Pak.J.Bot., 27(2): 309-319, 1995.

THE SEED BANK OF DESERT SOIL IN CENTRAL SAUDI ARABIA

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Abstract

Rate of emergence of seedlings from the uppermost 2 cm layer of soil from different habitats of the desert of North, South-West and South-East of Riyadh City in the Central Region of Saudi Arabia was examined. In most of the sites the emergence of the seedlings started after one week. The number of individual plants that emerged at the end of the experiment ranged from 44 to 2660 plants m^2. A number of 59 species of plants were identified. Biomass of the emerged seedlings ranged from 0.356 to 308.524 per sq metre.

Introduction

Knowledge of seed banks and their relationship to the desert vegetation is a fundamental part of understanding the ecological and physiological processes by which desert plants have become adapted to their harsh and variable environment. Although the literature concerning seed banks is large and expanding rapidly (Egley, 1986, 1989; Benoit *et al.*, 1989), very little is known about the seed banks in desert soils and their relationship to plant population dynamics (Kemp.1989).

Successful germination and establishment of seeds of many desert plants are dependent on the pattern and duration of the available soil moisture (Steenbergh & Lowe, 1969; Jordan & Nobel, 1982). Under desert conditions seed germination only occurs when enough rain falls to ensure the normal development of the seedlings (Fenner, 1992). Since there is lack of information about buried viable seeds into the soils of Saudi Arabia, experiments were therefore, carried out to determine the buried viable seed number in a series of study sites in the central region of Saudi Arabia.

Materials and Methods

Soil samples were collected from the sites situated at 100 Km N, SE and SW of the Riyadh City in Central Saudi Arabia (Fig.1) and each was sub-divided into six geomorphological units viz., a) Hills, b) Foothills, c) Plains, d) Sand sheets, e) Wadi banks and f) Depressions.

In the subsequent analysis each sample will be named after the geomorphological unit and the direction from Riyadh; e.g., the sample from the hills to the north will be called 'hills N'. Each sampling unit represents a volume of soil which is defined as the uppermost 2 cm of the soil over an area of 50 x 50 cm, the volume being 5000 cm^3. All samples were transported to the greenhouse in Botany Department at College of Sci-

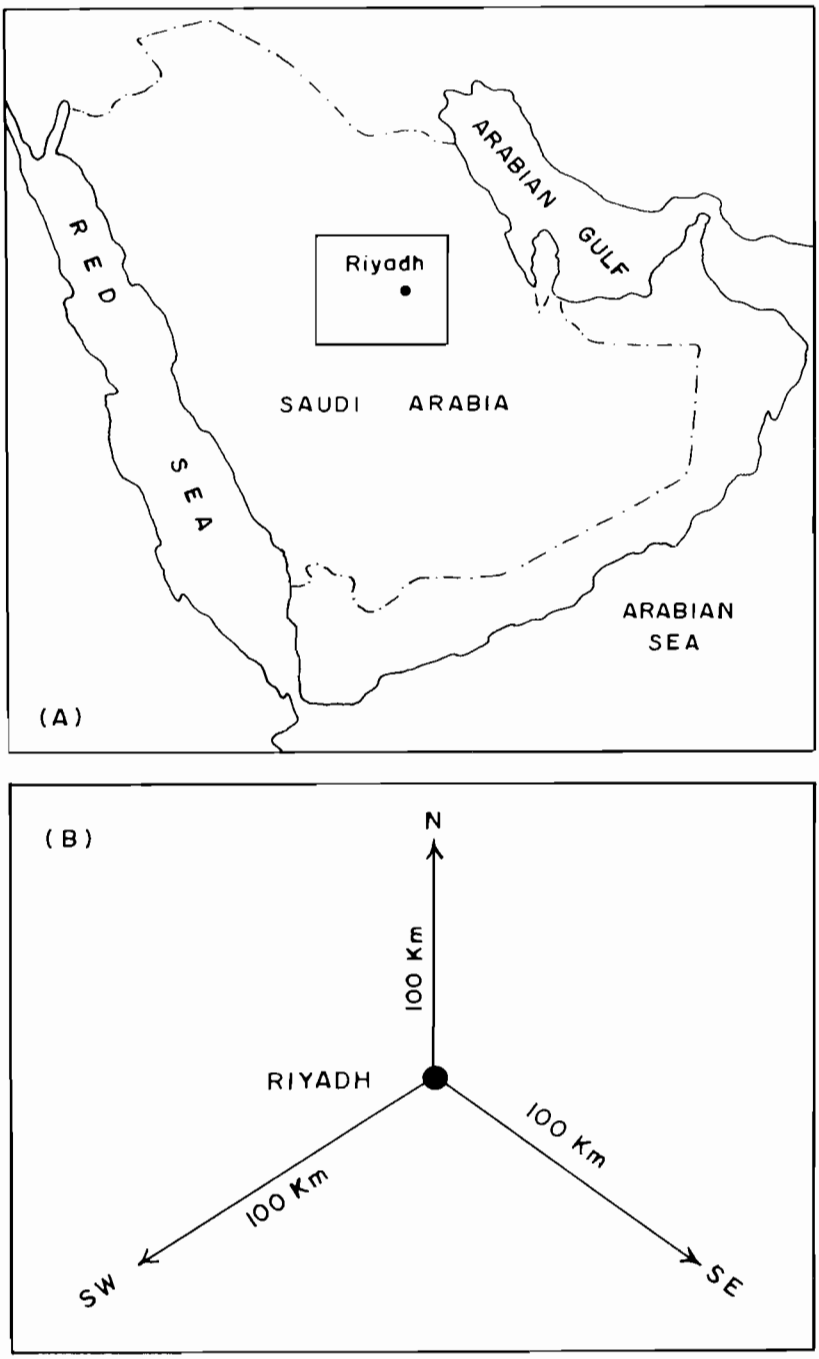

Fig.1. Map of Saudi Arabia (A) and the study sites (B).

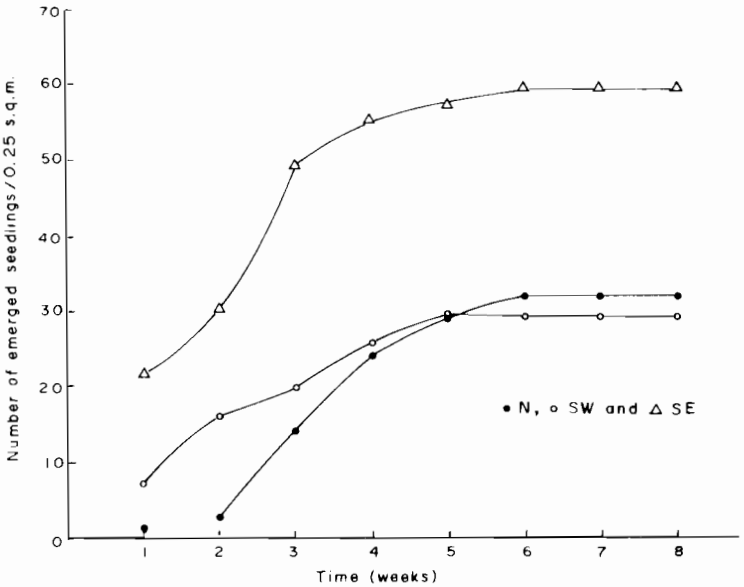

Fig.2. Emergence of seedlings per 0.25 m^2 from soils collected from hills ground Riyadh

ence, King Saud University in cloth bags. The samples were put into plastic trays, each 50x50 cm in area, to mimic the soil thickness in the study sites. The treatments were replicated five times and placed in completely randomized design in greenhouse with 36/21°C ± 2 day and night temperature. Irrigation was carried out twice a week with tap water. The number of emerged seedlings in each tray was counted daily until no further seedlings appeared for two successive weeks. Seedlings were identified according to Chaudhary & Zawawi (1983), Collenette (1985), Mandaville (1990) and Migahid (1990). The plants were oven dried at 80°C and the density and dry weight of the seedlings recorded.

Results and Discussion

Seed banks in desert soils are concentrated in the upper few centimeters of the soil as the seeds are mainly found near the soil surface Baker (1989) found that 80 to 90% of seeds were in the upper 2 cm of soil. Kemp (1989) found that the seeds of many desert annual species cannot germinate and emerge from depth more than one cm.

Number of Emerged Seedlings: In the majority of the sites the emergence of the seedling started in the first week except for the samples the plains SW and plains SE which started in the second week (Fig.2,3,4,5,6 and 7). The number of emerged seedlings showed a wide variation in the soil samples. On the third week, the number of seedlings per tray ranged from 6 to 646 seedlings. Lowest number was recorded in soil collected from the plains SE, while the highest number of seedlings was found in the soil collected from depression N.

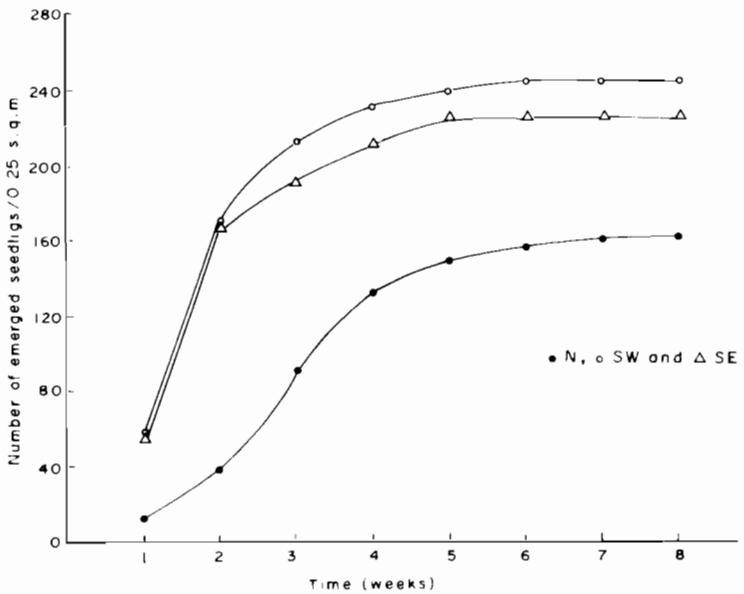

Fig.3. Emergence of seedlings per 0.25 m^2 from soils collected from foot hills ground Riyadh

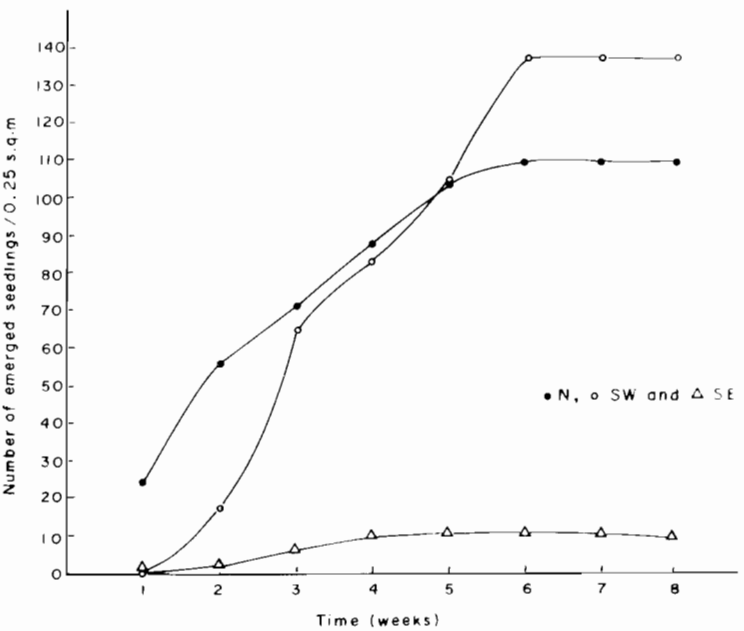

Fig.4. Emergence of seedlings per 0.25 m^2 from soils collected from plains ground Riyadh

Number of emerged seedlings increased on a weekly basis reaching a maximum on the 6th week from 11 to 665 seedlings per 0.25 m^2. After 6 weeks no seedlings emerged. Highest number of emerged seedlings were recorded from soils collected from depressions 2660, 1596 and 1284 plant/m^2 in the N, SE and SW direction respectively (Table 1) while the lowest values were recorded from soils collected from hills 116, 128 and 236 plant/m^2, in the SW, N and SE direction, respectively. Soil sample from plains SE had the lowest emergence rate of 44 plant/m^2.

The results show that within the uppermost 2 cm of desert soils it is possible that a tremendous number of plant individuals can emerge. In this study the number ranges from 44 to 2660 plant/m^2 and the values represent only part of the potential maximum of seedlings in these soils. Since the emerged seedlings represent only part of the viable seed bank which forms part of the total soil seed content. There are other seeds in a dormant state which have been recognized as a "deposit account" by Harper (1977). Not all seeds in the soil are able to germinate at any particular time for several reasons (Cloudsley-Thompson & Chadwick, 1964; Koller, 1969; Villiers, 1975; Copeland, 1976; Mayer & Poljakoff-Mayber, 1979; Bradbeer, 1988, Fenner, 1992).

Table 1. Density (plant/m^2) and biomass (mg/m^2) of plants emerged from soils collected from different sites.

	Sites	Density (plants/m^2)	Biomass (g/m^2)
	N	128	00.516
1	SW	116	01.416
	SE	236	16.232
	N	640	16.636
2	SW	980	36.888
	SE	908	75.656
	N	436	39.624
3	SW	548	12.044
	SE	044	00.356
	N	456	29.840
4	SW	1048	37.752
	SE	0120	04.832
	N	1212	57.748
5	SW	1064	23.704
	SE	0936	48.680
	N	2660	308.524
6	SW	1284	019.780
	SE	1596	114.308

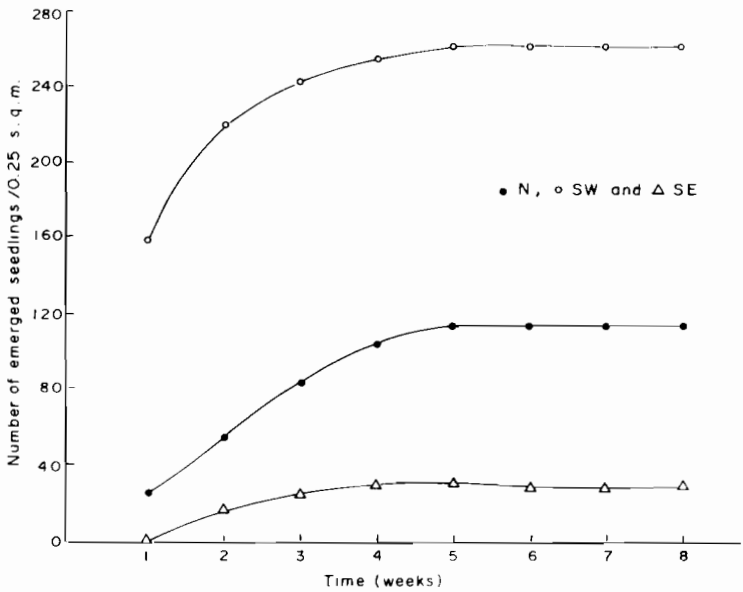

Fig.5. Emergence of seedlings per 0.25 m^2 from soils collected from sand sheets ground Riyadh

The number of seedlings that emerged in this experiment are relatively small in comparison to Zayed (1980) who reported that 6,400 seedlings/m^2 emerged in desert soils from Egypt. High rates of seedling emergence have been reported from cultivated fields ranging from 10,000 to 100,000 per m^2 (Roberts & Stocks, 1960; Roberts & Feast, 1972; Kellman, 1974, Williams & Egley, 1978). The number of buried seeds on rangelands can also be large. Dye (1969) reported 13,000 and 22,000 seeds/m^2 on two different desert grassland sites and Osman (1982) found 4,409 seed/m^2 on an ungraded area and 3.411 seeds/m^2 on grazed area in semi-desert sites in New Mexico.

Seeds of desert plants are known to germinate only after a threshold amount of rain that has fallen (Tevis, 1958; Beatley, 1974) and only under temperatures appropriate for growth (Mahmoud *et al.*, 1984; Kemp, 1989). Some plants germinate only at relatively high temperature e.g., summer annuals species while others do so at relatively lower temperature eg, winter annuals. In this experiment, soil moisture levels were adequate for seed germination but the temperature differences could account for the relatively low emergence rates compared to the other sites noted above.

Biomass: Total dry biomass of the emerged seedling was not proportional to seedling density, which can be attributed to the different floristic composition (Table 1). Highest biomasses were recorded from soil collected from depression N which also had the highest seedling density. The total dry weight of the emerged seedlings in one square meter ranged from 0.356 to 308.524 g. Dry weight was generally higher in the soils collected from the areas to the north of Riyadh in sites 3, 5 and 6 with 39.6, 57.7 and 308.5 g/m^2, respectively.

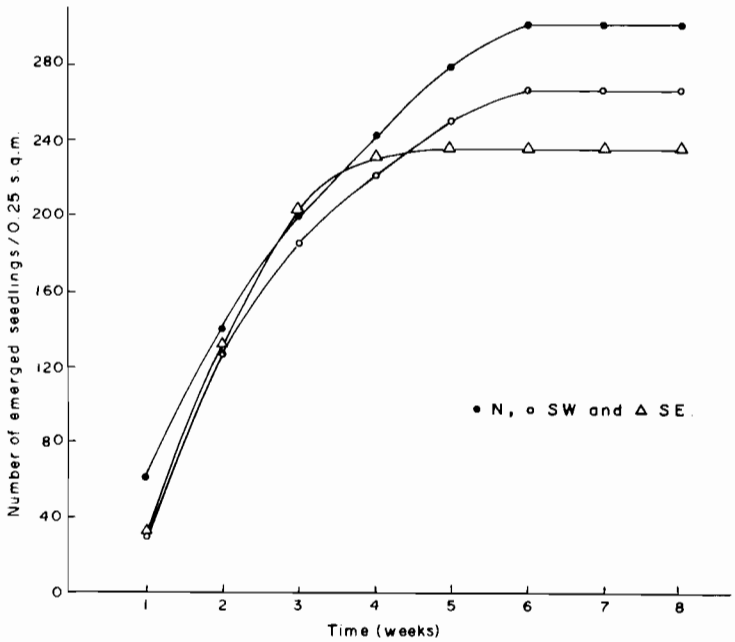

Fig.6. Emergence of seedlings per 0.25 m^2 from soils collected from wadi banks ground Riyadh

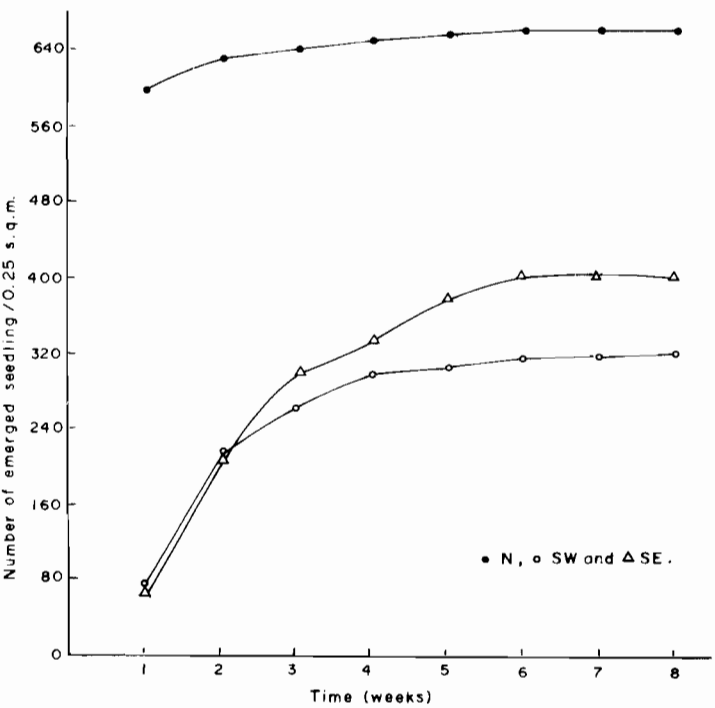

Fig.7. Emergence of seedlings per 0.25 m^2 from soils collected from depressions ground Riyadh

Table 2. Floristic composition of the emerged plants per 0.25 m^2 from sites of 1 = Hills; 2 = Foot hills; 3 = Plains; 4 = Sand sheet; 5 = Wadi banks and 6 = Depressions where A, B and C represent N, SW and SE respectively.

	1			2			3			4			5			6		
Species	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Aizoon hispanicum				2			1											
Amaranthues graecizans		1														2		1
Anisosciadium lanatum					1	44	3			1								10
Asphoedelus tenuifolius													3					
Astragalus corrugatus						1							10			8		
A. schimperi						1										4	1	1
Bassia muricata											1							
Beta vulgaris											1							
Bromus madritensis										3						3		
Cassia italica											1				1			
Chenopodium murale					3			4							1			
Citrullus colocynthis					1	1												
Compositae		1																
Cutandia memphitica							7			10			20			101		
Diplotaxis harra	1				1													
Emex spinosus															4			
Eragrostis barrelieri					12	11			2		36			1				22
Eremobium lineare					2	13						8					17	
Erodium laciniatum																5		1
Euphorbia dracunculides		3													1			
Fagonia bruguieri	3					1									6			
F. indica															1			1
Farsetia aegyptia											1							
Filago desertorum											1			2				
Gastrocotyle hispida																1		
Gerianium sp.																1		
Gramineae	2																	
Herniaria hirsuta													2					
Horwoodia dicksoniae				1	7		9				1		2			2		1
Ifloga spicata	2			8	4	8	10			2	7		34					3
Koelpinia linearis						1						2	3			1		
Lappula spinocarpos						3	3				9		3					
Launaea capitata	1	1		1	7	14	16	1	3	30	9		52	1	2	3	1	2
Lepidium aucheri								2										
Lolium rigidum						1												
Malva parviflora					1						9				1	19		1
Medicago laciniata				1		3		2		1			7		7	32		1

Table 2 (Cont'd)

Species	1			2			3			4			5			6		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Paronychia arabica			2	4			3		1	1	7	1	6		2	29		5
Phalaris minor											2							
Plantago amplexicualis											1			1		3		5
Picris babylonica																9		7
Plantago boissieri		2	1	3	110		2							7			156	
P. ciliata							6			2								
Poa annua		3	8	20	12	40	16	9		2	17	1	69		15	89		213
Polygonum argyrocoleum								1										
Pulicaria undulata						2		24			39				15			
Reichardia tingitana							2									2		
Rostraria pumila																16		
Savignya parviflora	1			14		2	4		1									25
Setaria viridis							1										1	
Sclerocephalus arabicus			1		2	1	6					1			31			1
Silene villosa					2											3		
Silene sp.								7								1		
Spergularia diandra	6			16			20			33			13					
Spergula fallax				2											3			
Stipagrostis sp.			2															1
Tragus berteronianus			5												8	2		9
Trigonella anguina				1			1							236	15			6
T. stellata													3					
Non-identified	23	17	23	82	86	61	8	86	5	30	121	18	78	16	12 8	325	145	86

Floristic Composition: There are reports that some seeds are born dormant, some acquire dormancy and some have dormancy thrust upon them (Bradbeer, 1988). One would therefore not expect to find many species germinating, especially in desert soil. In the present study it was difficult to identify all the emerged seedlings, the non-identified species represent a considerable number of seedlings (ranging from 5 to 325 plant/0.25 m^2) and were found in all soil sample (Table 2). The number of identified species was 59. *Poa annua* was relatively abundant, where a total of 506 individuals were found and it occurred at most sites. *Launnaea capitata* appeared in all of the sample sites except hills N' and 'sand sheets SE'. There were 17 species which only appeared at one site each.

There is need for further studies on the buried viable seeds both under greenhouse and under field conditions in Saudi Arabia.

Acknowledgements

The authors wish to express their thanks to Professor Andrew Millington, University of the Leicester, U.K., for reading the manuscript, Mr. R.A. Dosoky for laboratory assistance and Mr. Jacob Thomas for helping in plant identification.

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(Received for Publication 13 February, 1995)