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SEED BANK DYNAMICS OF *GYNANDROPSIS GYNANDRA* L. (BRIQ.), IN A ARID SHRUB LAND OF SINDH

SYLVIA SABIR AND SEEMI AZIZ*

Department of Botany, University of Karachi, Karachi-75270, Pakistan
**Corresponding author's email: seemiaziz12@gmail.com*

Abstract

The present research aims to understand the seed bank dynamics of a selected shrub land of Sindh. Studies were conducted for two consecutive years (2012 & 2013). Mostly annual species were observed to be growing on the study site which exhibited persistent nature of seed bank and few perennial species were also collected. Existing vegetation was well represented in the seed bank samples in both years however; the seed bank species in 2013 were not well represented in the above ground vegetation which was related to increased site disturbance. Seed densities for most species were highest before rainfall with a gradual decrease after rainfall. The onset of dispersal caused significant increase in seed densities in the third collection i.e., in soil samples collected after seed rain. Enhanced surface disturbance in the year 2013 caused a decline in overall seed count.

Key words: Arid, Seed bank, Disturbance, Seed density.

Introduction

Seeds are vital components of plant communities (Luzuriaga *et al.*, 2005) because they serve as initiators as well as sustainers of plant populations. Understanding of seed population enables scientists to determine the structure of standing vegetation (Wang *et al.*, 2005), colonization patterns (Abella & Wallace, 2007) and successional trends of plants in response to environmental implications as well as recovery potential (Ma *et al.*, 2009) for improved management of ecosystem. Seed bank composition of a community mainly depends upon the historic above ground vegetation as well as seeds dispersed from surrounding areas (Hutchings & Booth, 1996). Arid shrub lands are majorly composed of annual plants (DeFalco *et al.*, 2009). Similarities between the above ground vegetation and seed bank composition is high in communities dominated by annual plants (Peco *et al.*, 2012), however, the species composition of seed bank and above ground vegetation does not always resemble each other closely (Parker & Kelly, 1989). Shrub lands of Sindh constitute a fragile ecosystem primarily due to climatic extremities and their seed banks are vulnerable to an array of surface disturbances related to anthropogenic activities. This pertains to the fact that seeds tend to modify their dormancy and germination pattern to ensure their reproductive success and persistence (Khan, 1993), thereby affecting the dynamics of plant populations. Variation in rainfall patterns causes spatial, temporal and seasonal variability due to their direct dependence on important life processes of plants such as germination, growth and productivity (Jordan & Nobel, 1982; Gutierrez *et al.*, 2000; Johannsmeier, 2009). Compared to 1975, an increase in the seed bank was reported in 1976 in Sonora Desert which was attributed to comparatively higher rainfall (Kemp, 1989). Along with climate playing a controlling factor for seed banks, it has also been proposed by Gibson & Looney (1993) that disturbances can cause a failure in the carryover of seeds from one generation to the next, limiting the establishment of persistent seed banks (Sternberg *et al.*, 2003). On the contrary, few studies conducted to understand the effects of grazing revealed no impact (Meissner & Facelli, 1999) as well as increase in the overall seed bank (Navie *et al.*, 1996). Thus, contrasting findings show that seed banks serve as an important link to both historic and futuristic connections with the environment.

The aim of the present study was to determine the dynamics of seed bank by understanding the relationship between above ground vegetation (standing vegetation) and below ground seed bank.

Materials and Methods

Study site: The site chosen for the study is located in the Karachi university Campus, Sindh (Lat. 24˚ 48 N., Long. 65˚ 55 E.). Field study was conducted for two consecutive years i.e. 2012 and 2013. The site is located in a semi-shady area with minimal disturbance in 2012. However, sudden increase in anthropogenic activities such as trampling, garbage disposal and mild grazing was observed in year 2013. Initially, the site showed low plant diversity but with the onset of monsoon showers, emergence of annual species was observed in both years. Some commonly observed species included *Gynandropsis gynandra* L. (Briq.), *Dichanthium annulatum, Peristrophe bicalyculata, Corchorus depressus, Achyranthes aspera, Cencharus biflorus, Tephrosia subtriflora, Sida ovata, Eragrostis ciliaris* and *Rhyncosia minima.*

Seed bank analysis: Seed bank analysis was carried out using the method of Aziz & Shaukat (2012). Twenty soil samples were randomly collected from the study site using an aluminum corer (15cm deep and 2.5cm in diameter) for two consecutive years i.e., 2012 and 2013. Samples were collected at three phenological stages i.e. before rainfall (before germination), after rainfall (after germination) and after dispersal of seeds.

Seeds were sorted out manually with the help of a binocular microscope.

Results

The seed bank of the arid shrub land showed an adequate relationship with the vegetation. The seed bank in 2012 was represented by nine species while the vegetation survey indicated that there were twelve species on the ground (Table 1). There was an increase in the disturbance gradient in year 2013 in the study site which was mainly due to anthropogenic activities. In this year, the seed bank was represented by five species while the vegetation survey indicated that there were eleven species (Table 2). Seed bank composition in both years was relatively similar however seed bank species were less represented in the above ground vegetation in the year 2013, a possible result of anthropogenic intervention which included vehicle parking, garbage disposal and mild grazing. In both years, *G. gynandra*, *D. annulatum* and *P. bicalyculata* showed the highest seed densities.

Apparent variation in the seed densities was observed in three phenological periods (before rainfall, after rainfall and after dispersal) in both years (Figs. 1 & 2). The number of seeds declined post monsoon showers with a rapid increase in the post dispersal phase. Highest number of seeds was collected after dispersal and the lowest number of seeds was collected after rainfall. Overall seed density was higher in the year 2012 compared to that in 2013.

Table 1. Vegetation and seed bank characteristics of a *Gynandropsis gynandra* community in 2012.

Species	RD	RF	RC	Seed bank density
Gynandropsis gynandra	29.48	24.32	21.45	23
Dichanthium annulatum	32.05	24.32	14.43	25
Corchorus trilocularis	6.41	8.1	14.43	5
Cenchrus biflorus	7.69	8.1	3.66	6
Corchorus olitorius	5.12	8.1	5.036	-
Eragrostis ciliaris	8.97	5.4	3.69	12
Tephrosia subtriflora	2.56	5.4	2.94	2
Rhynchosia minima	1.28	5.4	2.38	7
Abutilon indicum	1.28	2.7	2.38	6
Achyranthes aspera	2.56	2.7	0.645	-
Peristrophe bicalyculata	1.28	2.7	1.37	15
Cleome viscose	1.28	2.7	0.857	-
Trichodesma amplexicaule	-	-	-	1

Table 2. Vegetation and seed bank characteristics of a *Gynandropsis gynandra* community in 2013.

Species	RD	RF	RC	Seed bank Density
Gynandropsis gynandra	24.65	23.68	25.99	18
Dichanthium annulatum	27.39	18.42	24.57	20
Peristrophe bicalyculata	15.06	13.15	13.26	11
Sida ovate	8.21	7.89	8.42	6
Rhynchosia minima	4.1	5.62	10.47	-
Corchorus depressus	5.47	7.89	6.422	-
Tephrosia subtriflora	4.1	7.89	3.84	3
Cenchrus biflorus	5.47	5.26	1.83	-
Corchorus olitorius	2.73	5.26	1.139	-
Abutilon indicum	1.36	2.63	2.239	-
Trichodesma amplexicaule	1.36	2.63	1.81	-

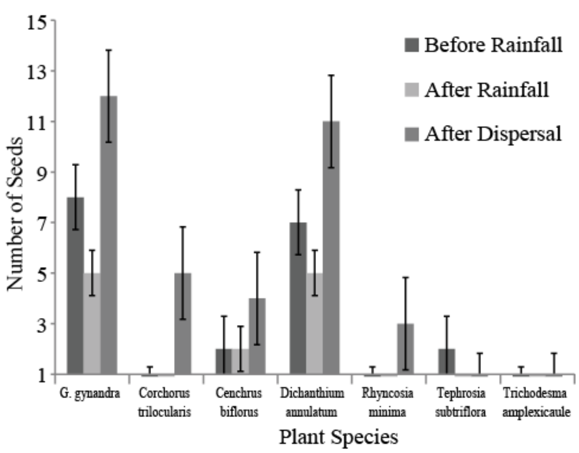

Fig.1. Seeds extracted from soil samples at three phenological stages (2012).

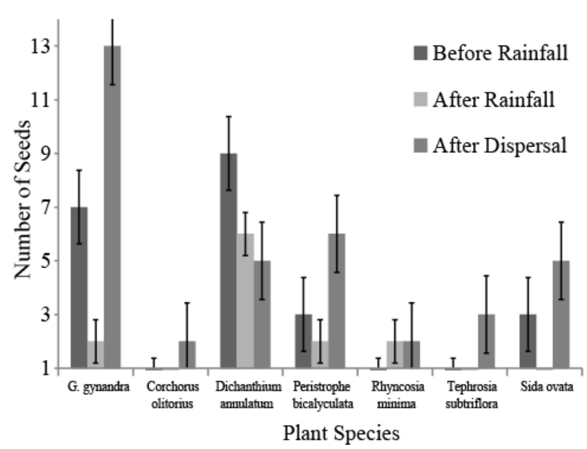

Fig. 2. Seeds extracted from soil samples at three phenological stages (2013).

Discussion

The study revealed that *G. gynandra* and *D. annulatum* were the dominant species in the soil as well as vegetation. It has been reported that in desert environments the intensity of aridity determines presence or absence of certain plant communities (Sotomayor & Gutierrez, 2015). Striking similarities were observed in the seed bank composition of both years, which indicated the persistent nature of seed bank that can be regarded as a survival strategy in response to extreme environments of desert. Similar results were obtained in a study conducted on *Stipagrostis pinnata* which confirmed that the persistent seed bank will ensure that the local population can be restored and will persist despite the population damage (Wang *et al.,* 2005). Another study conducted on two communities, 4 km apart in the Chihuahua Desert showed very slight differences in the mean seed densities and species composition (Dye, 1969).

Few perennials were also observed but their quantities in the seed bank were not as much as those of annuals. Strategically, perennials in desert regions produce less seeds every year and do not depend on seed banks for survival (Beatley, 1980).

It was also observed that the existing vegetation was well represented in the seed bank samples throughout the two years but seed bank species were not well represented in the above ground vegetation in the year 2013. Also, the overall seed densities also declined in year 2013.This is mainly attributed to increased anthropogenic activity in the study area in year 2013 which included trampling, garbage dumping, vehicle parking and mild grazing causing damage to the buried seed reserves as well as the standing vegetation. Such disturbances also directly impact seed bank due to their adverse effects on adult plants (DeFalco, 2009). Grazing and trampling are responsible for reducing the photosynthetic surface area as well as deterioration of reproductive structures leading to alteration in allocation of resources. This can be counted as another reason that even with an adequate momentum of disturbance, annual plant populations of arid environments tend to strategically shield themselves by bearing persistent seed banks (Kigel, 1995).

Our study showed that the beginning of monsoon showers in August marked the start of germination, subsequently causing a decrease in the seed bank of annuals and a gradual increase in the above ground vegetation. Towards the beginning of November the depleted seed reserves were replenished because of dispersal. Climatic variation in desert regions impacts population distribution and consequently affects seed banks (Kemp, 1989) posing a risk to successful population establishment. Therefore, predictable periods of stress cause temporary dormancy and seeds start to germinate with the onset of water availability which is a characteristic feature of annual plants. Similar results were obtained in the population ecology studies of *Cleome viscosa* (Aziz & Shaukat, 2012).

Another interesting observation was the presence of an adequate number of seeds belonging to family Poaceae (*E. ciliaris* and *D. annulatum*), which can be correlated to the addition of nutrients from faeces of herbivores which graze on the study site and organic supply from garbage disposal. This factor may be a hazard in the long term as it may promote the growth of forage species limiting nutrient availability for other plants (Pastor *et al.*, 1993).

From the above discussion it may be concluded that soil seed densities are influenced not only by climatic elements but also by varying intensities of surface disturbances. Therefore, evaluating how disturbances impact seed banks contribute to our understanding of the resistance of arid environments and leads to recommendations of conservation strategies for arid habitats.

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