

IMPACT OF GRAZING ON PLANT BIODIVERSITY OF DESERT AREA OF DISTRICT KHAIRPUR, SINDH, PAKISTAN

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ABSTRACT

The effect of grazing on desert plant species from three distinct habitats i.e. Kot Diji sand dune, Ubhan Shah flat dune and Sorah inter-dunal area of District Khairpur was studied by using quadrat method. We analyzed each plant species for cover, total plant cover of grazed, un-grazed and mean % reduction in cover (cm) from pre-monsoon and post-monsoon seasons. The results revealed a considerable effect of grazing on plant species; however the impact of grazing varied from plant to plant and season to season, in the studied areas. There was highest grazing intensity of *Indigofera* species leading to endanger in this area. In all sites, maximum reduction in cover was observed in *Indigofera oblongifolia* and *Indigofera argentea*, with 62.8 and 57.2cm, respectively during pre-monsoon, and 61.5 and 52.8cm in post-monsoon. *Aristida funiculata* also possesses high grazing intensity with 40.3 and 54.2cm in pre and post-monsoon seasons respectively. The species *Convolvulus prostratus*, *Cassia italica*, *Dipterygium glaucum* and *Digera arvensis* showed grazing intensities with 47.8, 57.4, 25.2, 42.7 in pre-monsoon season and 44.3, 35.9, 45.7, 53.7 in post monsoon seasons, respectively. The low grazing intensity was observed in dominant plant communities *Aerva javanica*, *Calligonum polygonoides*, and *Leptadenia pyrotechnica* in a pre-monsoon season with 7.8, 17.4, 13.2cm, whereas, it was increased in post-monsoon with 11.5, 25.9, 32 in the reduction of cover (cm), respectively. These plant species were grazed by the animals at that time when ephemerals were not available in the desert during a drought period. It is suggested that partial protection and controlled grazing can be beneficial to get positive results and maintain the desert vegetation in the study area.

Key words: Grazing effect, plant biodiversity, desert area, pre-monsoon, and post-monsoon

INTRODUCTION

Vegetation has played a significant role as reservoirs of fodder in the time of severe drought and provides perennial vegetation matrix. The plant cover is necessary to prevent soil erosion and consequent depletion of reservoirs of nutrients which are more concentrated in the surface rather than subsurface layers in many arid zone soils (Beadle, 1962; Charley and Cowling 1968; Marshall 1969). Vegetation of the desert region is adapted to high temperature and moisture fluctuations coupled with edaphic conditions. Plants of this region grow slowly but respond quickly to climatic conditions and a large portion of the species can possibly recover even with insufficient precipitation.

Grazing is very important factor to the desert habitat, where food is the first priority for the domestic animals of this area. Grazing may also promote biodiversity, but the extreme level of grazing significantly reduces the vegetation cover (Diaz *et al.*, 2007; Dreber and Esler, 2011; Tessema *et al.*, 2012). Lin *et al.*, (2010) studied the effects of grazing intensity on vegetation at various levels. High-intensity grazing decrease the above ground biomass, indicating that vegetation was more fragmented under higher grazing pressure. Cheng *et al.*, (2011) investigated the effect of

annual rainfall and grazing pressure, annual precipitation and showed the positive and negative relationship with grass and shrub richness; different groups affected by grazing and rainfall variability in different zones.

The reports published on rangelands in desert area and grazing effects from Cholistan, Thar and Nara Desert (Malik, 1986; Iqbal and Khan, 2001; Khan and Frost, 2001; Qureshi and Bhatti, 2005; Akhtar and Arshad, 2006) revealed that grazing has great impact on the rangeland in various ways. It affects vegetation cover, compacts soil by hoof actions, roughing up, an addition of minerals and nutrients by droppings. Overgrazing and lack of efficient management strategies destroy native vegetation, enhance soil erosion, increase weed invasion that leads to alter plant communities and floristic composition (Rao *et al.*, 1989; Nasir *et al.*, 2010). Qureshi and Ahmed (2010) observed that the anthropogenic activities are a non-stop threat in Achhro Thar Desert and as a result local plant species are disappearing at an alarming rate and most of them recorded as rare.

District Khairpur is situated on the left bank of the great Indus River in Sindh province of Pakistan. It lies between 26° – 12' to 27°-24, north latitudes and 68° – 13' to 70°-10' east longitudes. Its total area is about 15910 km², of which one-fourth area is fertile. The rest of the area encompasses galaxy of huge hills of sandy desert

known as “*Bhit*” (Fig. 1). The weather of this area is generally hot and arid with maximum average summer temperature ranges between 41.50°C to 44.30°C while in winter it goes down from 29.8°C to 6.4°C. The hot season begins from the middle of March to middle of September and hottest months are June, July and August. . The annual rainfall was recorded 29.7mm to 99.4mm during 2004 to 2007 per annum, out of which mostly falls in July and August. Humidity was high (56%) in August and 16% in April (CDPC, Metrological Department Karachi).

In study area of Khairpur District animals depend on the pastoral productivity/vegetation which is not abundant in the area because region receives a low amount of rainfall during the monsoon season. Plants generally compete for the resources and limitation of resources affects the growth and productivity of available vegetation. The present study was carried out to evaluate the grazing effects on vegetation of the area. To the best of our knowledge, not any research has been carried out to estimate the loss of vegetation of this area. Therefore, this was the first ever effort to evaluate the grazing impact on desert communities in the area.

MATERIALS AND METHODS

Three different field sites were selected to study the effects of grazing on the vegetation during 2004 to 2007. The sites include: Site A: Kot Diji Sand dunes area (27° 19' 42.00 N – 68° 42' .99 E), Site B: Ubhan Shah, flat dunes were selected area (27° 21' 23.00 N – 68° 46' .23 E) and Site C: Sorah: Inter dune area with hummocks (27° 17' 15.00 N – 68° 54' .54 E) as shown in Fig. 1. Data was collected in terms of cover of plant species from all three study sites, grazing preference by domestic animals for key plant species and check list of these species were prepared. The quadrat method was used in the study. Total number of quadrats was 100 from which 50 were temporary and 50 permanent. The size of each quadrat was 10x10 meters (Hussain, 1984; Hussain, 1989). The data of cover were collected from protected and unprotected areas from all three sites, twice a year in March-April (pre-monsoon) and September-October (post-monsoon) and calculated the percentage of cover reduction from grazed and un-grazed cover of under grazing plants species in pre monsoon and post monsoon. The information was collected from the field and estimated how much loss these plants could tolerate from overgrazing and how quickly these plants recover from the severe attack of over grazing and water stress and then analyzed in the laboratory.

RESULTS

In order to study the effect of grazing on vegetation from all 3 study sites of District Khairpur, the key plant species by grazing preference of domestic animals were selected and prepared a checklist of these species (Table 1). The grazing effects were observed during the study in the capacity of mean % reduction in cover (cm) in comparison to un- grazed plant species.

At the site A (Kot Diji), the highest intensity of grazing was found for *Indigofera oblongifolia* with 56.4 and 52.33% reduction cover as compared to un-grazed in pre-monsoon and post monsoon respectively. The same grazing effects were found in *D. arvensis*, 45.15% continuous grazed by animals, in pre-monsoon, and increased in post-monsoon 53.56%, followed by *C. italica* 37.78%, *L. pyrotechnica*, 34.58% and *S. oleiodes* 5.69%, reduction in cover in pre-monsoon while in post monsoon the grazing intensity decreased 29.58 and 19.5 of palatable species *C. italica* and *L. pyrotechnica* respectively. In contrast, the grazing intensity increased with 18.12 in *S. Oleiodes* during post monsoon. Grazing observed in *C. polygonoides* with 30.85 in post-monsoon season (Fig. 2A)

At the site B (Ubhan Shah), more species were added in the grazed plant species due to topography and better soil conditions at the site. Maximum grazing intensity in pre-monsoon season was found in *C. italica* 63.21% followed by *D. glaucum* 58.92%, *C. polygonoides* 40.59% and *S. oleiodes* 38.37%, *A. javanica* 37.72% whereas lowest grazing intensity of 2.92% was observed in *L. pyrotechnica*. In contrast, the grazing intensity was increased *D. glaucum* 75.9%, *P. lanceolate* (68.81%) and *L. pyrotechnica* (41.41%) in post monsoon season. While grazing intensity of *A. javanica* (18.57%), *A. funiculata* (39.28%), *C. polygonoides* (29.92%) and *C. italica* (29.99%) was decreased in pre-monsoon season (Fig. 2 B).

The site C (Sorah) exhibited a better position due to depression in inter dune area due to the availability of moisture content in soil and more plant species in addition to grazing plant list. In this site, there were 11 key plant species under-grazed. The highest intensity of grazing was observed in *I. argentea* with 62.67% and 57.43% and *C. prostratus* (48.28% and 43.46%) in pre and post-monsoon seasons respectively. These plant species were observed continuously throughout year for grazing *A. javanica* and *A. tomentosa* were found moderately grazed (20.15 and 37.30) in pre-monsoon, while the grazing intensity was increased with 28.88% and 52.16% in post monsoon, respectively. The grazing effect was observed in *H. europaem* and *L. pyrotechnica*, with 21.47%, and 26.74% respectively in post monsoon. In contrast, *S. oleiodes* (48.51%) reduction in cover recorded in pre-monsoon instead of post-monsoon (Fig. 2C).

During the study period the constant species of all three study sites (Kot Diji, Ubhan Shah and Sorah) were generally affected by animal grazing. In comparison to un-grazed, grazed plant species with more reduction in cover (cm) were observed. *Aerva javanica* was observed with moderate grazing at 26.6% in pre-monsoon, while the grazing intensity increased to 19.8% and 34.4% in post-monsoon in 2004 and 2007 respectively. *Aerva tomensa* at site C, continuously under grazed throughout study period, and the maximum grazing intensity recorded 67.3% in post monsoon of 2006 was recorded. It was also found that the grazing intensity was increased in post monsoon than pre-monsoon. *A. funiculata* showed 57.5% grazing rate at initial period of study in 2004. With the passage of time it was increased to 77 in pre-monsoon of 2007. A high grazing intensity 88.2 and 90.4 were recorded during 2006 and 2007 in post-monsoon (Fig. 3).

The *C. italica*, *C. prostratus* and *D. arvensis* were under grazed in both pre-monsoon and post-monsoon seasons. The *C. italic* showed maximum grazing intensity of 71.5% in pre-monsoon of 2006, while *C. prostratus* exhibited maximum grazing intensity (75.8%) in 2005 and decreased during 2006 and 2007 in pre-monsoon but the grazing intensity gradually increased from 15.3% to 55.5% during the study period from 2004 to 2007 in post-monsoon. The grazing intensity of *D. arvensis* grazing intensity was gradually increased from 50.1% to 89.35% in yearly from 2004 to 2007 in pre-monsoon season. In case of a post-monsoon season, the maximum grazing intensity 66.1% was recorded in 2006, while it decreased to 27.1% in 2007. The *D. glaucum* was affected by moderate grazing intensity with maximum 33.8% in 2004 during pre-monsoon, and intensity increased gradually and reached to 70.2% in 2007 during post-monsoon (Fig 3).

The species *I. argentea* and *I. oblongifolia* grazed by animals throughout the study period in both

seasons (pre-monsoon and post-monsoon) and grazing intensity increased as 56.2% to 58.4% and 45.7% to 81.2% in pre-monsoon whereas 53.7% to 76.6% and 38.1% to 64.2% reduction in cover from 2004 to 2007 were recorded. The grazing trend showed that both species of *Indigofera* were heavily under-grazed. The maximum grazing intensity of *C. polygonoides* with 35.9% and 31.2% in later study period of 2006 and 2007 respectively in pre-monsoon season and 16.7 to 28.1 during the study period from 2004 to 2007 in post-monsoon were observed. The *L. pyrotechnica* was not affected by animal grazing in early period of study but grazed moderately with 23.8% and 27.7% in pre-monsoon, and intensity was increased with 48.0 and 48.1 in post monsoon, later years 2006 and 2007 (Fig. 3).

Finally, grazing effects on vegetation in comparison with un-grazed in terms of mean % reduction in cover (cm), all sites and study period from 2004 to 2007, Highest grazing intensity was observed in *I. oblongifolia* and *I. argentea*, at site A (Kot Diji) and site B (Ubhan Shah), with 62.8% and 57.2% in pre-monsoon, same result observed with 61.5% and 52.8% in post monsoon, respectively, and it was observed in the field the seed-eating animals grazed all seasons. *A. funiculata* also possesses high grazing intensity with 40.3% and 54.2% in pre and post-monsoon; followed by *C. prostratus*, *C. italica*, *D. glaucum* and *D. arvensis* 47.8, 57.4, 25.2, 42.7 in pre-monsoon season and 44.3, 35.9, 45.7, 53.7 in post-monsoon season, respectively. First and later two species were shown vice versa results in pre and post-monsoon. *S. oleoides* moderately grazed with 38.2% and 32.5% cover reduction in both seasons. While the dominant plant communities at all sites *A. javanica*, *C. polygonoides*, *L. pyrotechnica*, observed low grazing intensity in a pre-monsoon season with 7.8, 17.4, 13.2, respectively, it was increased in post- monsoon with 11.5, 25.9, 32 in a reduction of cover (Fig. 4).

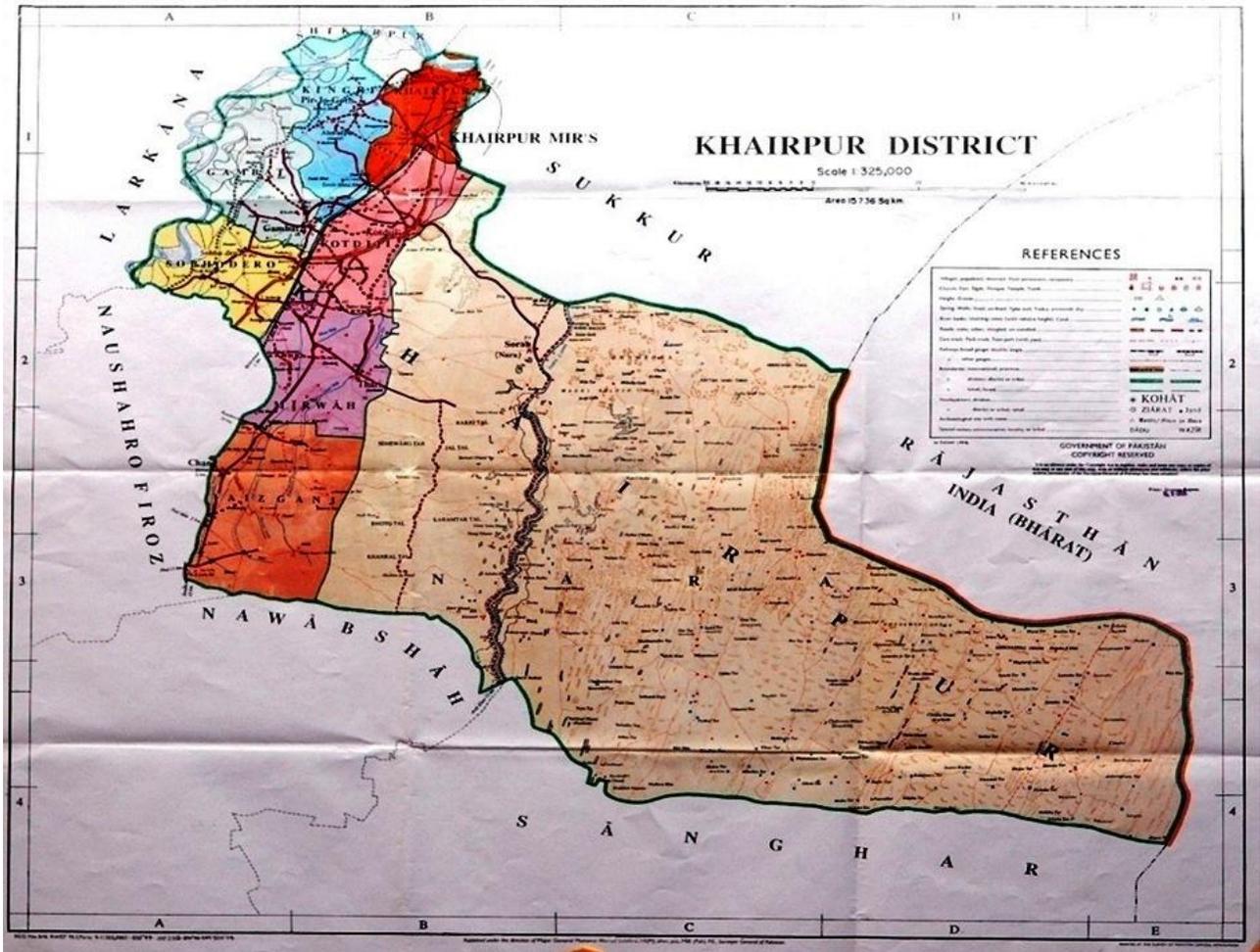
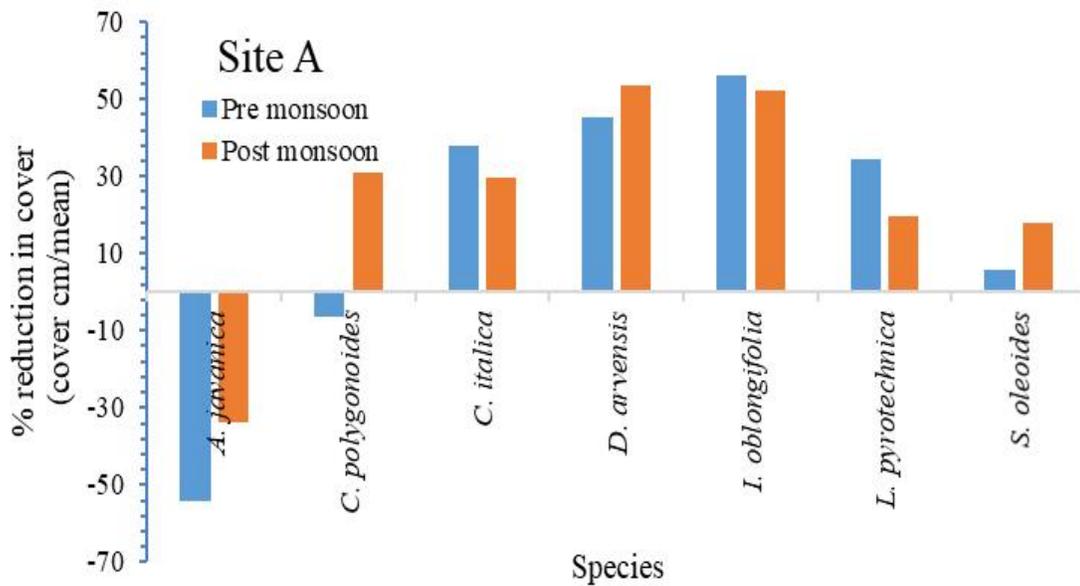


Fig 1: Map of District Khairpur



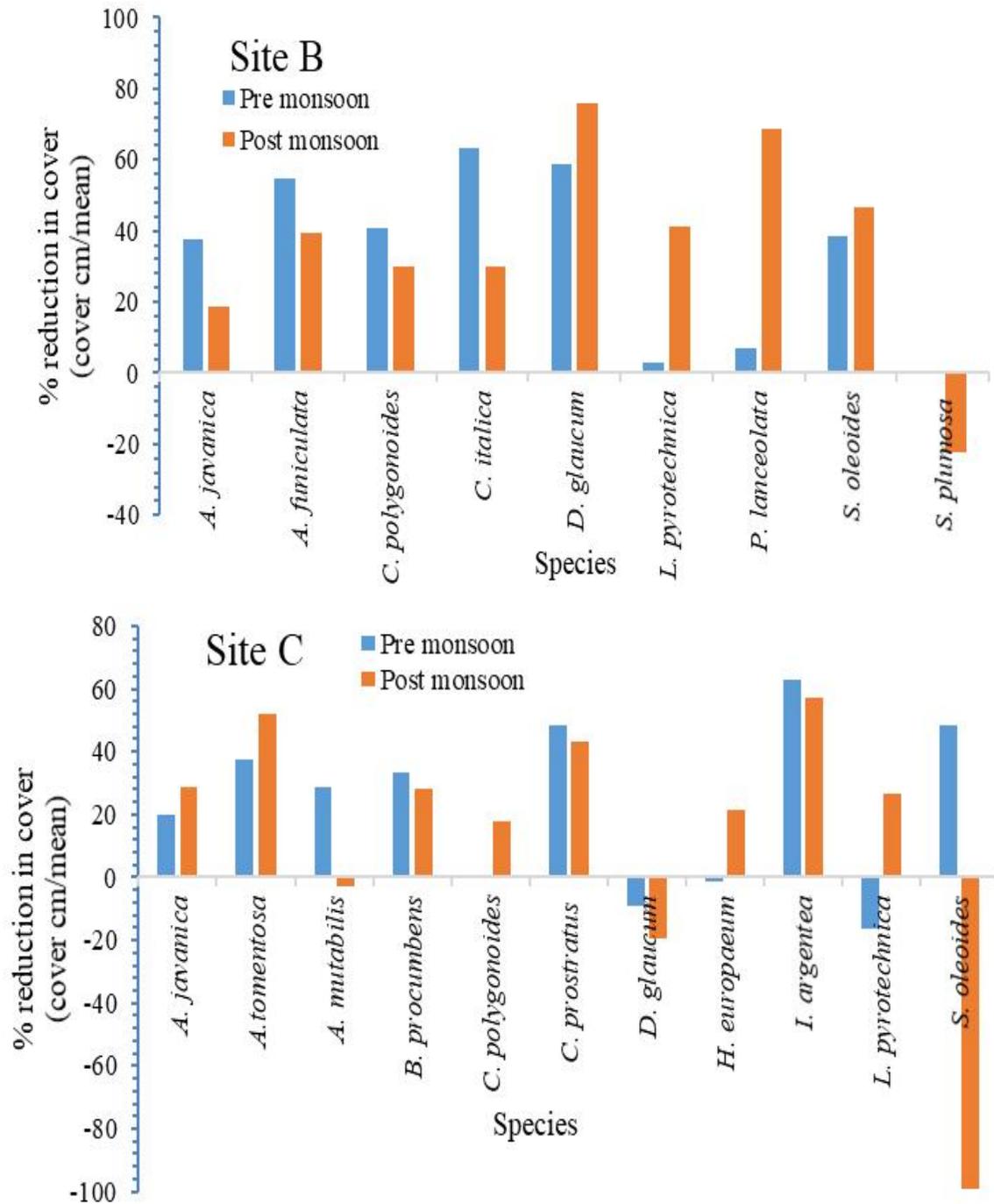
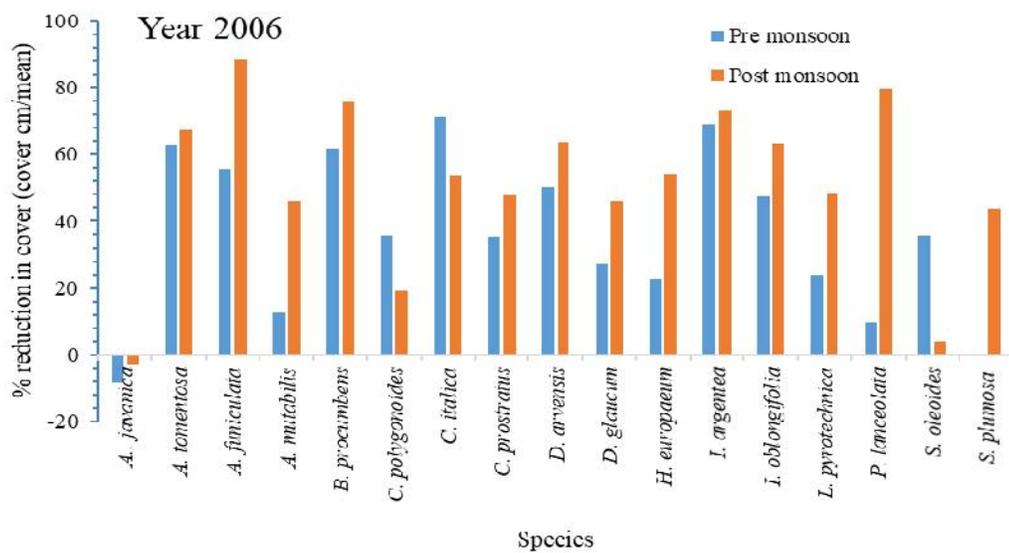
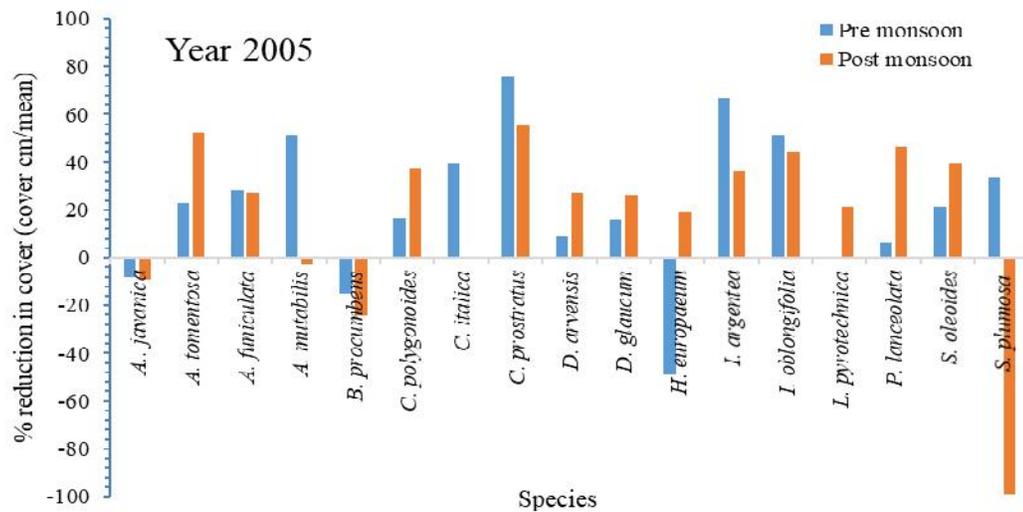
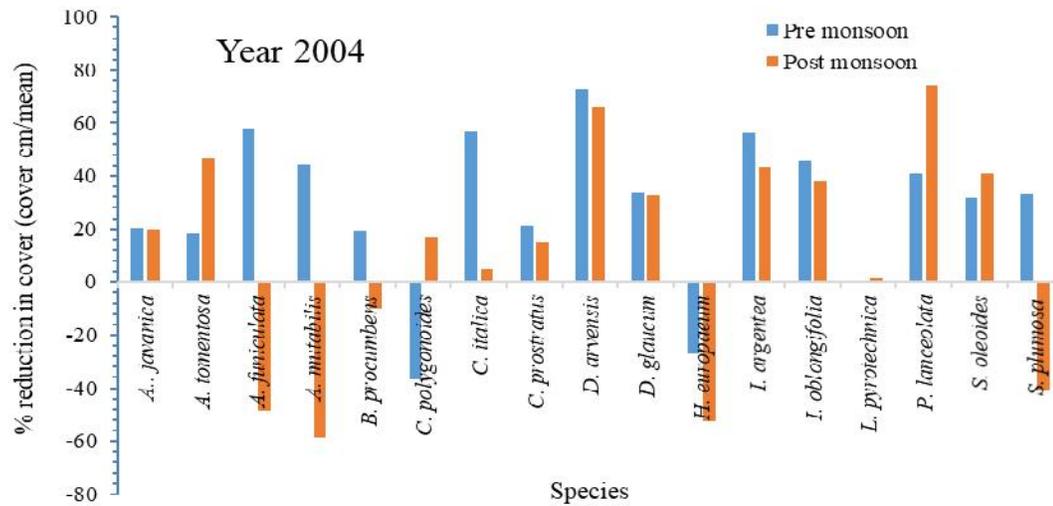


Fig: 2 .Percentage in reduction of cover at different study sites A. Site A Kot Diji Sand dunes area. B. Site B Ubhan Shah flat dune area. C. Site C Sorah inter dune area, District Khairpur.



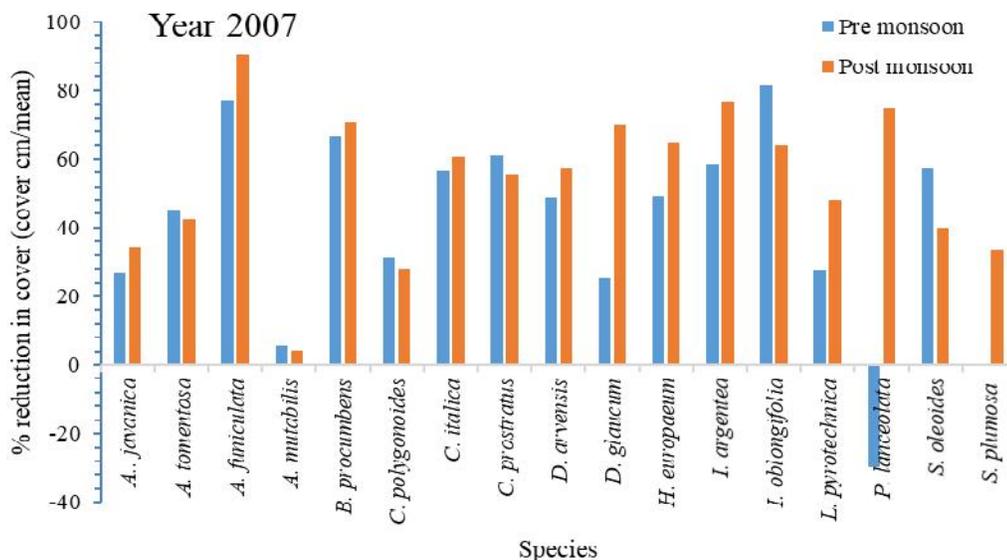


Fig.3. Percentage reduction in cover during the study period 2004 to 2007. Y indicates % reduction (cover cm / mean).

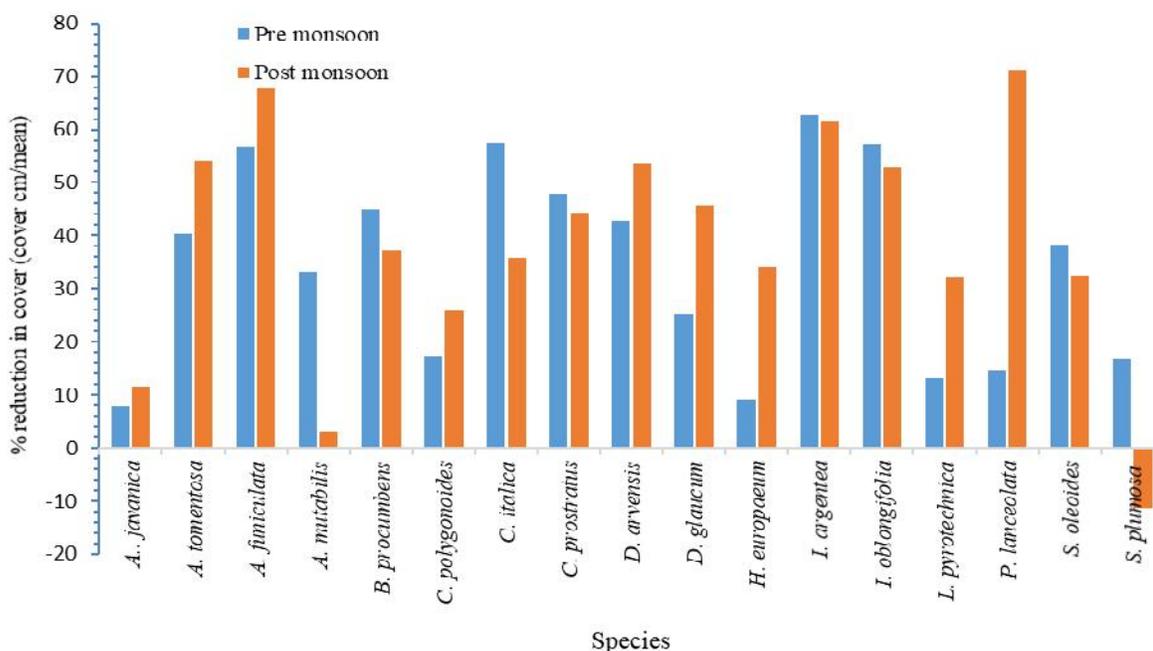


Fig:4 Percentages reduction in cover comparison between pre-monsoon and post-monsoon during study period in study sites, (cover cm/mean).

Table. 1. List of desert plants under grazing at three sites A, B and C, of District Khairpur.

C.No	Family	Plant species	Local Name	Habit	Grazing Animals	Sites
1	Amaranthaceae	<i>Aerva javanica</i> (Burm.F)Juss.	Booh	Perennial Shrub	Goat, Sheep & Camels.	A B C
2	Amaranthaceae	<i>Aerva tomentosa</i> Forssk.	Booh	Perennial Shrub	Goat, Sheep & Camels.	C
3	Poaceae	<i>Aristida funiculata</i> Trin. & Rupr.	Lumb Gaah	Annual Herb	Sheep.	B

4	Poaceae	<i>Aristida mutabilis</i> T.& R.	Lumb Gaah	Annual Herb	Sheep.	C
5	Nyctaginaceae	<i>Boerhavia procumbens</i> Bank ex Roxb	Sana wari	Perennial Herb	Goat, Sheep & Cattles.	C
6	Polygalaceae	<i>Calligonum polygonoides</i> L.	Phoog	Perennial Shrub	All Animals	A B C
7	Caesalpiniaceae	<i>Cassia italica</i> (Mill) F.W.Andr.	Ghora Wal	Perennial Shrub	All Animals	A B
8	Convolvulaceae	<i>Convolvulus prostratus</i> Fork.	Kranjh	Perennial Shrub	Goat, Sheep & Cattles.	C
9	Amaranthaceae	<i>Digera arvensis</i> Forsk.	Lular type	Annual Herb	All Animals	A
10	Capparidaceae	<i>Dipterygium glaucum</i> Dence.	Phair	Perennial or under shrub	All Animals	B C
11	Boraginaceae	<i>Heliotropium europaeum</i> L.	Utkharo	Annual Herb	Camels.	C
12	Papilionaceae	<i>Indigofera argentea</i> Burm.f.	Jhil	Perennial Shrub	All Animals	C
13	Papilionaceae	<i>Indigofera oblongifolia</i>	Jhil	Perennial Shrub	All Animals	A
14	Asclepiadaceae	<i>Leptadenia pyrotechnica</i> (Forsk) Dence.	Khipp	Perennial Shrub	Goats, Sheep & Camels	A B C
15	Asteraceae	<i>Pluchea lanceolata</i> Olive & Hiern.	Phar	Perennial or under shrub	Goat, Sheep & Cattles.	B
16	Salvadoraceae	<i>Salvadora oleoides</i> Dencene.	Peroon	Perennial Shrub	Camels.	A B C
17	Poaceae	<i>Stipagrostis plumosa</i> (L.) Munro ex T. Anders.	Lumb Gaah	Perennial Shrub	All Animals	B

DISCUSSION

A large proportion of world covers the rangeland, which is important for livestock feed as well as the farmer and local people of area (Suttie and Reynolds, 2003; Upton, 2004). The study areas of district Khairpur possess low productivity due to the harsh arid environment. Rearing livestock is specialty of the people of the desert area under study. Livestock grazing is much beyond the region's carrying capacity, hence over grazing affects the plant diversity and reduces the cover and density of plant communities due to preferential choice of plant species by animals.

In desert, soil degradation and perennial palatable plant species loss increase the biotic pressure on breakable ecosystems and determined the level of grazing in terms of capacity of cover and density in desert rangelands (Tarhouni *et al.*, 2006; Ouled *et al.*, 2008; Ouled and Louhaichi, 2013). The vegetative cover reduction and productivity lead to steppe and desertification (Le Houerou, 1969). Yeaton and Flores, (2009) described that grazing affects the vegetation by cover and density. Severe animal grazing results in higher reduction of cover (Diaz *et al.*, 2007; Dreber and Esler, 2011; Tessema *et al.*, 2012).

The results demonstrated that protected ungrazed plant species significantly increase the total

cover of plant while decreasing the cover of grazed plant species. The grazing effects were observed during study period 2004 to 2007. The study observed the highest grazing intensity >50% mean reduction in cover (cm), *I. oblongifolia* and *I. argentea* in both seasons pre-monsoon and post monsoon, at site A and site C, respectively. *Indigofera* grazed by animals in both seasons and affected severely, because of the high protein level in seeds and preferable for grain eating animals. Due to high-intensity grazing, *Indigofera* species were affected harshly and has become rare in the area. .

The moderate grazing intensity was found < 50% mean reduction in cover (cm), *D. arvensis*, in pre-monsoon but the grazing intensity was significantly increased in post monsoon at site A, while in case of *C. italic* the grazing intensity significantly higher in pre-monsoon than post monsoon. Dominant plant species *A. javanica*, and *C. polygonoides* high in pre-monsoon, while the grazing intensity significantly decreased in post monsoon, In contrast, grazing intensity *L. pyrotechnica* was observed low in pre-monsoon and significantly increased in post-monsoon at site B. In the field it was observed that foliage and smaller twigs of younger shoots of *A. javanica* grazed by animals at the time when other ephemerals were not available. *C. polygonoides* grazed by all animals all time and all the plant except roots and thick stem. In desert area *L. pyrotechnica* grazed by animals especially camels, sheep and goats grazed foliage

and legumes in drought period of the desert. The variation in grazing intensity of each plant species in different study sites due to the variation in soils and topography.

Enright and Miller, (2007) investigated that after rainfall species richness and cover significantly higher than dry season. Rainfall is an important factor for plant growth in desert communities (Arshad *et al.*, 2008). Perennial plant species dominant over annual species findings given by Qureshi *et al.*, (2011), so the presence of perennial plant species is an evident of low rainfall.

Results of the study found in line and agreed with above aforementioned studies (Arshad *et al.*, 2008 Qureshi *et al.*, 2011). Similarly, species richness was not affected by grazing in the study area because of monsoon rain falls. Mostly the grass species and annual eliminate in dry season but after monsoon rainfall the environmental conditions become favorable for the vegetative growth of desert plant species. In result, the seeds present under the canopy in sand germinate with quick response, resulting in increase in density and cover of the plant population. The mortality of seedlings under/around old bushes was increased due to grazing of animals in the desert area. Animal's grazing preferences changed with the seasons i.e pre-monsoon and post monsoon. Grazing intensity were subject to seasons, found in reduction in cover (cm), comprising all three sites and study period, highest intensity of grazing found by *I. oblongifolia*, *I. argentea*, and *A. funiculata* in both seasons pre-monsoon and post monsoon, respectively. It was also observed in the field that the seed-eating animals grazed all seasons. Moderate grazing intensity found < 50% mean reduction in cover (cm) *C. prostratus*, *C. italica*, *D. glaucum*, *D. arvensis* and *S. oleoides* in both seasons pre-monsoon and post-monsoon. The grazing intensity of *C. prostratus*, *C. italica* was higher than *D. glaucum*, *D. arvensis* in pre-monsoon, while lower in post-monsoon, grazing intensity varied in seasons.

The dominant plant communities *A. javanica*, *C. polygonoides*, *L. pyrotechnica*, observed with low grazing intensity in pre-monsoon season, and it was increased in post monsoon. It was also observed that these plant species were grazed by animals at the drought period, when ephemeral were not available at sites.

Conclusion: Plants provide the valuable fodder to the herbivores. The intensity of grazing varies from plant to plant and season to season. In harsh desert environment, overgrazing affects the vegetation in the loss of cover, decrease in plant diversity, enhances the desertification, and distribution of plant species. Due to over-grazing, *Indigofera* has become a rare species of the area. It is suggested that partial protection and controlled grazing can show positive results in desert plant communities of

the study area. Further studies are required to confirm the results.

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