cm		
Indigofera spp	Sharaya	8	16
Dactyloctenium aegyptium	Abu asabe	12	4
Schoenfeldia gracilis	Danab elnaga	12	8
Crotalaria senegalensis	Safari	0	4
Ipomoea cordofana	Tabar	12	0
Sarcopterium spinosum	Natash	0	4
Total		**44**	**36**

Table (3) Seed density (seed/m^2) at the rocky soil range site.

	Depth 0-10 cm		
Botanical Name	Local Name	Live Seed/m^2	Dead Seed/m^2
Dactyloctenium aegyptium	Abu asabe	36	32
Corchorus spp	Khudra bareya	36	20
Schoenfeldia gracilis	Danube image	28	12
Panicum turgidum	Tumam	24	4
Aristida spp	Gaw	24	0
Amaranthus graecizans	Lessan eltair	20	8
Indigofera spp	Sharaya	8	0
Crotalaria senegalensis	Safari	4	0
Eragrostis termula	Bano	0	8
Sarcopterium spinosum	Natash	0	12
Total		**188**	**96**
	Depth 11-20 cm		
Dactyloctenium aegyptium	Abu asabe	32	28

Corchorus spp	Khudra bareya	32	16
Panicum turgidum	Tumam	12	0
Aristida spp	Gaw	12	4
Amaranthus graecizans	Lessan eltair	8	0
Indigofera spp	Sharaya	12	4
Sarcopterium spinosum	Natash	20	0
Ipomoea cordofana	Tabar	8	4
Tribulus terrestris	Dressa	4	0
Total		**140**	**56**
	Depth 21-30 cm		
Dactyloctenium aegyptium	Abu asabe	12	8
Corchorus spp	Khudra bareya	8	4
Panicum turgidum	Tumam	4	0
Aristida spp	Gao	12	0
Amaranthus graecizans	Lessan eltair	12	4
Sarcopterium spinosum	Natash	16	0
Ipomoea cordofana	Tabar	4	0
		0	4
Total		**68**	**16**

Botanical Composition of Soil Seed Bank in Wad Omer Area:

Botanical composition of seed bank reflects the contribution of plant species in the future plant community at the study area. The result shown in table (4) illustrates the diversity of plants in the sandy soil range sites. Five plant species showed highest percentages in terms of botanical compositions these were *Indigofera spp*, *Dactyloctenium aegyptium*, *Schoenfeldia gracilis* and *Corchorus spp*, in two depths (0-10 and 11-20 cm), while only three species showed high species composition such as *Indigofera spp*, *Dactyloctenium aegyptium* and *Schoenfeldia gracilis* respectively in the last depth (21-30 cm). These results was confirmed that, the *Indigofera spp*, records the highest percentage in all soil depths, including live and dead seeds, but the percentage of dead seeds exceeded the percentage of living seeds, 44.5% and 21.4% in depth 0-10 cm, 44.4% and 24% in depth 11-20 cm and 44.4 and 18.1% in depth 21-30 cm of dead and live seeds botanical composition respectively. From these results, it can be concluded that, the seeds of the *Indigofera spp* lose a large percentage, making them vulnerable to loss of their seed bank in the soil and threatening their natural regeneration.

Table (5), indicated that there were three plant species records the highest botanical composition in the rocky soil range site they were, *Dactyloctenium aegyptium* (19.1% and 33.3%), *Corchorus spp* (19.1% and 20.8) and *Schoenfeldia gracilis* (14.9 % and 12.5), for all live and dead seed, respectively in the upper soil depth. While the *Dactyloctenium aegyptium* and *Corchorus spp* showed the highest botanical composition percentage in the lowest soil depths (11-20 cm and 21-30 cm). Species less preferred by animals like *Corchorus spp* showed a high percentage in plant composition in this range site, which may explain their competitive advantage compared with preferred species as a result of selective grazing. This site needs some management interventions to increase the proportion of desired plant species and reduce the competition between them and undesirable plants. Samia, (2012) confirmed that, the tangible impact of management practices including improving the vegetation composition of the more potential sites at large scale.

Table (4) Seed botanical composition % of the sandy soil range sites:

	Depth 0-10 cm		
Botanical Name	Local Name	Live Seed %	Dead Seed %
Indigofera spp	Sharaya	21.4	41.5
Dactyloctenium aegyptium	Abu asabe	19	4.9
Schoenfeldia gracilis	Danab elnaga	16.6	7.3
Amaranthus graecizans	Lessan eltair	14.3	22
Corchorus spp	Khudra bareya	14.3	7.3

Panicum turgidum	Tumam	4.8	4.9
Tribulus terrestris	Dressa	4.8	2.4
Crotalaria senegalensis	Safari	2.4	2.4
Ipomoea cordofana	Tabar	2.4	0
Eragrostis termula	Bano	0	7.3
Total		**100**	**100**
	Depth 11- 20 cm		
Indigofera spp	Sharaya	24	44.4
Dactyloctenium aegyptium	Abu asabe	24	11.1
Schoenfeldia gracilis	Danab elnaga	16	7.4
Amaranthus graecizans	Lessan eltair	16	18.5
Corchorus spp	Khudra bareya	16	7.4
Panicum turgidum	Tumam	4	7.4
Total		**100**	**99.9**
	Depth 21-30 cm		
Indigofera spp	Sharaya	18.1	44.4
Dactyloctenium aegyptium	Abu asabe	27.3	11.1
Schoenfeldia gracilis	Danab elnaga	27.3	22.2
Crotalaria senegalensis	Safari	0	11.1
Ipomoea cordofana	Tabar	27.3	0
Sarcopterium spinosum	Natash	0	11.1
Total		**100**	**99.9**

Table (5). Seed botanical composition % of the rocky soil range sites.

	Depth 10 cm		
Botanical Name	Local Name	Live %	Dead Soil %
Dactyloctenium aegyptium	Abu asabe	19.1	33.3
Corchorus spp	Khudra bareya	19.1	20.8
Schoenfeldia gracilis	Danab elnaga	14.9	12.5
Panicum turgidum	Tumam	12.8	4.2
Aristida spp	Gaw	12.8	0
Amaranthus graecizans	Lessan eltair	10.6	8.3
Tribulus terrestris	Dressa	4.3	0
Indigofera spp	Sharaya	4.3	0
Crotalaria senegalensis	Safari	2.1	0
Eragrostis termula	Bano	0	8.3
Sarcopterium spinosum	Natash	0	12.5
Total		**100**	**99.9**
	Depth 20 cm		
Dactyloctenium aegyptium	Abu asabe	22.9	50
Corchorus spp	Khudra bareya	22.9	28.7
Panicum turgidum	Tumam	8.6	0
Aristida spp	Gaw	8.6	7.1
Amaranthus graecizans	Lessan eltair	5.6	0
Tribulus terrestris	Dressa	2.9	0
Indigofera spp	Sharaya	8.6	7.1
Sarcopterium spinosum	Natash	14.3	0
Ipomoea cordofana	Tabar	5.6	7.1
Total		**100**	**100**
	Depth 21-30 cm		
Dactyloctenium aegyptium	Abu asabe	17.6	50
Corchorus spp	Khudra bareya	11.8	25
Panicum turgidum	Tumam	5.9	0
Aristida spp	Gaw	17.6	0
Amaranthus graecizans	Lessan eltair	17.6	25
Sarcopterium spinosum	Natash	23.5	0
Ipomoea cordofana	Tabar	5.9	0
Total		**99.9**	**100**

Live and Dead Seeds at the Two Range Sites of Wad Omer Area:

According to the results shown in table (6) there were no significant differences in the percentages of live and dead seeds between sandy and rocky soil range sites, but there was a high significant difference between the soil depths (Pro ≥T 0.04), especially the percentage of live seeds in the rocky soil where the last depth (21-30 cm), recorded the highest percentage of live seeds more than 80%, on the other hand the upper layer records lowest live seeds percentage (58%). These results may reflect the impacts of the soil erosion on the upper layer, which causes the disappearing of seeds as a result of wind movement.

Table (6). Percentages of live and dead seeds of the sandy and rocky soil range sites.

Soil Depth/cm		**Sandy Soil**		**Rocky Soil**	
		Live Seed %	Dead Seed %	Live Seed %	Dead Seed %
0-10		50.6	49.4	58	42
11-20		48.1	51.9	71.4	28.6
21-30		55	45	81	19
		Statistical Analysis			
Source	Mean	Std Dev	Std Error	T	Pro ≥T
Live Seed	-18.97	9.62	5.56	-3.41	0.07NS
Dead Seed	18.9	10.05	5.80	3.25	0.08NS
Depth	-64.80	25.75	14.87	-4.36	0.04*
Soil	-1.18	22.57	9.21	-1.28	1.00NS

Conclusion:

This study councluded that, the soil depth had a clear effect on the soil seed bank, and the rocky soil range site was better in seed bank density. The majority of seed bank density occurred in the upper layer of soil. There were many variations of soil seed bank in different soil depths on the both soil types.

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