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Assessment of Seasonal Dynamicity of Herbaceous Plant Diversity, Phytosociology and Composition in Narmada Canal Command Area of Kachchh District, Gujarat

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Abstracts: The seasonal phytosociological study in Narmada Canal Command (NCC) area of Kachchh district has revealed that there is seasonal variation in the herbaceous plant diversity. The qualitative assessment has shown that in the pre-monsoon season, 165 herbaceous plant species existed in the NCC area in Kachchh. On other hand, during post-monsoon season a total of 255 herbaceous species were recorded. The current study has reflected that, the Kachchh NCC area supports some locally rare or occasional plant species of Gujarat State. Values of density, frequency, abundance and species composition of herbaceous plants were in the range of 16133.33 ind. ha^{-1} to 66.67 ind. ha^{-1}, 32.00% to 0.67%, 10.70 ind. $quadrat^{-1}$ m^{-2} to 1.0 ind. $quadrat^{-1}$ m^{-2} and 16.85% to 0.07%, respectively during the pre-monsoon season while during the post-monsoon season the corresponding values were in the range of 34133.33 ind. ha^{-1} to 200 ind. ha^{-1}, 60.00 % to 1.33 %, 7.73 ind. $quadrat^{-1}$ m^{-2} to 1.50 ind. $quadrat^{-1}$ m^{-2} and 11.57% to 0.07%, respectively. In this study, the Simpson Diversity Index was higher (i.e. 0.97) in post-monsoon season as compared to that in pre-monsoon season (i.e. 0.93) indicating that the diversity was good in post-monsoon season. The study revealed that the seasonal dynamicity of herbaceous vegetation may be due to the availability of good habitat in the arid or semi-arid area of NCC.

Key words: Herbaceous, Ind. (=Individuals), Kachchh, Dynamicity, Phytosociology, Narmada Canal Command.

Unlike animal, herbaceous plants are sessile organism, but they undergo interesting and complex dynamic phenomena seasonally, annually or perennially. Seasonal changes in plants are noticeable after monsoon (CCPO, 2013). Herbaceous plants in semi-arid and arid areas express sequential variability in water availability and vegetation dynamics (Snyder and Tartowski, 2006). In arid environment, the herbaceous plant communities commonly shows dynamic nature and habitat heterogeneity with diverse ecological processes and are often rich in plant species diversity (Naiman *et al*., 2005). In the process of vegetation growth, drought creates an unfavourable condition by reducing water availability and soil moisture level (Choubin *et al*., 2019). Water from natural or artificial water bodies constitutes a key energy source for the survival and growth of herbaceous plants such as climbers, grasses, sedges etc.

The Kachchh region of the Gujarat state is considered to be an arid district that is characterised by tropical arid climate (Gavali *et al*., 2011) which gives rise to rich herbaceous plant diversity after rainfall or getting surface water from other source. However, the status of herbaceous plant diversity in many areas, including the NCC area of Kachchh district has not been studied in detail despite the fact that it can have high diversity due to the effect of Narmada canal water. As it is well known, the herbaceous plant species change their composition continuously under the effect of multitude of factors like grazing, fire and rainfall which can change the intensity and duration of herbaceous plants (Shameem *et al*., 2010). Therefore, in the current study, an attempt has been made to know the herbaceous vegetation status in two different seasons of the NCC area of arid district Kachchh to know the effect of water on vegetation diversity.

Materials and Methods

Study area

The herbaceous plant field investigation was carried out in NCC area of Kachchh district

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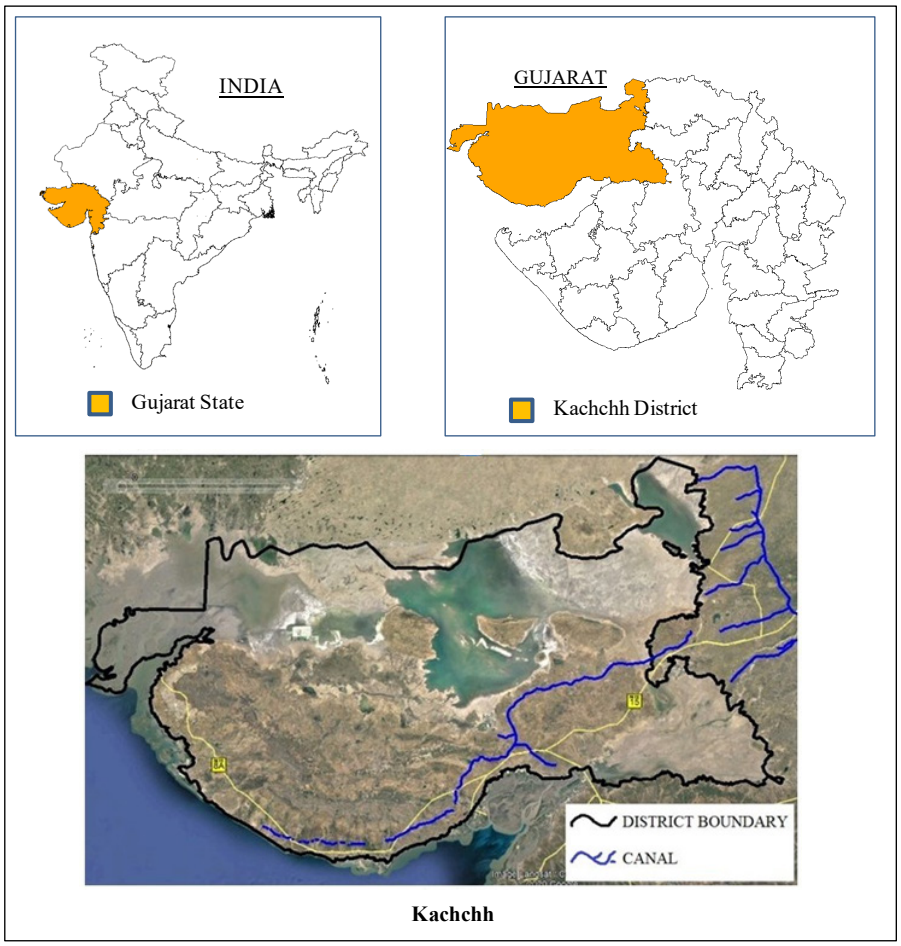

Fig. 1. Narmada Canal and its branches in Kachchh district.

which is located in the western most part of India and composed of Kachchh mainland (Plateau), Greater Rann of Kachchh (GRK) and a portion of Little Rann of Kachchh (LRK). The district, though occupied by Rann has potential for agriculture in mainland area (Kachchh Plateau) due to Narmada Canal passing through 7 blocks (*talukas*) of the district. The Kachchh district has been considered as the largest district of India covering an area of 45652 km^2 constituting 22.29% area of the Gujarat state. The NCC area in Kachchh district is located between 23°51′27′′N to 22°46′30′′N latitudes and 69°01′51′′E to 71°17′20′′E longitudes which forms a good habitat for various endemic flora and fauna of India. The Kachchh district is having international border with Pakistan in north or north west side and state boundary with Rajasthan in north east side.

To assess seasonal floristic change (i.e. pre and post monsoon floristic change), floristic field survey were carried out during year of 2019-2020 in pre-monsoon and post-monsoon seasons in 10% villages (Yadav *et al*., 2020; Suthar *et al*., 2021) falling in the NCC area in Kachchh district. In the study area, during the study year the average rainfall of Kachchh district were found to be 373.3 mm and 545 mm (IMD, 2019; Hindu, 2020) in the year of 2019 and 2020, respectively. Plant sampling in the sampled villages were carried out in such a way that the sampling would cover maximum number of habitats in each sampled village. In other words, transects and quadrats were laid in the habitats of sampled villages in such way that it represented different habitats of canal command area. A total of 18 transects and 310 quadrats (each of 1 m × 1 m size) were laid down in the sampled villages of the NCC area. The quadrats were laid down at interval of 500 m on laid transects. The quadrat size was kept 1 m × 1 m as suggested by Selim *et al*. (2021) and Saxena and Singh (1982) considering the need for quantitative assessment of herbaceous vegetation (herbs and grasses) only. During the

first season (i.e. pre-monsoon season) of the phytosociological study, the coordinates of all quadrats were marked so as to get the same location easily in the subsequent post-monsoon season.

Data analysis

The qualitative and quantitative data analysis such as density, frequency, abundance and species composition were carried out as described by Menon and Balasubramanyan (1985), Mishra (1968) and Raunkiaer (1934). Different formulas for quantitative analysis are given below.

$$Density = \frac{Total\ number\ of\ individuals\ of\ particular\ species\ in\ smapled\ are}{Total\ number\ of\ quadrates\ studied \times Area\ of\ quadrat\ (ha)}$$

$$Frequency = \frac{Number\ of\ quadrats\ in\ which\ species\ occurred}{Total\ number\ of\ quadrates\ studied} \times 100$$

$$Abundance = \frac{Total\ number\ of\ individuals\ of\ a\ species\ in\ all\ quadrats}{Total\ number\ of\ quadrates\ in\ which\ indiciduals\ of\ the\ species\ occures\ x\ Area\ of\ quadrat\ (ha)}$$

Simpson's Dominance index has been calculated by using following diversity indexes:

Simpson's Dominance index

For calculating Simpson dominance index following formula are used:

$$D = \sum pi2$$

where, D = Simpson's dominance index; pi = the proportion of the important value of the species ni/N; ni = is Number of individuals of the particular species; N = Number of individuals of all species

If D increases then it indicates that diversity of species has decreased, Therefore, Simpson Diversity index is usually expressed as 1–D or 1/D.

Furthermore, all data regarding plant species had been analysed based on their lifespan and seasonal diversity was calculated using the formula given by Simpson (1949) and recommendation given by Magurran (1988).

Results and Discussion

Qualitative assessment

Seasonal qualitative assessment of herbaceous vegetation in the NCC area, Kachchh showed that the NCC area supported a total of 255 herbaceous plant species (139 annuals, 3 biennials, 94 perennials, 2 annuals/biennials and 17 annuals/perennials) during post-monsoon season which belonged to 47 families. Of the total 47 families, 10 most dominant families (as given in Fig. 2) constituted 68.62% of total recorded plant species. On other hand, during pre-monsoon season a total of 165 herbaceous plant species (84 annuals, 3 biennials, 69 perennials, 1 annuals/biennials and 8 annuals/perennials) were recorded which belonged to 38 families Of these, 10 most dominant families constituted about 70.30 % of the total recorded plant species. Moreover, the family wise analysis showed that during the both seasons (post and pre-monsoon) Poaceae, Asteraceae and Fabaceae were found to be the dominant families each of which reflected different plant species diversity (Fig 2). Malvaceae, Amaranthaceae, Acanthaceae, Euphorbiaceae, Solanaceae, Lamiaceae, Boraginaceae were found dominant families in post-monsoon season while in pre-monsoon season, the dominant families were Solanaceae, Acanthaceae, Amaranthaceae, Lamiaceae, Malvaceae, Boraginaceae and Euphorbiacea but all these families (except-Solanaceae) reflected different species composition in both the seasons. Furthermore, a total of 101 herbaceous species have been noted in quadrat study which showed a drastic change of ephemeral vegetation during the post-monsoon season in which a total of 70 species (47 species annual, 6 annual/perennial and 17 perennial) were found to be added (Table 1).

An analysis of annual, biennial and perennial plant species indicated that there was dynamicity in number of annual, biennial and perennial herbaceous plant species during pre-monsoon and post-monsoon seasons. The plant inventory in post-monsoon season had led to record of otherwise rare or occasional species of Gujarat (Shah, 1978) such as *Pavonia arabica*, *Periploca aphylla, Indigofera coerulea*

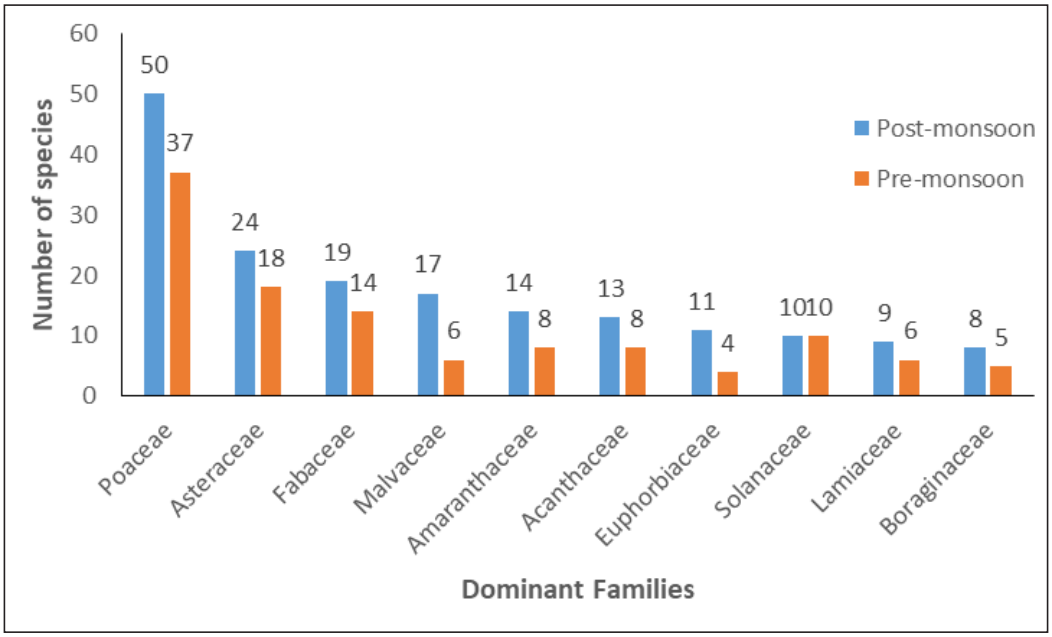

Fig. 2. Family wise analysis of species.

var. *monosperma* and *Convolvulus stocksii*. The qualitative herbaceous plant assessment during the present study showed that much higher plant species diversity occurred in post-monsoon season as compared to pre-monsoon season. Similar findings were conveyed by Singh and Yadava (1974) in their study done at Kurushetra, India, in which, they had recorded more species diversity during post-monsoon as compared to pre-monsoon season.

Quantitative assessment of herbaceous vegetation

The density, abundance, frequency and plant composition in NCC area of Kachchh district were analysed to know the quantitative status of herbaceous vegetation.

Density

In the current seasonal study, a total of 19 plant species (Table 1) had shown increase in density (ind. ha^{-1}) during the post-monsoon season while, a total of 11 plant species (Table 1) showed a decline in the density. Thus, the post-monsoon season represented high density of individuals per year. During post- monsoon season, maximum density was represented by *Eragrostis ciliaris* followed by *Aristida adscensionis*, *Peristrophe bicalyculata*, *Vernonia cinerea*, *Chloris barbata*, *Dactyloctenium aegyptium*, *Cynodon dactylon*, *Cressa cretica*, etc. as given in Table 1 and the density values were found to be in ranging from 34133.33 ind. ha^{-1} to 200 ind. ha^{-1}. In the pre-monsoon season, maximum density was noted for *Vernonia cinerea, Typha domingensis, Triumfetta pentandra, Tridax procumbens, Tephrosia purpurea, Suaeda nudiflora* and *Sporobolus coromandelianus* etc. (Table 1) and the density values were found to be ranging from 16133.33 ind. ha^{-1} to 66.67 ind. ha^{-1} while Suthar *et al*. (2021) have studied herbaceous vegetation in Saurashtra region of Gujarat where they have noted density of herbaceous vegetation 20439.56 to 21.98 ind.ha^{-1} during pre- monsoon and 1734.66 to 21.98 ind. ha^{-1} during post-monsoon season.

Abundance

Among all the herbaceous plant species recorded in the NCC area (Kachchh), maximum abundance was noted for *Desmostachya bipinnata* followed by *Aeluropus lagopoides*, *Enicostema hyssopifolium*, *Cyperus bulbosus, Arundo donax, Cynodon dactylon* and *Tridax procumbens* etc. (Table 1) during pre-monsoon season. The abundance values of all the herbs species ranged from 1.0 ind. $quadrat^{-1}$ to 10.70 ind. $quadrat^{-1}$. During the post-monsoon season, maximum abundance was noted for *Suaeda nudiflora*, *Arundo donax*, *Chenopodium album*, *Eragrostis ciliaris*, *Sporobolus coromandelianus*, *Boerhavia erecta* and *Eragrostis cilianensis* etc (Table 1). The abundance values were found ranging from 1.50 ind. $quadrat^{-1}$ to 7.73 ind.

Table 1. Quantitative analysis of herbaceous plants species

SN	Scientific Name	Density (ind. ha^{-1})		Abundance* (ind. quadrat^{-1})		Frequency (%)		Composition (%)	
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon
1	*Abelmoschus manihot* (L.) Medik.	NA	333.33	NA	2.50	NA	1.33	NA	0.11
2	*Abutilon muticum* (Delile ex DC.) Sweet	200.00	1000.00	1.50	3.75	1.33	2.67	0.21	0.34
3	*Acalypha indica* L.	NA	1200.00	NA	3.00	NA	4.00	NA	0.41
4	*Acanthospermum hispidum* DC	NA	733.33	NA	2.75	NA	2.67	NA	0.25
5	*Achyranthes aspera* Linn.	4600.00	7800.00	2.88	2.72	16.00	28.67	4.81	2.64
6	*Achyranthes lappacea* L.	NA	2200.00	NA	4.13	NA	5.33	NA	0.75
7	*Aeluropus lagopoides* (L.) Trin. Ex Thw	9400.00	733.33	9.40	2.75	10.00	2.67	9.82	0.25
8	*Alternanthera paronychioides* A.St.-Hil.	NA	1200.00	NA	2.57	NA	4.67	NA	0.41
9	*Amaranthus spinosus* L.	NA	733.33	NA	2.20	NA	3.33	NA	0.25
10	*Amaranthus viridis* L.	NA	1200.00	NA	3.00	NA	4.00	NA	0.41
11	*Ammannia baccifera* L.	NA	600.00	NA	3.00	NA	2.00	NA	0.20
12	*Apluda mutica* L.	NA	1333.33	NA	3.33	NA	4.00	NA	0.45
13	*Aristida adscensionis* Linn	3400.00	16600.00	2.32	4.02	14.67	41.33	3.55	5.63
14	*Aristida funiculata* Trin. and Rupr.	NA	866.67	NA	2.60	NA	3.33	NA	0.29
15	*Arundo donax* L.	1466.67	933.33	5.50	7.00	2.67	1.33	1.53	0.32
16	*Bergia ammannioides* Roxb.	NA	733.33	NA	3.67	NA	2.00	NA	0.25
17	*Blepharis maderaspatensis* (L.) B.Heyne ex Roth	NA	2666.67	NA	2.35	NA	11.33	NA	0.90
18	*Blumea lacera* (Burn f.) DC.	NA	933.33	NA	2.33	NA	4.00	NA	0.32
19	*Boerhavia erecta* L.	NA	666.67	NA	5.00	NA	1.33	NA	0.23
20	*Brachiaria ramosa* (L.) Stapf	NA	3200.00	NA	4.00	NA	8.00	NA	1.08
21	*Cassia holosericea* Fresen.	800.00	1866.67	2.40	3.11	3.33	6.00	0.84	0.63
22	*Celosia argentea* L.	NA	2400.00	NA	2.77	NA	8.67	NA	0.81
23	*Cenchrus biflorus* Roxb.	NA	2533.33	NA	2.92	NA	8.67	NA	0.86
24	*Chenopodium album* L.	NA	2466.67	NA	6.17	NA	4.00	NA	0.84
25	*Chenopodium murale* L.	NA	466.67	NA	3.50	NA	1.33	NA	0.16
26	*Chloris barbata* Sw.	2733.33	13066.67	3.42	4.00	8.00	32.67	2.86	4.43
27	*Cleome viscosa* Linn.	NA	7533.33	NA	3.32	NA	22.67	NA	2.55
28	*Coldenia procumbens* L.	NA	466.67	NA	3.50	NA	1.33	NA	0.16
29	*Commelina benghalensis* L.	NA	933.33	NA	3.50	NA	2.67	NA	0.32
30	*Convolvulus prostratus* Forsk.	NA	3000.00	NA	3.21	NA	9.33	NA	1.02
31	*Corchorus aestuans* L.	200.00	3200.00	1.50	2.67	1.33	12.00	0.21	1.08
32	*Corchorus capsularis* L.	NA	2600.00	NA	2.79	NA	9.33	NA	0.88
33	*Corchorus depressus* (L.)	NA	466.67	NA	2.33	NA	2.00	NA	0.16
34	*Corchorus tridens* L.	NA	3333.33	NA	3.13	NA	10.67	NA	1.13
35	*Cressa cretica* L.	2933.33	9200.00	2.59	6.57	11.33	14.00	3.06	3.12

Table 1. Contd...

SN	Scientific Name	Density (ind. ha^{-1})		Abundance* (ind. quadrat^{-1})		Frequency (%)		Composition (%)	
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon
36	*Crotalaria hebecarpa* (DC.) Rudd	NA	2133.33	NA	2.67	NA	8.00	NA	0.72
37	*Cynodon dactylon* (L.) Pers.	16133.33	9800.00	5.04	3.27	32.00	30.00	16.85	3.32
38	*Cyperus laevigatus* L.	NA	1133.33	NA	3.40	NA	3.33	NA	0.38
39	*Cyperus rotundus* L.	2733.33	2333.33	8.20	2.92	3.33	8.00	2.86	0.79
40	*Cyperus bulbosus* Vahl	9133.33	NA	6.85	NA	13.33	NA	9.54	NA
41	*Dactyloctenium aegyptium* (L.) P. Beauv.	NA	10266.67	NA	3.35	NA	30.67	NA	3.48
42	*Dactyloctenium scindicum* Boiss.	NA	466.67	NA	2.33	NA	2.00	NA	0.16
43	*Desmostachya bipinnata* (L.) stapf	7133.33	1200.00	10.70	3.60	6.67	3.33	7.45	0.41
44	*Dichanthium annulatum* (Forsk) Stapf	NA	6533.33	NA	3.63	NA	18.00	NA	2.22
45	*Dicoma tomentosa* Cass.	NA	1666.67	NA	2.50	NA	6.67	NA	0.57
46	*Digera muricata* (L.) Mart.	NA	2866.67	NA	2.87	NA	10.00	NA	0.97
47	*Digitaria adscendens* (H.B. and K.) Henr.	NA	333.33	NA	2.50	NA	1.33	NA	0.11
48	*Echinochloa colona*(L.) Link.	NA	933.33	NA	2.80	NA	3.33	NA	0.32
49	*Echinops echinatus* Roxb.	666.67	4000.00	2.00	2.73	3.33	14.67	0.70	1.36
50	*Eclipta prostrata* (L.) L.	NA	1933.33	NA	3.63	NA	5.33	NA	0.66
51	*Enicostema hyssopifolium* (Wild.) verdoon	2400.00	200.00	7.20	1.50	3.33	1.33	2.51	0.07
52	*Eragrostis cilianensis* (All.) Janch.	NA	666.67	NA	5.00	NA	1.33	NA	0.23
53	*Eragrostis ciliaris* (L.)R. Br.	NA	34133.33	NA	5.69	NA	60.00	NA	11.57
54	*Euphorbia hirta* L.	NA	3800.00	NA	4.75	NA	8.00	NA	1.29
55	*Euphorbia prostrata* Aiton	NA	666.67	NA	2.50	NA	2.67	NA	0.23
56	*Euphorbia serpens* Kunth	NA	733.33	NA	2.75	NA	2.67	NA	0.25
57	*Euphorbia thymifolia* L.	NA	533.33	NA	2.00	NA	2.67	NA	0.18
58	*Evolvulus alsinoides* (L.) L.	NA	1400.00	NA	3.00	NA	4.67	NA	0.47
59	*Fagonia cretica* Linn	8133.33	6000.00	2.65	2.31	30.67	26.00	8.50	2.03
60	*Heliotropium supinum* L.	66.67	466.67	1.00	1.75	0.67	2.67	0.07	0.16
61	*Heliotropium strigosum* Willd.	NA	200.00	NA	1.50	NA	1.33	NA	0.07
62	*Heteropogon contortus* (L.) P.Beauv. ex Roem. and Schult.	NA	1133.33	NA	2.43	NA	4.67	NA	0.38
63	*Indigofera linnaei* Ali.	1000.00	5400.00	3.00	3.00	3.33	18.00	1.04	1.83
64	*Indigofera coerulea* var. *monosperma* (Santapau) Santapau	NA	400.00	NA	2.00	NA	2.00	NA	0.14
65	*Indigofera cordifolia* Roth	NA	933.33	NA	2.80	NA	3.33	NA	0.32
66	*Laggera aurita* (DC.) Sch.Bip. ex Schweinf.	NA	1400.00	NA	2.33	NA	6.00	NA	0.47
67	*Launaea procumbens* (Roxb.) Ram. and Raj.	1266.67	5533.33	3.80	2.52	3.33	22.00	1.32	1.88

Table 1. Contd...

SN	Scientific Name	Density (ind. ha^{-1})		Abundance* (ind. quadrat^{-1})		Frequency (%)		Composition (%)	
		Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon
68	*Lepidagathis trinervis* Nees	8066.67	3533.33	3.90	2.41	20.67	14.67	8.43	1.20
69	*Leucas aspera* (Wild.) Spr.	NA	3066.67	NA	3.29	NA	9.33	NA	1.04
70	*Leucas cephalotes* (Roth) Spreng.	NA	933.33	NA	2.80	NA	3.33	NA	0.32
71	*Mitracarpus hirtus* (L.) DC.	NA	1400.00	NA	3.50	NA	4.00	NA	0.47
72	*Pedalium murex* L.	NA	733.33	NA	2.75	NA	2.67	NA	0.25
73	*Periploca aphylla* Decne.	NA	333.33	NA	1.67	NA	2.00	NA	0.11
74	*Peristrophe bicalyculata* (Retz.) Nees	2133.33	15133.33	2.67	4.05	8.00	37.33	2.23	5.13
75	*Phyllanthus maderaspatensis* L.	NA	333.33	NA	2.50	NA	1.33	NA	0.11
76	*Phyllanthus niruri* L.	1066.67	NA	3.20	NA	3.33	NA	1.11	NA
77	*Physalis minima* L.	NA	1066.67	NA	2.67	NA	4.00	NA	0.36
78	*Physalis pruinosa* L.	NA	800.00	NA	2.40	NA	3.33	NA	0.27
79	*Polygala erioptera* DC.	NA	333.33	NA	2.50	NA	1.33	NA	0.11
80	*Pulicaria wightiana* (DC.) C.B.Clarke	NA	2066.67	NA	2.58	NA	8.00	NA	0.70
81	*Ruellia patula* Jacq.	NA	1066.67	NA	2.67	NA	4.00	NA	0.36
82	*Rungia repens* (L.) Nees	NA	2466.67	NA	3.08	NA	8.00	NA	0.84
83	*Salvia aegyptiaca* L.	NA	866.67	NA	3.25	NA	2.67	NA	0.29
84	*Schoenefeldia gracilis* Kunth	NA	2600.00	NA	3.25	NA	8.00	NA	0.88
85	*Setaria glauca* (L.) P.Beauv.	NA	1266.67	NA	2.71	NA	4.67	NA	0.43
86	*Sida acuta* Burm.f.	NA	1133.33	NA	2.13	NA	5.33	NA	0.38
87	*Sida cordifolia* L.	NA	2533.33	NA	3.17	NA	8.00	NA	0.86
88	*Solanum surattense* Burm. f.	933.33	7666.67	2.33	2.95	4.00	26.00	0.97	2.60
89	*Solanum indicum* L.	NA	1000.00	NA	3.75	NA	2.67	NA	0.34
90	*Sonchus oleraceus* (L.) L.	NA	1000.00	NA	3.75	NA	2.67	NA	0.34
91	*Spermacoce articularis* L.f.	NA	1333.33	NA	2.86	NA	4.67	NA	0.45
92	*Sporobolus coromandelianus* (Retz.) Kunth	600.00	3400.00	1.80	5.67	3.33	6.00	0.63	1.15
93	*Suaeda nudiflora* (Willd.) D. Hou	2933.33	5666.67	2.93	7.73	10.00	7.33	3.06	1.92
94	*Taverniera cuneifolia* (Roth) Arn.	NA	866.67	NA	4.33	NA	2.00	NA	0.29
95	*Tephrosia purpurea* (L.) Pers.	600.00	666.67	1.80	2.50	3.33	2.67	0.63	0.23
96	*Trianthema portulacastrum* L.	NA	2266.67	NA	3.78	NA	6.00	NA	0.77
97	*Trichodesma indicum* (L.) Lehm.	NA	1333.33	NA	2.86	NA	4.67	NA	0.45
98	*Tridax procumbens* (L.) L.	2000.00	5333.33	4.29	3.64	4.67	14.67	2.09	1.81
99	*Triumfetta pentandra* A.Rich.	800.00	NA	1.71	NA	4.67	NA	0.84	NA
100	*Typha domingensis* Pers.	466.67	1133.33	2.33	3.40	2.00	3.33	0.49	0.38
101	*Vernonia cinerea* (L.) Less.	1733.33	13200.00	1.86	3.25	9.33	40.67	1.81	4.48

NA- Not Available, Ind.- Individual * Abundance of individual quadrat^{-1}

quadrat^{-1} which means that both seasons have reflected good abundance status of plant. Similar study done by Suthar *et al*. (2021) in Saurashtra region where they have noted density of herbaceous vegetation in the range of 1.10 to 20.07 ind. quadrat^{-1} during pre-monsoon season and 14.43 to 1.0 ind. quadrat^{-1} during post monsoon season.

Frequency

During post-monsoon season, more frequent species were *Eragrostis ciliaris*, *Aristida adscensionis*, *Vernonia cinerea, Peristrophe bicalyculata*, *Chloris barbata*, *Dactyloctenium aegyptium, Cynodon dactylon* and *Achyranthes aspera* etc (Table 1). The frequency values were found ranging from 1.33% to 60.00%. During pre- monsoon season, more frequent species were *Cynodon dactylon*, *Fagonia cretica*, *Lepidagathis trinervis*, *Achyranthes aspera*, *Aristida adscensionis, Cyperus bulbosus, Cressa cretica* and *Aeluropus lagopoides* etc (Table 1) and their frequencies value were between 0.67% to 32.00% in NCC area of Kachchh district while a study done by Suthar *et al*. (2021) in Saurashra region where they have noted frequency of herbaceous vegetation in the range of 24.47 to 0.22% during pre-monsoon season and 35.60 to 0.22 % during post monsoon season.

Species composition

During post-monsoon season, maximum per cent composition was noted for *Eragrostis ciliaris* fallowed by that of *Aristida adscensionis*, *Peristrophe bicalyculata*, *Vernonia cinerea*, *Chloris barbata*, *Dactyloctenium aegyptium, Cynodon dactylon* and *Cressa cretica* etc (Table 1). Their composition values ranged from 0.07% to 11.57%. In pre-monsoon season, *Cynodon dactylon* showed maximum per cent composition followed by that of *Aeluropus lagopoides*, *Cyperus bulbosus*, *Fagonia cretica*, *Lepidagathis trinervis*, *Desmostachya bipinnata* and *Achyranthes aspera* etc. (Table 1). The per cent composition values were found to be ranging from 0.07% to 16.85%. Almost, similar percent composition dynamics was found by Kie (2005).

Dominance and Diversity Indices

The seasonal comparison of dominance and diversity indices showed that the value of Simpson Diversity Index was higher, i.e., 0.97 in post monsoon season as compared to pre-monsoon season i.e. 0.93. During both the seasons, the value of Simpson Diversity Index was almost similar which indicated that the Narmada Canal Command Area provided good habitat conditions to various herbaceous species in both the seasons. Narmada Canal waters provided moisture to the plants even during lean (pre-monsoon) season and maintained relatively good herb diversity even during pre-monsoon (lean season). A study done by Kassas and Elabyad (1962) had shown, that the moisture is concentrated in furrows, tunnels, effluent and main channel of drainage system which may lead to good growth of herbaceous vegetation.

Habit	Simpson index * (D)		Simpson Index of Diversity** (1-D)	
	Pre-monsoon	Post-monsoon	Pre-monsoon	Post-monsoon
Herbaceous	0.07	0.03	0.93	0.97

*Indicates Dominance.
** Indicates Species Diversity/Richness.

Moreover, the probable cause of nearly similar value of diversity index in pre-monsoon season and post-monsoon season might be due to the availability of the Canal water even in pre-monsoon season which might have maintained the seed viability by providing moisture even during otherwise drier part of a year. Almost similar diversity index was found by Suthar *et al*. (2021) in Saurashtra region of Gujarat where pre and post monsoon season reflects almost similar biodiversity index due to availability of Canal water which means natural vegetation dynamics is mostly dependent on water availability from different resources such as rivers, canals, ponds etc. which also reflect its impact on diversity and density in different seasons. A study was done by Ozaslan *et al*. (2017) also suggested that seed germination progressively increased by running water as water effectively released the dormancy of seeds of different species.

Conclusion

The study for NCC area, Kachchh district has indicated that there had been a dynamicity in the values of density, frequency, abundance and composition of herbaceous plants species

with respect of seasonal change (from pre to post monsoon). There has also been some variation in species diversity of herbaceous plants from pre to post-monsoon seasons, the change was not so substantial due to water availability from Narmada Canal even during pre-monsoon (lean) season.

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