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Diet Composition of Migratory Houbara Bustard (*Chlamydotis macqueenii*) in District Dera Ismail Khan, Pakistan

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SUMMARY

Houbara Bustard (*Chlamydotis macqueenii*) is a bird of the Otididae family. The current study looked at the diet composition and habitat quality of migrating Houbara bustards in the Dera Ismail Khan area. Knowledge of eating and foraging is essential for species management and conservation. From October 2015 to February 2016, two research sites, Ganju and Jhok Machi, were chosen in their likely winter habitat in the study region for collecting faecal samples and reference plant species. The results showed that fruit and leaves of *Capparis decidua* (41.085%), and flowers of *Brassica campestris* (12.29%), were the most preferred food items of Houbara. The preferred herb was *Arva javanica* (13.52%). Because ants and beetles were included in its diet, the Houbara bustard is an omnivore bird. A vegetation survey utilising the quadrate approach was used to conduct the habitat analysis. Twenty quadrates (1km x 1km) were picked at random in both research areas with sparse and thorny vegetation. In the research region, twenty-one plant species were identified, including six trees, five shrubs, five herbs, three grasses, and two cereal crops. Houbara bustard prefers open and sparse vegetation cover and was mostly found around *Capparis decidua* and hiding underneath it. Houbara is a protected bird in Pakistan and its hunting is prohibited. For Conserving Houbarapopulation, habitat degradation should be controlled. A ban on Hunting Houbara bustards should also be strictly implemented.

Keywords: Houbara bustard, migratory, Dera Ismail Khan, Diet composition, habitat status, illegal hunting.

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INTRODUCTION

Asian Houbara bustard (*Chlamydotis macqueenii*) falls in the family Otididae which comprises 25 species of bustards, distributed across the Old World with a great majority (21spp.) found in or partly in Africa. The distribution range of the Asian Houbara bustard stretches from Egypt to Mongolia and east of river Nile and China, while crossing Afghanistan, It reaches to Bahrain, China, Egypt, India, Iran, Iraq, Jordan, Kazakhstan, Kuwait, Oman, Kyrgyzstan, Mongolia, Pakistan, Palestine, Qatar, Saudi Arabia, Syria, Tajikistan, Turkmenistan, UAE, Uzbekistan, Yemen in

addition to Nepal and some parts of Europe. Houbara bustard is almost extinct in Turkey (IUCN, 2014). The northern population of Houbara bustard is migratory and spends winter in southern areas. The wintering habitat of the Chinese Houbara bustard is at the eastern extremity of the Karakorum Desert which is situated at Turkmenistan and also in the Cholistan desert of Pakistan (Combreau et al., 2011; Altaf, 2022).

The population of Houbara bustard in Pakistan consists of two classes i.e., thetering population and breeding population. Breeding populations mostly inhabit the distant areas of Baluchistan province including Nag Valley, Panjgan, Chagai, and Kharan (Rashid, 2003). The Houbara bustard migrates to Sindh province and then move towards Punjab to spend winter. Parched and semi-parched areas of Baluchistan, Punjab and Sindh provide wintering habitats for migratory population. Houbara bustard coming from China, Central-Kazakhstan and Eastern side, thus comprisethe wintering population in Pakistan (Rashid, 2003; Combreau et al., 2011).

This ground-homing bird stays away from trees and thick forests, areas situated beside human habitations and with dense vegetation cover (Cramp and Simmons, 1980; Mian, 2003). The female lays out 3-4 eggs by digging a shallow scrape in the ground (Collar, 1996; IUCN, 2014). Their nests are mostly vulnerable to predators that pick and swallow their eggs, for example foxes in Nag Valley, Baluchistan (Rashid, 2003). Females entirely look after their young ones; the incubation period is of 24 days and fledging mainly comprises 35 days (Collar, 1996; IUCN, 2014).

Over the last few decades, Houbara bustard populations, both resident and migrant, have declined in Pakistan. The causes of this decline include almost the same factors that have affected its populations in other parts of their range including combined effects of unsustainable hunting, habitat loss through overgrazing and agricultural development and disturbance by human encroachments (Collar, 1980). Thousands of birds have been captured every year in Iran and Pakistan for export to Arab countries for use of falcon training for sports. Most of trades were checked at the time of entry or exit at ports and captured live birds and released these birds in the wild. Unlike the previously published method, this technique is also more amenable for birds. It could be useful to explore the diversity of the diets primarily in wild birds for conservation practitioners and wildlife rescue center activities.

MATERIALS AND METHODS

STUDY AREA

From October 2015 to February 2016, the current study was carried out in the district of Dera Ismail Khan (Figure 1) in Khyber Pakhtunkhwa Province (Marwat et al., 2013). Dera Ismail Khan district has a total size of 7326 km^2. Summer is completely dry and scorching. Temperatures continue to climb in April, with May and June being the warmest months, with temperatures exceeding 42 degrees Celsius. The chilly weather begins in October. The months of December, January, and February have quite good weather. The average temperature in the coldest month (January) is 12.4 °C (54.4 °F), while the average temperature in the hottest month (June) is 33.6 °. Dera Ismail Khan receives 268.8 mm (10.6 in) of rain per year on average.

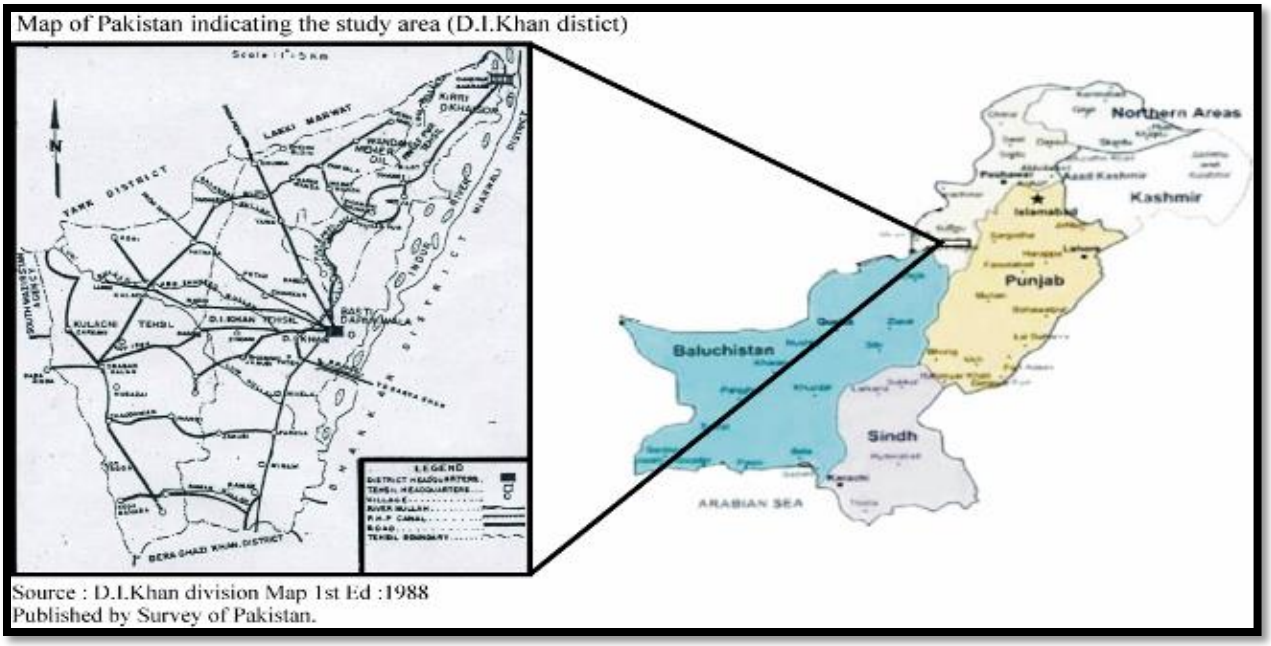

Figure 1: Map of study area showing study sites selected at DIK district Pakistan.

Flora

Vegetation of the area mostly consists of sub-tropical thorn forest. River Indus is situated on its eastern side with its sand banks, floodplain and waterworks. These are low, xerophytic forests in which thorny species are predominant including *Prosopis cineraria*, *Acacia nilotica, and Capparis decidua*, which provide suitable habitat for the Houbara bustard population. There are several genera of shrubs including *Calotropis, Periploca* and Fagonia *indica* (Khylanpaa, 2000).

Fauna

Fauna of study area consists of animal species including Chinkara (*Gazella bennettii*), Black buck (*Antilopecervicapra*), Wolf (*Canis lupus*), Jackal (*Canis Aureus*), Houbara bustard (*Chlamydotisundulata*), Jungle cat (*Felischaus*), Black francolin (*Francolinusfrancolinus*), Grey francolin (*Francolinuspondicerianus*) etc(Janjua, 2016).

METHODOLOGY

Sample collection

A reconnaissance survey of the study area was conducted from Oct 2015 to 2016 to locate the Houbara bustard population with the help of the staff of the wildlife department and local people in the Ganju and Jhok Machi areas. Faecal samples of the Houbara bustard and reference plants were collected from its occupied habitat (Tables 1 and 2). The faecal/ droppings of the Houbara bustard were identified with the help of field staff of the wildlife department and local people of the area. Fresh faecal pellets were collected and stored at ambient temperature in plastic bottles labelled with location and date of collection. Seventy percent ethanol was added to the bottles on the same day of collection to preserve samples. All reference plant and animal food of the Houbara bustard was collected from its winter foraging ground in the study area. Two specimens of each organism were collected; one for identification and maintenance of the herbarium and the other for preparation of reference slides (Korschgen, 1980).

Table 1: Fecal samples of Houbara bustard collected from study sites during 2016.

Sr.	Sampling site	No. of samples
1	Jhok Machi	10
2	Ganju	10
	Total samples	20

Table 2 Reference plant species collected from the Houbara habitat in the study area during 2016.

Sr.	Scientific Name	Common Name	Type	Family
1	*Convolvulus arvensis*	Bindweed	Herb	Convolvulaceae
2	*Fagoniabruguieri*	Dhamasa	Herb	Zygophyllaceae
3	*Aerva javanica*	Kapok bush	Herb	Amaranthaceae
4	*Tamarixaphylla*	Farash	Shrub	Tamaricaceae
5	*Sorghum bicolor*	Grain sorghum	Grass	Poaceae
6	*Brassica campestris*	Mustard	Shrub	Brassicaceae
7	*Zizyphusoxylphylla*	Jujube	Tree	Rhamnaceae
8	*Medicago sativa*	Alfalfa	Shrub	Leguminosae
9	*Peganumharmala*	Syrian Rue	Shrub	Nitrariaceae
10	*Bassiaindica*	Unknown	Herb	Amaranthaceae
11	*Capparis decidua*	Karir	Tree	Capparaceae
12	*Rumexdentatus*	Toothed dock	Herb	Polygonaceae
13	*Salvadoraoleoides*	BadaPilu/Vann	Tree	Salvadoraceae
14	*Ochthochloacompressa*	Forssk	Herb	Poaceae

SLIDE PREPARATION

The samples were analyzed in the laboratory at Department of Wildlife Management, PirMehr Ali Shah Arid Agriculture University, Rawalpindi. Micro-histological examination of faeces revealed the diet of the Houbara bustard. For slide preparation, the following actions were taken:

1. Faecal samples from different localities of Houbara bustard habitatswere collected from the study site and dried under air.
2. After that the fecal samples were broken up into small pieces and then filtered to remove fine material and dust particles.
3. The samples were washed in fresh water and sink in soaking solution (1Part Ethyl alcohol, 1 part distilled water, 1 part glycerin) for whole night.
4. These samples were again crushed in Virtis Homogenizer for further paste.
5. 50% of the samples were shiftedto test tube and 5% warm NAOH solution was added to it.
6. This test tube was kept for 4-5 minutes under boiling water.
7. These particles were freely settled down before removing the bouncy dark fluid and this treatment were repeated until clear solution came out.
8. Then material was sink for 2 minutes under warm distilled water.
9. It was dehydrated under a series of 25%, 50%, 75% and 100 % alcohol treatment, sink each sample for ten minutes.
10. This alcohol was then washed with a series of Xylene solution and then alcohol mixture (25%, 50%, 75 % and 100 % xylene) each for ten minutes, except 100 %for

whole night.

11. Then very next day these materials was shift to a clean glass slide this was spread on the slide and mounted in butyl phthalate xylene mounting medium and covered the material with cover slip.
12. The same method was applied to reference plant collection for preparing same slides, except for using 10 percent NaOH solution.
13. The cells of the reference slides and fecal samples slides were compared. The num of repetition of each plant species were recorded.

The photo-micrographs of reference plant slides and fecal samples of *Chlamydotismacqueenii*were captured by electronic microscope known as Celestron and compound microscope model (XSZ-701AN/XSZ-107AN) to fulfill the objectives magnification of 100X, exposure, color andbrightness. These micro-photographs of vegetative samples and fecal samples slides were compared and validity of the material was checked at same light intensity and magnification.

SLIDE OBSERVATION

Spark and Malecheck (1968) were utilized to assess each microscopic slide. In each faecal sample, plant species occurrence was calculated by operating an ocular grid micrometre which is fixed at the eyepiece of the microscope. From each pooled sample four slides were prepared randomly. Five locations were evaluated per slide randomly (5 x 4 = 20 locations) per sample. Observation begins from the lower-left turn of each slide, shifting from bottom to top, and then moves from left side to right side, to and from movement. From each microscopic field, particles were gauged and determined if identified epidermal material was present, traces of stomata cells and any other type of cells in the faecal sample slide. A microscopic field was defined as a 2mm diameter section of slide detected using a microscope at 100X magnification. First, the total number of distinct plant species in the entire slide was counted. The number of squares filled with plant material in each row of the ocular grid, as well as the number of squares in each row containing each of the plants described, was then counted. The frequency (number of identified pieces out of 100 sites) for each plant species in each faecal sample was calculated using the following approach (Sparks and Malecheck, 1968; Alipayo et al., 1992).

Frequency of occurrence = A/B x 100

A= Numbers of rows (ocular grid) loaded with its plant species.

B= Numbers of rows (ocular grid) filled with all plant species.

Habitat analysis of study sites was conducted through the quadrate method following Schemnitz (1980). On each study site, 10 quadrates were taken randomly. For tree species, the size of the quadrate was 10 m x 10m, for shrubs 4m x 4m and for herbs and grasses1m x1m. Thus 20 quadrates were taken on both study sites. A measuring tape was used to draw the quadrate in the field, Frequency, relative frequency, density, relative density, and dominance of plant species were calculated. Vegetation was estimated by calculating the IVI of each plant species (Hacker *et al*. 1990).The following formulae were applied for vegetation analysis:

$$\text{Density (D)} = \frac{\text{Total no of individuals of species}}{\text{Total area sampled}}$$

$$\text{Relative Density (D)} = \frac{\text{Total no of individuals of species}}{\text{Total no. of individual of all species}} \times 100$$

$$\text{Frequency (F)} = \frac{\text{No of quadrates in which species occurs}}{\text{Total no of quadrates}}$$

$$\text{Relative Frequency (RF)} = \frac{\text{Frequency value of species}}{\text{Total frequency value of all species}} \times 100$$

$$\text{Cover (C)} = \frac{\text{Cover of individuals of a species}}{\text{Total cover of all species}}$$

$$\text{Relative Cover (RC)} = \frac{\text{Total basal area of individuals species}}{\text{Total basal area of all species}} \times 100$$

Importance value index (IVI) of all species was calculated with this formula:
IVI = Relative Density + Relative Frequency + Relative Cover

RESULTS AND DISCUSSION

DIET COMPOSITION

Twelve plant species were recorded in the fecal samples of Houbara bustard including three tree species (*Zizyphusoxylphylla, Capparis decidua, Salvadoraoleoides*), five herb species (*Ochthochloacompressa, Fagoniabruguieri, Aerva javanica, Bassiaindica, Rumexdentatus),* three shrub species *(Peganumharmala, Medicago sativa, Brassica campestris*) and one grass species (*Sorghum bicolor*). The most frequent species used by Houbara bustard in its diet was *Capparis decidua* (41.085%), followed by *Aerva javanica* (13.52%), *Brassica campestris* (12.29%), *Sorghum bicolor* (10.128%), *Fagoniabruguieri* (5.625%), *Zizyphusoxyphylla* (5.39%) and *Rumex dentatus* (4.15%) (Table 3). Fecal samples of Houbara also contained animal matter which included insects like Ants and Beetles belonging to Order Hymenoptera and Coleoptera, respectively. Some calcium grit and seeds of *Triticum aestivum* were also recorded in fecal pellets.

Capparis decidua was present in all fecal samples showing maximum (41.085%) frequency of occurrence and the least frequent food included *Salvadoraoleoides* (1.176%).Results showed that Houbara bustard had preference for fruit of *Capparis decidua*, *Brassica campestris* and *Aerva javanica*. Frequency of occurrence revealed that Houbara bustard have more preference for tree species (47.65%) as compared to herb species (26.53%), shrubs (17.88%) and grasses (9.95%). Preferred food sequence in the diet of Houbara bustard was recorded as follows: *Capparis decidua >Aerva javanica > Brassica campestris>Sorghum bicolor>Rumexdentates>Zizyphusoxylphylla> Medicago sativa > Fagonia bruguieri > Ochthochloa compressa > Peganum harmala > Salvadora oleoides.*

VEGETATIVE ANALYSIS OF STUDY AREA

Twenty-one plant species were identified from Houbara bustard habitat in the study area including 6 trees, 5 shrubs, 5 herbs, 3 grasses and 2 cereal crops (Table 4). Prominent plant species in its habitat included *Desmostachya bipannata* (IVI 64.08) followed by C*ynodon dactylon* (IVI 59.63), *Symbopogan schoenanthus* (IVI 51.22), *Capparis decidua* (IVI 48.94), *Nerium oleander* (IVI 45.65), *Acacia nilotica* (IVI

47.8) *Prosopis cineraria* (IVI 39.7), *Zizyphus nummularia* (IVI 35.79), *Tamarix aphylla* (IVI 32.83), *Brassica campestris* (IVI 33.23) and *Sorghum bicolor* (IVI 30.03).

The faecal analysis revealed that the Houbara bustard shifts its diet according to season and shows less preference for grasses and more preference for trees, shrubs and few insect species in wintering habitat (Nadeem *et al*. 2004). Because Houbara bustard is an omnivorous bird, faecal samples contain few insect species in the winter season. Results revealed that the Houbara bustard is omnivores and feeds on a variety of plants and animals' part. During severe winter it also consumes ants and beetles as observed in their diet of plants as well as animal parts including Ants and Beetles due to the severe winter season. Ants were also present in its diet.

An earlier study by Collins (1993) on the diet of the Houbara bustard showed that its food consisted of four main categories including insects, annual plants, flowers and fruits. More beetles were found in wetter years and more ants and plants were found in its feces in drier years. This study also showed that during winter, Houbara bustard preferred the same diet along with parts of plants, insects, few grains and anthropogenic material. Barbara *et al.* (2000) reported the analysis of 161 faeces of Houbara which showed that all faeces contained invertebrate material and the percentage frequency showed that ants were more frequent than beetles in its diet. The diet consisted of weevils, tenebrionids and ants. Ants and beetles were also found in the present study but weevils were not found probably due to differences in habitat and climate between these two sites.

Fox (1988) examined 52 gizzards of Houbara bustards collected from Baluchistan, Layyah, and Rajanpur region of the Punjab. Plants comprise 53% of dry weight and most frequently consumed species were *Farsetiajacquemonii*, *Capparis*spp and *Tribulusterrestris*. The most frequently recorded tenebrionid beetles were *Adesmiaaenescens* (23%), *PimeliaindicaPimeliainexpectata*(20%), and *Arthrodosis*spp, (10%). Gubbin (1995) found that beetles were present in 50% of fecal samples. Roberts (1991) noted that the proportion of animal matter increased from 17% in early winter to 50% in late winter. In present study, ants were found frequently in samples but beetles were few in fecal samples. Above calculated result showed that Houbara bustard prefer parts of leaves due to shortage of insects in winter season. Only ants were present frequently and few grains and grits were also present which help to digest the food.

CONCLUSIONS

Houbara Bustard is a winter visitor to district Dera Ismail Khan. A total of 12 plant species were recorded at the fecal samples of Houbara bustard including *Capparis decidua, Aerva javanica, Brassica campestris*, *Ziziphusoxyphylla*, *Pegnumharmala*, *Medicago sativa, Fegoniabruiguri, Bassiaindica, Rumex dentatus, Sorghum bicolor, Ochthocloacompressa*, *Salvadoraoleoides*. The diet of Houbara contains dominantly the fruit of *Capparis decidua* but it also takes *Brassiacampestris, Arvajavanica*, *Fagoniabrugneri*and*sorghum bicolor* in addition grains, chickpea, etc. Ants and beetleswere also found in their droppings which show its omnivorous feeding behavior. A total of 21 plant species were identified from Houbara bustard habitat in the study area including 6 trees, 5 shrubs, 5 herbs, 3 grasses and 2 cereal crops.

Dominant plant species in its habitat included; *Desmostachyabipinnata*, C*ynodondactylon, Capparis decidua*,*Acacia nilotica, Prosopis cineraria*and*Brassica campestris.* Most preferred habitat is bushes of *Capparis decidua.*

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Table 3: Frequency of Occurrence of plant species consumed by Houbara bustard during 2016.

Sample	Trees			Shrub			Herb					Grosses
Sr.	***Capparis decidua (%)***	***Salvadora Oleoides (%)***	***Zizyphus Oxylphylla (%)***	***Peganum Harmala (%)***	***Brassica campestris (%)***	***Medicago sativa (%)***	***Fagonia Bruguieri (%)***	***Aerva javanica (%)***	***Bassia indicia (%)***	***Rumex dentatus (%)***	***Ochthochloa compressa (%)***	***Sorghum Bicolor (%)***
1	41.7	23.52	0	0	0	11.9	11.9	5.8	0	11.9	0	0
2	26.92	0	19.23	0	19.23	0	19.23	6.84	0	0	8.69	0
3	50.82	0	1	0	6.89	0	0	20.68	0	13.79	0	8.69
4	20.18	0	0	15.18	13.63	0	0	29.27	0	0	0	22.72
5	20.35	0	12.9	6.45	0	20.35	0	22.58	0	19.35	0	0
6	42.85	0	0	0	13.18	0	0	30.57	0	0	0	14.28
7	48	0	0	0	12.6	0	0	18.75	0	0	0	20.69
8	66.66	0	0	0	20.98	0	0	0	0	0	14.33	0
9	51.7	0	8.89	6.89	0	0	13.79	0	0	0	0	20.68
10	48.61	0	0	0	0	0	0	14.98	0	38.09	0	0
11	42.8	0	14.28	1.14	10.71	0	0	10.71	0		0	21.4
12	38.09	0	14.28	0	0	19.04	0	14.28	0	0	0	19.04
13	42.1	0	0	0	31.57	10.52	9.072	0	0	0	0	15.78
14	43.47	0	0	0	26.08	0	0	21.739	0	0	8.69	0
15	47.05	0	0	0	0	0	11.76	17.99	0	0	23.529	0
16	42.1	0	15.78	0	15.78	0	0	0	0	0	0	26.31
17	33.33	0	0	0	14.28	4.76	28.57	19.04	0	0	0	0
18	47.05	0	0	0	29.4	0	0	0	0	0	0	23.52
19	31.57	0	21.05	15.78	31.5	0	0	0	0	0	0	0
20	36.36	0	0	0	0	0	18.18	27.37	9.09	0	0	9.09
%	41.085	1.176	5.39	2.272	12.29	3.32	5.625	13.52	0.4545	4.15	2.76	10.128
Mean	41.085	1.176	5.39 ±1,73	2.272	12.29	3.32	5.625	13,52	0.4545	4.1565	2.76 ±1.411	10.128
S.E+-	±2.46	±1.176		±1.108	±2,54	±1.477	±1.944	±2.387	±.454	±2.18		±2.300

Table 4. Plant species recorded in the Houbara bustard habitat in the study area.

S.NO	Botanical Names	Relative Density (%)	Relative Frequency (%)	Relative Cover (%)	Importance Value Index (%)
1	*Acacia nilotica*	7.	18.12	22.27	47.8
2	*Ziziphusnummularia*	5.57	16.35	13.87	35.79
3	*Capparis decidua*	8.41	20.07	20.76	48.94
4	*Ziziphusoxyphylla*	1.8	14	4.22	20.12
5	*Salvadora oleoides*	0.78	3.53	4.55	8.87
6	*Peganum harmala*	3.38	9.1	12.9	25.38
7	*Madicago sativa*	1.77	4.71	3.94	10.42
8	*Nerium oleander*	8.22	12.14	25.2	45.65
9	*Tamarix aphylla*	3.4	21.92	8.11	32.83
10	*Desmostachya bipinnata*	36.29	17.03	10.69	64.08
11	*Cynodon dactylon*	31.71	14	13.25	59.63
12	*Symbopogan schoenanthus*	29.36	12.14	9.71	51.22
13	*prosopis cineraria*	1.92	12.82	24.94	39.7
14	*Sorghum bicolor*	14.89	6.07	9.05	30.03
15	*Cicer arietinum*	6.49	2.35	3.94	12.79
16	*Brassica campestris*	15.84	9.78	7.59	33.23
17	*Bassia indica*	5.24	7.24	0.3	12.2
18	*Fegoniabruguieri*	5.92	12.14	0.96	19.03
19	*Rumex dentatus*	1.69	10.96	0.33	12.99
20	*Convolvulus arvensis*	3.54	5.88	0.42	9.85
21	*Aerva javanica*	7.36	12.14	2.82	22.35