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Research Article

Assessment of Halophytes Diversity of Northwest Saline Regions of Daund Tehsil, Maharashtra, India

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Abstract

Salinity emerges as a growing challenge, leading to substantial crop yield losses across global regions. To optimize agricultural productivity in affected areas, there is a need for the utilization of salt-tolerant plants to mitigate salinity. The exploration of saline flora presents a valuable opportunity for phytoremediation in saline regions, offering a potential solution for salinity reduction. This study is specifically designed to assess the floristic diversity within the Nangaon–Dapodi saline area in Daund Tehsil, Maharashtra, with the aim of identifying salt-tolerant plants for phytoremediation to address the escalating issue of salinity-induced yield losses. A comprehensive floristic survey was conducted from 2021 to 2023, resulting in the identification of 55 plant species across 43 genera and 21 families. The most dominant families, including Poaceae and Asteraceae, exhibit promising salt-tolerant activity. Noteworthy additions to Maharashtra's flora, such as Suaeda fruticose, Salvadora alii, and Juncus martimus, were observed. Additionally, the study identifies aquatic marshy habitats with high-water salinity indicators like Vernonia anagalis, Typha latifolia, and Bacopa monnieri. The findings underscore the potential of these identified plants for phytoremediation in saline areas, offering a sustainable approach to mitigate salinity-related challenges in agricultural regions.

INTRODUCTION

Salinization poses a significant challenge to contemporary agriculture, impacting extensive areas globally (Negacz et al. 2022; Shabbir et al. 2018). According to the FAO (2015), salinity's adverse effects extend to approximately one billion hectares of land worldwide (Ghassemi et al. 1995; Qadir et al. 2014). The escalating salinization has particularly threatened the global food supply system, posing a substantial threat to food security due to decreased agricultural production (Negacz et al. 2022). Additionally, the economic toll is substantial, with agriculture facing annual losses amounting to hundreds of millions of dollars, specifically USD 11.4 billion (Ghassemi et al. 1995). In various regions of India, salt-affected lands see crop yield reductions ranging from 36 to 69%, especially in arid and semi-arid zones (Qadir et al. 2014). Salinity emerges as a pressing issue significantly diminishing yields, necessitating the utilization of underutilized areas that could be reclaimed by employing salt-tolerant flora and vegetation to optimize crop yield (Hasanuzzaman et al. 2014; Khan and Qaiser 2006).

Numerous saline plant species, including grasses, shrubs, and trees, employ morphological, anatomical, and physiological adaptations at the cellular level to eliminate salt from the soil through exclusion, excretion, or accumulation (Salvi et al. 2017; Hasanuzzaman et al. 2014). Utilizing plants with salt tolerance and dual salt accumulation and exclusion capabilities is an effective approach to mitigate salinity (Hasanuzzaman et al. 2014).

Saline plants, owing to their ease of implementation, prove advantageous for phytoremediation in saline environments (Negacz et al. 2022). Halophytes, an underutilized resource, hold significant potential for diverse human needs, encompassing food, fuel, fodder, fiber, medicine, industry, household, and soil reclamation (Khan et al. 2009; Das et. al. 2020; Qasim et al. 2011). Despite their potential, the utilization of halophytes has only recently gained attention, with various studies highlighting their potential in animal feed (Khan et al. 2009; Ehsen et al. 2016).

Currently, botanists have identified and classified 2200 halophytic plant species from over 550 taxa across 100 families in saline and semi-arid regions (Khan and Qaiser 2006). Khan et al. (2009) demonstrated the efficacy of halophytes in reducing soil salinity and enhancing soil fertility in similar arid regions. Additionally, Garg and Bhandari (2020) emphasized the role of halophytes in accumulating and sequestering salts from the soil, thereby contributing to the amelioration of saline environments. Consequently, there is a pressing need for comprehensive research on floristic assessments and their documentation to provide valuable insights for the future.

The northwest saline regions of Daund Tehsil are characterized by high salinity levels. Understanding the halophytic diversity is vital for phytoremediation strategies. Furthermore, the identification of halophyte species with superior adaptive traits will inform the selection of suitable candidates for large-scale phytoremediation initiatives. In the present study, a diverse array of plants was identified and information about scientific names, families, vernacular names, habits, habitats, seasonal availability, and salt-tolerant properties was compiled. This meticulous documentation serves as a valuable resource for understanding the flora in saline-rich areas and provides insights into potential candidates for phytoremediation purposes.

MATERIALS AND METHODS

Study Area:

The present investigation focused on specific villages in the Daund tehsil, namely Nangaon, Dapodi, Khopodi, Kangaon (Amoni maal), Ganesh Road, and Hatvalan, all of which are grappling with the issue of soil salinity. The study encompasses the region traversed by the Bhima River in the Daund Tehsil within the Pune district of Maharashtra state (Table 1, Fig. 1). This geographical expanse spans a total area of 1289.86 square kilometers (128986 ha.), with latitudes ranging from 18°18' to 18°41' north and longitudes from 74°07' to 74°51' east. The prevailing climate in this zone is categorized as semi-arid, and agriculture in the river basin primarily revolves around sugarcane cultivation. The salinization of areas occurs due to suboptimal crop rotation practices and the excessive use of chemical fertilizers.

Methodology:

Throughout the course of this research, 10 to 12 intensive field visits were meticulously organized in the study area, across different seasons from 2021 to 2023. The primary objective of these visits was to document and investigate the diverse range of saline plants in the Nangaon-Dapodi areas of Daund tehsil, with a specific emphasis on their potential for phytoremediation. Various localities, particularly those rich in salinity such as Nangaon, Dapodi, Khopodi, Kangaon, Amoni maal, Ganesh Road, and Hatvalan villages in Daund Tehsil, were included. A comprehensive list of plants was compiled as part of this floristic study. Data collection took place in various settings, including forests, barren lands, roadsides, agricultural farms, and nearby localities. Different locations were thoroughly examined, and digital photographs were captured of diverse plant specimens. Plant specimens were accurately identified using available literature and various regional and local floras, and confirmed by experts. The detailed information on plants available in selected saline areas was documented (Table 2). By analyzing physico-chemical properties of the soil and water from the study area, plants were categorized into salt tolerant, fairly salt tolerant, highly salt tolerant and drought tolerant (Hasanuzzaman et. al 2014).

RESULTS AND DISCUSSION

The investigation into floristic composition is crucial for comprehending the current state of biodiversity conservation, as highlighted by Salvi et al. (2017). The study undertaken in the selected areas of Daund tehsil yielded notable diversity of plant life (Fig. 2). A total of 55 distinct species belonging to 43 genera across 21 families were documented (Table 2, Fig. 3). The studies revealed that a total 53 species belonged to the potential of salt tolerant with different category including highly salt tolerant, salt tolerant, drought tolerant, and fairly salt tolerant. Amongst them, 21 species were recorded as highly salt tolerant (HST), 25 species as salt tolerant (ST), 06 species as drought tolerant (DT), and 01 species as fairly salt tolerant (FST). These taxa were further categorized into 7 clades as per the APG-III classification system (Table 3). The distribution of these genera and species within the identified clades provides a clear overview of the composition across different taxonomic groups. This comprehensive floral inventory and diversity assessment contribute valuable insights into the plant biodiversity of the study area.

The plant species distribution across different clades and families revealed interesting patterns. The Monocot clade emerged as the most speciose, comprising 11 genera with 13 species, followed by Euasterids-I (8 genera with 10 species), Eurosids-I (7 genera with 7 species), Eurosids-II (5 genera with 10 species), Eudicot (6 genera with 7 species), Core Eudicot (3 genera with 5 species), and Commelinids (3 genera with 3 species). The family-wise distribution highlighted that Poaceae and Asteraceae exhibited the highest species diversity with 8 species each. Following closely were Convolvulaceae (5 species), Amaranthaceae (4 species), Cyperaceae (4 species), Fabaceae (3 species), Apocynaceae (3 species). Other families, such as Asclepidiaceae, Commelinaceae, Malvaceae, Plantaginaceae, Salvodoraceae, and Solanaceae were each represented by 2 species. Additionally, families like Acanthaceae, Chenopodiaceae, Cucurbitaceae, Euphorbiaceae, Juncaceae, Lamiaceae, Lytharaceae, and Typhaceae were represented by 1 species each. This detailed investigation provides a comprehensive overview of the diversity present in the studied area, highlighting the richness of various clades and families within the local flora. The majority of these plants exhibit a herbaceous growth habit. The recorded plant taxa display a diverse array of life forms, including annuals, biennials, and perennials, encompassing herbs, undershrubs, climbers, creepers, a few trees, and some aquatic plants. The collection and documentation efforts primarily centered around the dominant members of various plant families, with a notable emphasis on Asteraceae, Poaceae, Apocynaceae, Salvadoraceae, Chenopodiaceae, Plantaginaceae, Malvaceae, Amarantaceae, Euphorbiaceae, Cyperaceae, Convolvulaceae, Commelinaceae, Juncaceae, Fabaceae, Asclepiadaceae, Acanthaceae, Typhaceae, and others. Significantly, the families Poaceae, Juncaceae, Chenopodiaceae, Salvadoraceae, Typhaceae, Convolvulaceae, and Amaranthaceae were identified as the most salt-tolerant plants in the study area. These plants exhibit substantial potential for phytoremediation against salinity. The plant diversity in saline regions provides valuable insights into the dominant plant families within these challenging environments.

In aquatic marshy habitats, several species such as *V. anagalis, T. latifolia, A. philoxeroides*, and *B. monnieri* were reported for the first time, serving as indicators of high-water salinity. Additionally, the study identified *S. fruticose, S. alii, S. persica*, and *J. martimus* as new additions to the flora of Maharashtra state. Notably, *S. fruticose, S. alii*, and *S. persica* demonstrated a range extension from the seashore to the plains of Western Maharashtra.

All the reported plants in the study areas showcase potential for future use in phytoremediation endeavors aimed at addressing salinity issues in saline regions. The findings contribute valuable insights into the unique plant diversity and adaptations in response to saline conditions in Daund tahsil. Species like *S. perennis, S. argentinensis, S. maritima,* and *S. densiflora* have been demonstrated to accrue heavy metals (Qasim et. al. 2011, Khan and Qaiser 2006). The following species can be used for phytoremediation: *A. nummularia, M. crystallinum, S. portulacastrum, P. oleracea, P. aculeata, S. fruticosa, S. nudiflora, X. strumarium, H. portulacoides A. triangularis, S. glauca, S. vera, P. australis, T. pergranulata, S. longicuspis, F. serpyllifolia, S. sesban, A. dealbata, S. rostrata, P. filiformis, P. acutifolius, A. halimus, A. hortensis, A. nummularia, S. Senegal, V. seyal* and *P. juliflora* (Mushtaq et. al. 2020).

Conclusion:

The present study highlights the extensive salinization issues faced by the Daund Tehsil region and underscores the potential of halophytic plants in mitigating soil salinity. Our comprehensive floristic assessment identified a total of 53 plant species across 43 genera and 21 families, showcasing a diverse range of salt-tolerant taxa. These findings are crucial for advancing phytoremediation strategies in saline environments. Species such as *S. fruticosa, S. alii, S. persica,* and *J. martimus* were newly recorded in Maharashtra, indicating a range extension and contributing to the state's floristic knowledge. *S. perennis, S. argentinensis, S. maritima,* and *S. densiflora*, have shown potential in accumulating heavy metals, making them suitable candidates for phytoremediation. The floristic diversity documented in Daund Tehsil offers a valuable resource for developing effective phytoremediation strategies. By harnessing the potential of these salt-tolerant species, it is possible to mitigate the adverse effects of soil salinity, improve soil health, and promote sustainable agricultural practices in saline regions. Future research should focus on detailed physiological studies of these halophytic species to better understand their mechanisms of salt tolerance and heavy metal accumulation. Additionally, large-scale field trials are necessary to evaluate the practical applications of these salt-tolerant species.

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Table 1: Details of salinized sectors covered in study areas.

Sr. No.	Sectors	Latitude	Longitude	Elevation (Meters)
1.	Nangaon	18.5391981 N	74.4284752 E	682 M
2.	Dapodi	18.5091948 N	74.3818103 E	680 M
3.	Amoni Mal (Kangaon)	18.5420403 N	74.4263434 E	545 M
4.	Khopodi	18.5232198 N	74.3635803 E	679 M
5.	Hatvalan Road	18.529312 N	74.441928 E	540 M
6.	Ganesh Road	18.5472699 N	74.3947753 E	545 M

Table 2: Detailed list of plants available in saline area under study (ST: Salt tolerant; FST: Fairly salt tolerant; HST: Highly Salt Tolerant; DT: Drought tolerant).

S.N.	Name of plant	Family	Vernacular Name	Habit	Seasonal Availability	Salt tolerancy
1.	*Ruellia pohlii* Nees	Acanthaceae	*Wild petunia*	Herb	July to March	ST
2.	*Achyranthes aspera* L.	Amaranthaceae	Chaff-flower	Herb	Entire year	ST
3.	*Alternanthera pungens* Kunth.	Amaranthaceae	Khaki weed	Creeper	Entire year	HST
4.	*Alternanthera philoxeroides* (Mart.) Griseb	Amaranthaceae	Alligator weed	Creeper	Entire Year	HST
5.	*Alternanthera sessilis* (L.) R.Br.ex. DC	Amaranthaceae	Sissoo spinach	Herb	Entire year	HST
6.	*Asclepias currasavica* L.	Apocynaceae	Maxican Butterfly weed	Shrub	June to December	ST
7.	*Cryptostegia grandiflora* R.Br.	Apocynaceae	Kavali	Climber	Entire year	ST
8.	*Pentatropis microphylla* (Roxb.) Wight & Arn.	Apocynaceae	Salt killer wine	Climber	Entire year	ST
9.	*Calotropis* gigantea (L.) Dryand.	Asclepidiaceae	Milkweed	Shrub	Entire year	DT
10.	*Calotropis procera* (Aiton)	Asclepidiaceae	Milkweed	Shrub	Entire year	DT
11.	*Blumea angustifolia* (L.) DC	Asteraceae	Kukraundha	Herb	Entire year	ST
12.	***Blumea pungens* W. Fitzg**	Asteraceae	-	Herb	Entire year	ST
13.	*Blumea crinite* Arn.	Asteraceae	-	Herb	Entire year	ST
14.	*Flaveria trinervia* C. Mohr.	Asteraceae	Yellowtops	Herb	July to March	ST
15.	*Pluchea sericea* (Nutt.) Cov	Asteraceae	Camphorweeds	Herb	December to April	ST
16.	*Solidago chinensis* L.	Asteraceae	Goldenrod	Herb	September to March	ST
17.	*Sonchus oleraceus* L.	Asteraceae	Milky tassel	Herb	August to December	FST
18.	*Xanthium strumarium* L.	Asteraceae	Landaga	Herb	Entire Year	DT
19.	*Suaeda fruticose* Forssk.ex.J.F.Gmel.	Chenopodiaceae	Moras	Herb	Entire year	HST
20.	*Cyanatis cristata* D.Don	Commelinaceae	Nabhali	Herb	August to December	DT
21.	*Commelina benghalensis* L.	Commelinaceae	Benghal dayflower	Herb	August to December	DT
22.	*Ipomoea marginata* (Desr.) Manitz	Convolvulaceae	Lacsmana	Climber	August to April	HST

23.	*Ipomoea carnea* Jacq.	Convolvulaceae	Bush Morning glory	Climber	August to April	ST
24.	*Ipomoea obscura* (L.) Ker Gawl.	Convolvulaceae	Obscure morning glory	Climber	August to April	ST
25.	*Ipomoea trifida* (Kunth) G. Don	Convolvulaceae	Three fork morning glory	Climber	August to April	ST
26.	*Merremia quancifolia* Dennst.ex.Endl.	Convulvulaceae	Morning Glory	Climber	Entire year	ST
27.	*Coccinea indica* R.Wight.	Cucurbitaceae	Tondale	Climber	June to December	ST
28.	*Cyperus distans (*L.) F	Cyperaceae	Slender sedge	Herb	August to March	ST
29.	*Cyperus rotundus* L.	Cyperaceae	Red Nut Grass	Herb	August to March	ST
30.	*Fimristylis dichotoma (*L.) Vahi.	Cyperaceae	Eight-day grass	Herb	Entire year	HST
31.	*Schoenoplectus tabernaemontani* (C.C.Gmel.) Palla	Cyperaceae	Grey club rush	Herb	Entire year	ST
32.	*Euphorbia prostrata* Aiton.	Euphorbiaceae	Dugdhika	Herb	July to March	ST
33.	*Cassia uniflora* (Mill.) H.S.Irwin & Barneby	Fabaceae	Sena/ Unhali	Herb	Entire year	DT
34.	*Prosopis juliflora* (Sw.) DC.	Fabaceae	Vedibabhul	Tree	Entire year	HST
35.	*Cullen corylifolium (*L.) Medik	Fabaceae	Babchi	Herb	Entire year	-----
36.	*Juncus maritimus* Lam.	Juncaceae	Sea rush	Herb	Entire Year	HST
37.	*Neanotis neptifolia* (L.) R. Br	Lamiaceae	Klip dagga	Herb	Entire year	HST
38.	*Ammania baccifera* L.	Lythraceae	Monarch redstem	Herb	July to November	HST
39.	*Abelmoschus manihot* (L.) *Medik*	Malvaceae	Ambika	Shrub	Entire year	ST
40.	*Abutilon indicum* (L.) Sweet	Malvaceae	Kanghi	Shrub	Entire year	HST
41,	*Bacopa monnieri* (L.) Pennell	Plantaginaceae	Brahmi	Herb	Entire year	HST
42.	***Veronica anagallis-aquatica* L.**	Plantaginaceae	Water speedwell	Herb	Entire year	HST
43.	*Aristida foetida* L.	Poaceae	Kusal	Herb	July to March	ST
44.	*Chloris barbata* Sw.	Poaceae	Fingergrass	Herb	Nov to March	ST
45.	*Dinebra retroflexa* Jacq.	Poaceae	Viper grass	Herb	August to March	_____
46.	*Eragrostis plumila* (L.) (Wolf.)	Poaceae	Love grass	Herb	July to March	HST
47.	*Paspaldium punctatum* Burm. A.Camus	Poaceae	Watercorn grass	Herb	Entire year	HST
48.	*Paspaldium distans* Trin.Hughes.	Poaceae	Water crown grass	Herb	Entire year	HST
49.	*Saccharum spontaneum* L.	Poaceae	Wild sugarcane	Herb	August to December	HST
50.	***Tetrapogon bidentatus* Pilg.**	Poaceae	Four beard grass	Herb	August to March	HST
51.	*Salvadora alii* Maradiaga	Salvadoraceae	Miswak	Shrub	Entire year	HST
52.	*Salvadora persica* L.	Salvadoraceae	Miswak	Shrub	Entire year	HST
53.	*Solanum nigram* L.	Solanaceae	Raan Vange	Herb	Septeber to March	ST

54.	*Solanum trilobatum* L.	Solanaceae	Purple fruit	Herb	Septeber to March	ST
55.	*Typha latifolia* L.	Typhaceae	Broadleaf cattail	Herb	Entire year	HST

Table 3. Detailed distribution of identified plants according to APG-III classification.

Sr. No.	Clades	Family	No. of Genus	No. of Species
1.	Monocot	Cyperaceae	03	04
		Poaceae	07	08
		Typhaceae	01	01
2.	Commelinids	Commelinaceae	02	02
		Juncaceae	01	01
3.	Eudicot	Acanthaceae	01	01
		Apocynaceae	03	03
		Salvadoraceae	01	02
		Lamiaceae	01	01
4.	Core Eudicot	Amaranthaceae	02	04
		Chenopodiaceae	01	01
5.	Eurosids-1	Cucurbitaceae	01	01
		Euphorbiaceae	01	01
		Fabaceae	03	03
		Plantaginaceae	02	02
6.	Eurosids-2	Lythraceae	01	01
		Solanaceae	01	02
		Asclepiadaceae	01	02
		Convolvulaceae	02	05
7.	Euasterids-1	Malvaceae	02	02
		Asteraceae	06	08
	Total Families: 21		43	55

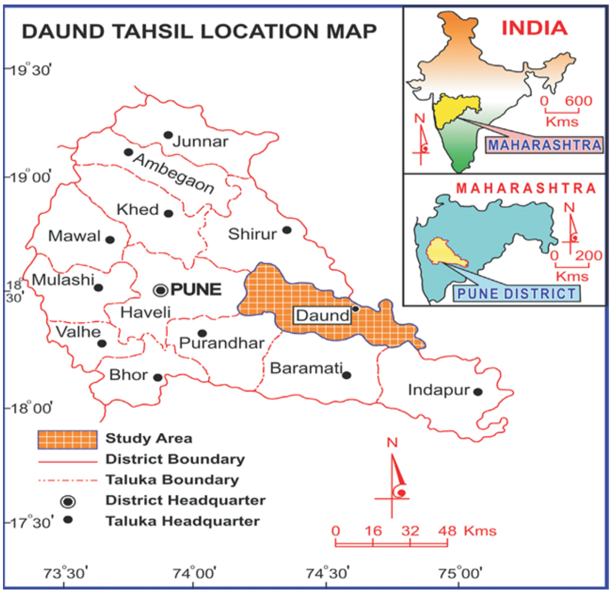

Figure 1. Location map of Daund Tahsil of Pune District, Maharashtra.

Author's contribution :

Research concept- P. Sangale, and K. Saste, Research design- P. Sangale, A. Chaudhari and R. Zanan, Supervision- R. Zanan, A. Chaudhari, and S. Kamble, Data collection- P. Sangale, and K. Saste, Data Analysis and Interpretation- R. Zanan, A. Chaudhari, and P. Sangale, Literature search- A. Chaudhari, Writing article- P. Sangale, and R. Zanan, Critical review- S. Kamble, and A. Chaudhari, Article editing- S. Kamble, and R. Zanan, Final approval- R. Zanan.

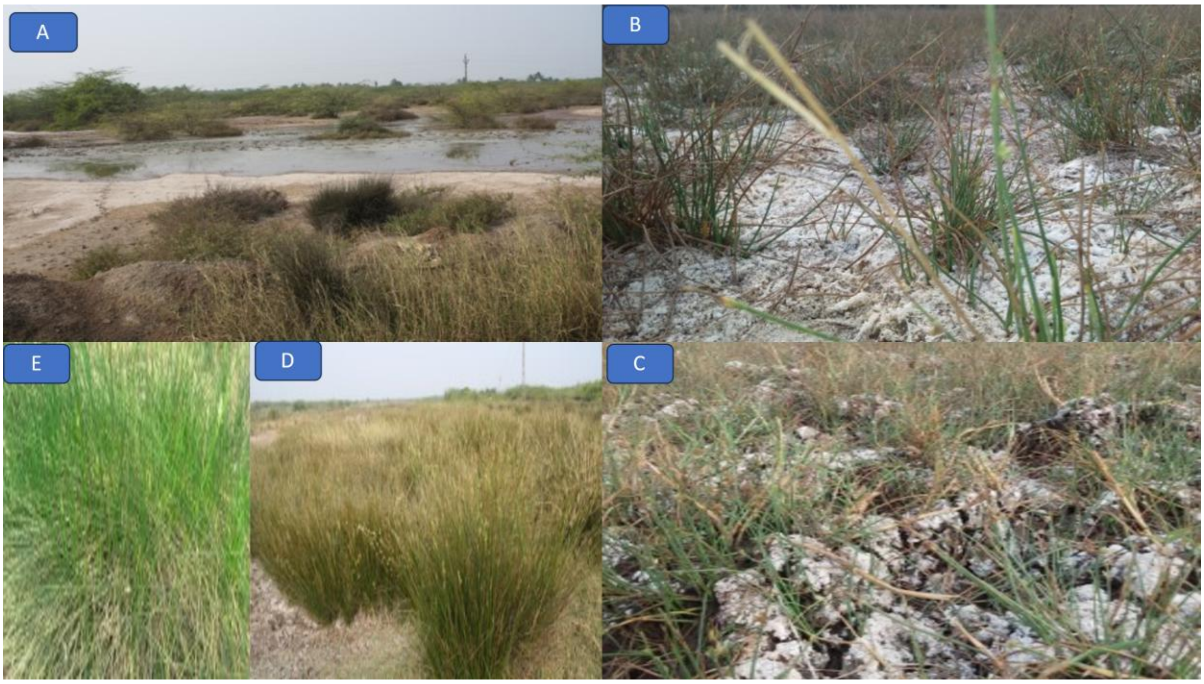

Figure 2. High salinity area due to salt accumulation and sedge habitat of *Fimbristlis dichotoma* and *Juncus. martimus* (A: Marshy saline land habitat; B and C: Accumulation of a salt layer on the soil, D and E: Sedge habitat of *Juncus martimus* and *Fimbristylis dichotoma*)

REFERENCES

Das S, Dasgupta N and Hazra A, 2020. Halophytes: A Glimpse of Indian Sundarbans – A World Heritage Site, Its Existing Status, and Sustainability. In: Grigore MN, (eds) *Handbook of Halophytes, pp. 1-36*. Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-030-17854-3_6-1.

Ehsen S, Qasim M, Abideen Z, Rizvi R, Gul B, Ansari R, and Khan M, 2016. Secondary metabolites as anti-nutritional factors in locally used halophytic forage/fodder. *Pakistan Journal of Botany*, 48, 629-636.

FAO-ITPS-GSP Report, 2015, FAO-ITPS-GSP Status of the world's soil resources. *Food and Agriculture Organization of the United Nations, Rome, Italy*. 125–127. http://www.fao.org/3/a-i5199e.pdf

Garg N, and Bhandari P, 2020. Interactive effect of plant growth-promoting rhizobacteria and the halophyte *Salvadora persica* on remediation of coastal saline soils. *Environmental Science and Pollution Research International,* 27, 6132-6143.

Ghassemi F, Jakeman AJ, and Nix HA (eds) 1995. *Salinization of land and water resources: human causes, extent, management and case studies*. 526. CAB International.

Hasanuzzaman M, Nahar K, Alam MM, Bhowmik PC, Hossain MA, Rahman MM, Vara Prasad MN, Ozturk M, and Fujita M, 2014. Potential Use of Halophytes to Remediate Saline Soils. *BioMed Research International*, 589341. Doi : dx.doi.org/10.1155/2014/589341.

Khan MA. and Qaiser M, 2006. Halophytes of Pakistan: Characteristics, Distribution and Potential Economic usages. *Sabkha Ecosystems: Volume II: West and Central Asia*, 11, 129-153.

Khan MA, Ansari R, Ali H, Gul B, and Nielsen, BL, 2009. *Panicum turgidum*, a potentially sustainable cattle feed alternative to maize for saline areas, *Agriculture, Ecosystems & Environment,* 129, 542-546.

Mushtaq W, Bedair H, and Shakeel A, 2020. Halophytes: A Phytoremediation Tool for Salt-Affected Soils with Special Reference to Indian Subcontinent. In: Grigore MN, (eds) *Handbook of Halophytes, pp.* 1-16. Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-030-17854-3_95-1

Negacz K, Malek Ž, Arjen de V, and Vellinga P, 2022. Saline soils worldwide: Identifying the most promising areas for saline agriculture. *Journal of Arid Environments,* 203, 1-9. https://doi.org/10.1016/j.jaridenv.2022.104775.

Qadir M, Quillérou E, Nangia V, Murtaza G, Singh M, Thomas R, Drechsel P, and Noble A, 2014. Economics of salt-induced land degradation and restoration. *Natural Resources Forum,* 38, 282-295.

Qasim M, Gulzar S, and Khan MA, 2011. Halophytes as medicinal plants. In Ozturk, M., Mermut, A.R., Celik, A. (eds) *Urbanisation, Land Use, Land Degradation and Environment* pp. 330-343. Daya Publishing House, New Delhi.

Salvi H, Das L, Brahmbhatt B, Vaghela N, and Kamboj R, 2017. Diversity of Halophytes in Gulf of Kachchh, Gujarat*. International Journal of Life-Sciences Scientific Research,* 3, 995-1002.

Shabbir AS, Mohammad Z, and Lee H, 2018. Soil Salinity: Historical Perspectives and a World Overview of the Problem. In:

Heng L, Zaman M, and Shahid SA, (eds) *Guideline for Salinity Assessment, Mitigation and Adaptation Using Nuclear and Related Techniques, pp.* 43-53. Springer Open.

Figure 3. Selected Highly salt-tolerant plant species in study areas (A: *Salvadora persica,* B: *Cyperus distans,* C: *Bacopa monnieri,* D: *Bacopa monnieri,* E: *Juncus martimus,* F: *Salvadora Alii,* G: *Ammania baccifera,* H: *Asclepias currasavica,* I: *Pentatropis microphylla,* J: *Coccinea indica,* K: *Solanum nigram,* L: *Abutilon indicum*)