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INFLUENCE OF DISTURBANCE ON THE SEED BANK DYNAMICS OF DESERT PLANTS

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ABSTRACT

Seed bank studies of summer annuals emerging after monsoon showers were carried out at two different sites designated as site 'A' and 'B'. Site 'A' was a disturbed site, trampling, grazing, mowing to garbage dumping. Whereas, site 'B' was an undisturbed site. Annual species were the dominant flora at both the sites besides a few perennials. Species richness and diversity were much greater at undisturbed site. Seed bank samples were collected at three stages (before rainfall, after rainfall and after seed dispesal from the existing vegetation). Maximum number of seeds were collected in the first sampling i.e., data collected before rainfall (before germination of underground reserves), followed by third collection i.e., data collected after dispersal of seeds from the existing vegetation. Substantial amount of seed loss was observed in the second collection i.e., the data collected after rainfall when majority of seeds get germinated. Annual plant species at both the sites exhibited persistent type of seed bank. High degree of similarity between below and above ground vegetation was observed at both the sites. Disturbance seems to affect the seed bank dynamics; undisturbed sites have larger persistent seed bank and high species diversity than the disturbed site.

KEYWORDS: Seed bank, Persistent, Disturbance, Degree of similarity.

INTRODUCTION

Seed banks are meant for conservation and restoration of species (Bakker *et al.,* 1996). That's why they are regarded as one of the most important constituents of plant communities (Harper, 1977). They play a major role in the dynamics and diversity of plant communities. Moreover, they are helpful in reducing the probability of species extinction (Venable & Brown, 1988). In some communities the soil seed bank role is very critical for maintenance of species population (Kemp 1989; Harrod & Halpern, 2005). Another important function of soil seed bank is that it has potential to influence above ground-vegetation (Fenner, 1985). Similarly, species composition, distribution and dominance of above ground species is also reflected in the soil seed bank (Parker & Kelly, 1989).

Disturbances of different frequencies and scale greatly affect the number and density of seeds in the reserved soil pool (Aziz & Khan, 1995), because any sort of disturbance at above ground vegetation directly affects dynamics of buried seed reserves. Animals play a vital role in plant's seed dispersal but sometimes due to grazing they have major role in reducing the soil seed banks. Seed reduction and lower species diversity has been observed at certain grazed sites (Bertiller, 1996; Mayor *et al*., 2003). Sometimes due to heavy grazing, soil seed banks become only factor for recovery and persistence of palatable vegetation (O`Connor & Pekett, 1992). Human disturbance also contributes to the variability in soil seed bank.

The change in composition and density of soil seed bank along its effects on above ground vegetation at different communities have also been reported (Parkar & Kelly, 1989). When the natural vegetation is lost due to disturbance the seed banks are not readily reestablished. It is very necessary to understand the correlation between disturbance and seed bank characteristics. Therefore, the present study is designed to elucidate the seed bank composition and the degree of similarity between above and below ground vegetation at two sites varying in disturbance levels.

MATERIALS AND METHODS

Study site: Two sites were chosen for the study named as site 'A' and 'B'. Both the sites were located in the Karachi University Campus, Sindh (Lat. 24˚ 48' N., Long. 65˚ 55' E.). The area is a maritime desert with an average summer temperature of 32˚C. On the commencement of monsoon showers, large number of summer annuals emerges and the whole area looks like a grassland for few months. Due to high temperature, the rate of evapotranspiration is also high. Site 'A' is considered as disturbed site and site 'B' as undisturbed site. At site 'A' there is disturbance due to construction, aggregation of polythene bags and other garbage, poor sewerage system and other anthropogenic activities. Disturbances like, grazing, mowing, trampling and to a lesser extent garbage dumping are common. Whereas, site 'B' was comparatively less disturbed and was free from human interference. The site is located in a semi-shady area where huge trees are present at random distances. Initially, the site showed low plant diversity but with the onset of monsoon showers, emergence of annual species was observed.

Seed bank: Ten soil samples were randomly collected from each site using an aluminum corer (2.5 cm diameter, 15 cm depth) at three phenological states, i.e. before rainfall (before germination), after rainfall (after germination) and after the dispersal of seeds. Seeds were separated out manually from the soil sample with the help of a binocular microscope and identified with the help of seed album.

RESULTS

Above ground vegetation of site A is composed of five species i.e., *Sida ovata*, C*orchorus trilocularus, Amaranthus viridus, Heliotropium ophioglosum* and *Tephrosia strigosa.* While, seeds of four species i.e., *Corchorus trilocularis, Amaranthus viridus, Salvia santolinifolia* and *Tephrosia strigosa* were sorted out from the seed bank samples. With the exception of two perennial species *S. ovata* and *H. ophioglossum,* annual plant species C*orchorus trilocularis, Amaranthus viridus* and *Tephrosia strigosa* were present in both above and below ground vegetation (Table 1).

At Site 'B' nine species were present on the ground which are *Corchorus trilocularis, Cenchrus biflorus, Tephrosia strigosa, Trichodesma amplaxicaule, Cyperus bulbosus, Sida ovata, Heliotropium ophiglossum, Salvia santolinifolia* and *Triblus terrestris*. Whereas, seeds of following seven species were sorted out from the soil samples: *Corchorus trilocularis, Cenchrus biflorus, Trichodesma amplaxicaule, Sida ovata, Tribulus terrestis, Rhyncosia minima* and *Peristrophe paniculata* (Table 2). Five species were found to be common in both above and below ground vegetations i.e., *Corchorus trilocularis, Cenchrus biflorus, Trichodesma amplaxicaule, Sida ovata* and *Tribulus terrestris*. Interestingly, at this site also all annual plant species and one perennial are common at both above and below ground vegetation. *Corchorus trilocularis* was the abundant species in the seed bank samples and is also the dominant species on the ground.

Species diversity and density on the ground and in the seed bank samples were considerably greater at undisturbed site (site 'B'). High degree of similarity was observed between above and below ground vegetation. Close relationship of existing vegetation and buried seed reserves was noted, which was more pronounced at undisturbed site. Significantly higher number of seeds ($P< 0.001$) were sorted out from the samples collected before rainfall i.e., in the first collection followed by third collection i.e., samples collected after dispersal of seeds at both the sites. The lowest number of seeds was sorted out from the samples collected after rainfall i.e., after germination of seeds from the buried seed reserves. Buried seed reserves of all the species showed significant differences ($p<0.001$) among the three collections and also between sites.

Table 1. Seeds / m^2 extracted from the soil samples collected at three different phenological states from site 'A' (Mean Standard Error).

Species	Before rainfall	After rainfall	After dispersal
Chorchorus trilocularis	32351.21 ± 2.76	173.22 ± 0.99	21277.38 ± 2.11
Amaranthus viridus	18799.20 ± 2.35	-	14990.21 ± 2.24
Heliotropium ophioglossum	1743.33 ± 1.79	227.35 ± 0.75	351.15 ± 1.33
Tephrosia strigosa	1116.35 ± 1.07	-	1245.68 ± 1.05
Sida ovata	397.22 ± 0.88	175.21 ± 0.38	-

Table 2. Seeds / m^2 extracted from the soil samples collected at three different phenological states from site 'B' (Mean Standard Error).

Species	Before rainfall	After Rainfall	After Dispersal
Chorchorus trilocularis	66511.90 ± 3.23	407.44 ± 0.88	32558.90 ±2.63
Cenchrus biflorus	32034.45 ± 2.56	163.25 ± 0.89	22173.77 ± 1.87
Tephrosia strigosa	1270.11 ± 2.61	-	1532.00 ± 1.54
Trichodesma amplexicaule	1621.37 ± 1.83	-	1770.87 ± 2.07
Cyperus bulbosus	1048.15 ± 1.77	-	-
Sida Ovata	1027.71 ± 1.23	725.37 ± 1.35	621.22 ± 0.55
Heliotropium ophioglossum	901.15 ± 0.99	620.37 ± 0.76	664.26 ± 1.05
Salvia santolinifolia	325.13 ± 0.85	337.55 ± 1.21	-
Tribulus terrestris	264.15 ± 0.35	-	223.15 ± 0.72

DISCUSSION

Disturbance seems to affect the seed bank. Undisturbed site seems to have higher species diversity and density in both above and below ground vegetation. Disturbance at site 'A' appeared to create changes in species composition and other floral characteristics, which is resulted in reducing species diversity and richness. According to Pang *et al*. (2011); Salehi *et al.* (2011) and Costa *et al.* (2012) disturbances also involve in altering soil properties and vegetation communities. Trampling of ground by human and animal effects soil compaction and loss of organic matter (Heydari *et al*., 2013), these changes affect not only above ground vegetation but also composition of soil seed bank and its storage (Abule *et al*., 2005).

Seeds of annual plant species at both the sites decreased considerably in the second collection i.e., after the germination of seeds (after rainfall) but did not disappear and again showed higher increase in the third collection which was collected after the dispersal from the existing vegetation. Both study sites were found to have annual as well as perennials on the above and below ground vegetation. Strong similarity was observed between soil bank species and above ground species. Seeds of annual species at both the sites were very well represented in the vegetation. While perennial species exhibited poor relationship between above and below vegetation. High degree of similarity between above and below ground vegetation of annual plant species was reported by many workers (Aziz & Khan, 1996; Qaderi *et al*., 2002; Shaukat & Siddiqui, 2004). According to Ungar & Woodell (1996), it is not important that above ground vegetation should reflect soil seed bank. At site 'A' five species were present on the ground and four in the buried seed reserves. Whereas, only three annual species were common in both the vegetations i. e., *C. trilocularis, A. viridus and T. strigosa.* On the other hand, species diversity of an undisturbed site (site 'B') was much higher than disturbed site (site 'A'). Nine species were present on the ground, whereas, seeds of seven species were sorted out from the seed bank samples. Five species were common in above and below vegetation, among them four are annuals (*C. trilocularis, C. biflorus, T. strigosa* and *T. amplexicaule*) and one is the perennial (*Sida ovata*). Annual plant species at both the sites exhibited persistent nature of seed bank. Seeds of annual plant species remain dormant in the soil till monsoon showers. Synchronus germination in higher numbers was observed soon after the summer rains. Seeds of these species seem to have enforced dormancy. Similar results for annual species were also reported for *Tephrosia strigosa* (Aziz & Khan, 1993), *Leucus urticifolia* (Aziz & Khan, 1996), *Cleome viscosa* (Aziz & Shaukat, 2011), and *Ipomoea sindica* (Aziz & Shaukat, 2012). Perennial species showed little or no resemblance between above and below ground vegetation. Low degree of concordance of perennial species might be due to the capacity of seeds to survive in the soil for many years without being present in the above ground vegetation (Thompson & Grime, 1979; Hill & Stevens, 1981). Bakker *et al*., (1996), also reported low extent of similarity between above ground vegetation and soil seed bank component in temperate grassland, which is largely composed of perennial species. An alternative explanation of mismatch of perennial plants between seed bank and above ground flora may be due to their historic past. Soil seed banks can often contain species lost from above ground vegetation and thus represent a source for regeneration and maintenance of plant communities.

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