

## THE EFFECT OF CANAL IRRIGATION ON THE NATURAL FLORA OF NORTH-WEST RAJASTHAN

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The North-West Rajasthan is being irrigated by the Ganga canal, Bhakra canal and Indira Gandhi canal which has greatly affected the natural flora of the area during the last 60 years or so. The irrigated areas are green all over in place of desolate, undulating barren sand-dunes. The irrigation waters, which owe their source to the Punjab rivers, have been bringing seeds and other propagules of a number of extralimital species year after year and many of these have become successfully established in the area as crop weeds or along the banks of canals. In the irrigated regions, there are 87 species which do not occur in the unirrigated regions of the entire Thar desert. Some of the most conspicuous of these are temperate elements like *Marchantia polymorpha*, *Cotula anthemoides*, *Astragalus subumbellatus*, *Ammi majus*, *Verbascum thapsus*, *Plantago amplexicaule* and *Pouzolzia Pentandra*.

**Key words :** Natural flora; Canal irrigation; Sand-dunes; Weeds.

### Introduction

The North-West Rajasthan was not always the forbidding desert as it is today. There is geological and epigraphic evidence that the river Saraswati on the bank of which the Vedic civilization flourished, used to flow through what is today the Thar desert. Scanty rainfall and overgrazing denuded the land of all vegetation and turned it into what can be appropriately described as the lunar surface.

The transformation of the desert into green fields had started with the

introduction of Ganga canal (1927), Bhakra canal (1951-52) and Rajasthan canal (1957) having their sources in the waters of Sutlej and Beas at Husainiwala Head, Bhakra-Nangal and Harikapattan, respectively in Punjab. The area to be served by the Rajasthan canal, now names as Indira Gandhi canal, falls mainly in the districts of Ganganagar, Bikaner and Jaisalmer. The regions of Bikaner and Jaisalmer districts through which the canal is flowing is at present covered with sand-dunes, with interdunal areas and sandy plains. The change which are likely to take

place in the Indira Gandhi canal demmand area can be visualised by the study of the present day vegetation of Ganganagar district.

The district of Ganganagar having an area of 20,629 sq. km. is situated in the North of Rajasthan State between 28°40'–30°6' N Lat. and 72°36'–75°30' E Long. It constitutes a part of great Indian Desert. The district is being irrigated by Ganga canal, Bhakra canal and Indira Gandhi canal which has greatly affected the natural flora of the area in many ways. The irrigation waters which owe their source to the Punjab river has been bringing seeds and other propagules of a number of extralimital species year after year and many of these have already become established successfully in the area as crop weeds or along the banks of canals (Dhillon and Bajwa, 1972; Dhillon and Bhandari, 1974; Brar, 1981; Singh and Brar, 1984; Singh and Dhillon 1989). The most striking example of naturalization in the Great Indian Desert includes the frequent occurrence of species of *Riccia*, *Marchantia* and *Ophioglossum vulgatum* L. (Singh and Brar, 1980) in the canal irrigated areas.

### Materials and Methods

The present work is based on the results of more than 8 years of intensive and extensive study of the flora of this region. Excursions were un-

dertaken twice or thrice a week and covered all the 13 tehsils of the district and plants were collected in flowering and fruiting stage. Efforts were made to identify the plants from the fresh materials and those which could not be satisfactorily identified, were preserved and later checked and authenticated at Bombay, Dehradun and Calcutta Herbaria. The specimens have been preserved in the Herbarium, SGN Khalsa College, Sriganganagar (Rajasthan).

### Results and Discussions

The eastern and the extreme western border regions of the district are unirrigated and are covered with sandy plains interspersed with sand-dunes. These sand-dunes may be unstable and of shifting type as in the regions west to Anupgarh or may be stable as in the regions east to Anupgarh. The soil here, in general, falls under the group 'Desert Soil', which is low in organic contents. The vegetation is similar to that found in similar habitats in the other parts of the Thar desert, like Bikaner and Churu districts. The vegetation of these unirrigated areas can be classified as under : (a) Vegetation of loose sand-dunes and spread out sand : When the loose sand is spread out, the common plants in the area are *Dipterygium glaucum* Decne., *Ziziphium nummularia* (Brum. f.) Wt. & Arn., *Prosopis cineraria* (Linn.) Druce, *Citrullus colocynthis* (Linn.) Schrad.,

*Salvadora oleoides* Decne., *Leptadenia pyrotechnica* (Forsk.) Decne., *Arnebia hispidissima* DC., *Convolvulus deserti* Hochst., *Cyperus niveus* Retz., *Cymbopogon jwaranchusa* (Jones) Schult., and *Lesiurus hirsutus* (Forsk.) Boiss. (b) Vegetation of stabilized sand-dunes : Due to vegetable cover, sand-dunes get stabilized and support a comparatively rich vegetation. The common elements of these stabilized sand-dunes are *Capparis decidua* (Forsk.) Edgew., *Acacia tortalis* Hayne, *Prosopis chilensis* (Mill.) Stuntz, *Crotalaria burhia* Buch.-Ham., *Tephrosia strigosa* (Delz.) Santapau et Maheshw., *Carthamus oxycantha* M. Bieb., *Echinops echinatus* Roxb., *Cistanche tubulosa* Wight., *Calligonum polygonoides* Linn., *Calotropis procera* R. Br., *Heliotropium ellipticum* Ladeb., *Lycium europaeum* Linn., *Aristida adscensionis* Linn. and *Panicum antidotale* Retz.

The soil in the Ghaggar alluvial plain come under the type 'Reverine Soil'. Alkalinity and saline problem in these soils is comparatively greater and the organic carbon status is also slightly higher (Kumar *et al.*, 1973). The natural vegetation here is sparse, especially in the low lying saline tracts. The common plants found in the Ghaggar river bed are *Ranunculus sceleratus* Linn., *Nymphaea stellata* Willd., *Aeschynomene indica* Linn., *Potentilla supina* Linn., *Trapa natans* Linn. var. *bispinosa* (Roxb)

Makino, *Ipomoea aquatica* Forsk., *Utricularia inflexa* Forsk., *Polygonum barbatum* Linn., *P. plebeium* R. Br., *Hydrilla verticillata* (Linn. f.) Royle, *Eichhornia crassipes* (Mart.) Solms., *Cyperus exaltatus* Retz., *C. michelianus* (Linn.) Link, and *Vetiveria zizanioides* (Linn.) Nash. Ghaggar river bed is extensively used for cultivation of rice as main *kharif* crop and wheat, barley and gram as *rabi* crop. Many weeds of cultivation are, therefore, naturally found here.

The extensive irrigation facilities due to Ganga, Bhakra and Indira Gandhi canals have resulted in agriculture being the mainstay in Ganganagar district. The agricultural year includes two seasons, the *kharif* (rainy season) from July to October and the *rabi* (winter season) from November to May. The *kharif* crops include *Gossypium* spp., *Oryza sativa* Linn., *Cajanus cajan* Mill. and *Cyamopsis tetragonolobus* Taub. The *rabi* crops include *Triticum aestivum* Linn., *Brassica campestris* var. *sarson* Prain, *B. campestris* var. *toria* Duthie et Fuller, *Saccharum officinarum* Linn. and *Beta vulgaris* Linn.

A large number of weeds are found in the cultivated fields and orchards. The most prominent weeds of winter season are *Malcolmia africana* R. Br., *Fumaria indica* Pugsl., *Hypocoum procumbens* L., *Arenaria serpyllifolia* Linn., *Astragalus subum-*

**Table 1.** A broad spectrum of flora of Sri Ganganagar District of Rajasthan : Comparison of flora of Canal irrigated and unirrigated region

(a) Families represented by a single genus :

	UIR		IR		UIR		IR		UIR		IR	
	G	S	G	S	G	S	G	S	G	S	G	S
Fumariaceae	1	1	1	1	—	—	—	—	1	1	4	5
Ranunculaceae	—	—	1	3	1	4	1	4	1	1	1	1
Polygalaceae	1	2	1	1	1	2	1	4	1	2	1	2
Elatinaceae	1	2	1	2	—	—	—	1	1	1	1	3
Wastraceae	1	1	—	—	1	4	1	3	1	1	1	1
Moringaceae	1	1	1	1	2	1	1	1	1	1	1	1
Haloragaceae	—	—	1	1	—	—	—	1	1	—	—	1
Trapaceae	—	—	1	1	1	2	1	2	1	2	1	1
Sphenocleaceae	—	—	1	1	1	1	1	1	1	2	1	2
Gentianaceae	—	—	1	1	2	4	1	3	1	2	1	3
Lentibulariaceae	—	—	1	1	1	2	1	2	1	1	1	1
Aristolochiaceae	1	1	—	—	—	—	—	1	1	—	—	1
Ceratophyllaceae	1	1	1	1	—	—	—	1	1	—	—	1
Commelinaceae	1	1	1	2	1	1	1	1	1	1	1	2
Typhaceae	1	1	1	1	—	—	—	1	1	1	1	1
Potamogetonaceae	1	1	1	2	—	—	—	1	1	1	1	1

(b) Families represented by 2-5 genera :

	UIR		IR		UIR		IR		UIR		IR	
	G	S	G	S	G	S	G	S	G	S	G	S
Menispermaceae	2	2	3	3	—	—	2	3	2	2	2	3
Tiliaceae	2	5	3	7	4	6	4	5	1	1	2	2
Meliaceae	2	2	3	3	4	6	4	11	1	1	2	2
Molluginaceae	4	5	4	5	4	4	3	4	4	8	4	7
Convolvulaceae	3	9	3	11	1	1	2	2	4	4	5	5
Pedaliaceae	2	2	2	2	3	3	3	3	4	5	5	7
Lamiaceae	2	4	3	6	4	5	3	6	2	4	2	8
Hydrocharitaceae	2	2	2	2	—	—	—	—	—	—	—	—

(c) Families represented by 5-10 genera :

Brassicaceae	8	11	9	12	6	6	7	7	5	7	7	12
Mimosaceae	7	10	6	10	6	9	6	9	6	7	5	5
Solanaceae	7	12	7	9	4	5	7	9	8	12	9	15
Chenopodiaceae	5	7	6	8	5	11	7	18	4	8	7	18

(d) Families represented by more than 10 genera :

Papilionaceae	17	30	24	50	7	7	11	11	20	26	30	40
Poaceae	33	66	45	76	—	—	—	—	—	—	—	—

UIR=Unirrigated; IR=Irrigated G=Genus S=Species

*bellatus* Klotzsch., *Lotus corniculatus* Linn., *Medicago minima* Lamk., *Trigonella hamosa* Linn., *T. occulta* Delh., *Vicia hirsuta* (Linn.) Gray, *Crotella asiatica* (Linn.) Urban, *Psammogeton canescence* (DC.) Vatke, *Cichorium intybus* Linn., *Cotula anthemoides* Linn., *Centaurium centaurioides* (Roxb.) N. C. Nair, *Veronica anagallis-aquatica* Linn., *Salvia plebeia* R. Br., *Zeuxine strateumatica* (Linn.) Schltr., *Catambrosa aquatica* (Linn.) P. Beauv., *Lolium temulentum* Linn. and *Lophocloa phleoides* (Vill) Reichb.

The most prominent weeds of rainy season are *Corchorus fascicularis* Lamk., *C. olitorius* Linn., *Triumfetta rhomboides* Jacq., *Tribulus alatus* Del., *Oxalis latifolia* HBK., *O. corymbosa* DC., *Aeschynomene indica* Linn., *Alysicarpus bupleurifolius* (Lina.) DC., *A. longifolius* Wt. & Arn., *Ammannia multiflora* Roxb., *Ludwigia adscendens* (Linn.) Hara., *Soliva anthemifolia* R. Br., *Sphenoclea zeylancia* Gaertn., *Utricularia inflexa* Forsk., *Pouzolzia pentandra* (Roxb.) Benn., *Commelina diffusa* Burm., *Fimbristylis schoenoides* Vahl, *Dinebra retroflexa* (Vahl) Panz., *Eragrostis nutans* (Retz.) Nees ex Steud., *Koeleria argentea* Griseb., *Panicum paludosum* Roxb. and *Tragus roxburghii* Panigrahi.

Along the banks of canals which are generally marshy the common species are *Ranunculus cantonensis* DC., *R. sceleratus* Linn., *Lotus cornicu-*

*latus* Linn., *Bistella digyna* (Retz.) Bullock, *Anethum graveolens* Linn., *Centella asiatica* (Linn.) Urban, *Oenanthe javanica* (Bl.) DC., *Cotula hemispherica* (Roxb.) Hook. f., *Soliva anthemifolia* R. Br., *Grangea mederaspatana* (Linn.) Pior., *Bacopa monnieri* (Linn.) Wettst., *Salvia plebeia* R. Br., *Alternanthera sessilis* (Linn.) DC., *Polygonum barbatum* Linn., *P. glabrum* Willd., *P. lanigerum* R. Br., *Pouzolzia pentandra* (Roxb.) Benn., *Zeuxine strateumatica* (Linn.) Scgltr., *Typha angustata* Bory & Chaub., *Carex fedia* Nees, *Imperata cylindrica* (Linn.) P. Beauv., *Phragmites karka* (Retz.) Trin. ex Steud., *Saccharum spontaneum* Linn. and *S. bengalensis* Retz. In addition to the above, taxa like *Riccia*, *Marchantia*, *Ophioglossum vulgatum* Linn., *Equisetum ramosissimum* Desf., and *Marseilia minuta* Linn. occur frequently along canal banks.

The aquatic plants occurring in the area are *Myriophyllum spathulatum* Blatt. et Hallb., *Ceratophyllum demersum* Linn., *Hydrilla verticillata* (Linn. f.) Royle, *Vallisneria spiralis* Linn., *Eichornia crassipes* (Mart.) Solms., *Lemna paucicostata* Hegelm., *L. trisulca* Linn., *Spirodela polyrrhiza* Linn., Schleid., *Wolffia arrhiza* (Linn.) Horkelex Wimmer, *Najas graminea* Del., *Potamogeton crispus* Linn., *P. pectinatus* Linn. and *Azolla pinnata* R. Br.

The saline localities are restricted to very small areas or cover extensive

areas. The vegetation is very sparse and the common species found only on saline soils are *Dilophia salsa* Thoms., *Zygophyllum simplex* Linn., *Heliotropium curassavicum* Linn., *Haloxylon salicornicum* (Moq.) Bunge, *Kochia indica* Wt., *Salsola baryosma* Dandy and *Suaeda fruticosa* (Linn.) Forsk. In the sandy areas, the most common parasites are *Cistanche tubulosa* Wight, *Orobanche aegyptiaca* Pers. (total root parasites on *Calotropis procera* and *Eruca sativa*, respectively) and *Striga angustifolia* a partial root parasite on a number of grasses. *Cuscuta* spp. are total stem parasites. Of these, *C. reflexa* Roxb. parasitises almost every plant it comes in contact with; *C. capitata* Roxb. parasitises *Medicago sativa* and *C. hyalina* Roth. parasitises the species of *Tribulus* and *Zaleya*.

A comparison of the flora of Ganganagar district (Table 1) with that of the rest of the Rajasthan desert revealed that 87 species found in Ganganagar district have not been reported from other parts of the Rajasthan desert (Singh and Dhillon, 1989). Most of these species have come down to Ganganagar district from Punjab, many of them presumably through water or as contaminations of crop seeds and have either established themselves along the banks of canals or are found as seasonal weeds in the irrigated areas. The natural flora has been modified yet in another way. Many of the

common species of the unirrigated desert which originally belong to this area have disappeared obviously due to protracted irrigation, most probably due to losing competition against the new entrants. Though irrigation has effected the water content and texture of the soil substantially, not all the changes for the worse in the floristic richness can be attributed to irrigation alone. With the availability of irrigation, large tracts are now under cultivation and wastelands have become scarce. Wild species can grow only as crop weeds or on the sides of the roads and canals. This reduction in the realm of wild plants has obviously contributed substantially to the reduction in the number of wild species. However, whatever might be the factors responsible for the change of natural flora they are all consequence of the introduction of canal irrigation.

The changes which have taken place in Ganganagar district due to increased irrigation facilities are bound to take place in the Indira Gandhi canal command area in Bikaner and Jaisalmer districts also, perhaps on a much larger scale. As it happened in Ganganagar district, there will be extensive cultivation, tremendous increase in weed flora, phenomenal increase in population and destruction of natural vegetation. The canal irrigation will play an important role in introducing species from neighbouring districts and

States is already evident in Bikaner district with the reports of species like *Ranunculus sceleratus* Linn., *Hypocoum procumbens* L., *Lotus corniculatus* Linn., *Centella asiatica* (Linn.) Urbans, *Anethum graveolens* (Linn.) Benth., *Oenanthe javanica* (Bl.) DC., *Soliva anthemifolia* R. Br., *Salvia plebeia* R. Br. *Zeuxine strateumatica* (Linn.) Schltr., *Myriophyllum spathulatum* Blatt. et Hallb., *Potamogeton nodosus* Poir. and *Phragmites karka* (Retz.) Trin. ex Steud., earlier not reported from Bikaner district.

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