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Study of Vegetation Distribution, Diversity and Xerophytic Characteristics in Sardarshahar Region of Churu District, Rajasthan

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ABSTRACT: The present study investigates the distribution, diversity, and xerophytic characteristics of natural vegetation in the Sardarshahar region of Churu District, Rajasthan. The region is characterized by extreme temperature fluctuations, sandy and saline soils, and limited groundwater availability, all of which strongly influence vegetation structure and composition. Systematic field surveys were conducted to document plant species diversity, their spatial distribution, and adaptive features associated with arid and semi-arid environments.

KEYWORDS: Vegetation, Xerophytes, Sardarshahar, Diversity, Survey.

I. INTRODUCTION

Vegetation is a crucial natural resource that demonstrates spatial and temporal variety in its scope and distribution. Consequently, accurate data regarding the scope and distribution of plant species is essential for the management and planning of natural resources. Understanding plant classifications has recently become essential for evaluating and monitoring the possible susceptibility of natural ecosystems to human-induced global environmental change. Additionally, India possesses a vast range of plant species, featuring four biodiversity hotspots, several of which have indigenous flora. The abundant resources are rapidly diminishing due to over-exploitation and climate change. The protection of traditional medicinal plant resources has become essential (Sharma and Thokchom, 2014). Furthermore, the total forested area in Rajasthan is 16,036 square kilometers, constituting 4.69% of the state's total geographical expanse (Chintala et al., 2011). The physiographic and ecological diversity significantly increases the state's floristic diversity, indicating the variety and variability of plant species within a specific geographical area. It also denotes the number of species existing in a specific place (Mishra, 2015). The Aravalli Range is a significant geological structure in western India, extending from Gujarat to Delhi. It spans four states: Gujarat, Rajasthan, Haryana, and Delhi. The majority of the Aravalli range is located in Rajasthan (Sharma, 2019). Rajasthan, including around 342,239 square kilometers, is situated in the northwestern part of India, characterized by dry and semi-arid regions of the Thar Desert. Rajasthan is a region where the number of sacred groves surpasses that of communities (Katewa and Chaudhary, 2000). Sacred groves serve substantial socio-cultural functions. A multitude of festivities occurs in these sacred woodlands (Sharma et al., 1993). Other studies regarding the treatment of other illnesses from other parts of Rajasthan and other states have demonstrated significant findings (Rana et al., 2016; Saini et al., 2014; Saxena et al., 2014). Therefore, a comprehensive survey of these plants as an important resource is necessary in Churu district specially Sardarshahar tehsil, which is the main objective of this study. Sardarshahar region has been selected as the study region because it has seen not much interest from the researchers.

II. METHODS

Study Area: The present study focuses on Sardarshahar tehsil, situated in Churu district of Rajasthan, India, which lies in the northeastern part of the Indian Thar Desert. Figure 1 shows the map of study area.

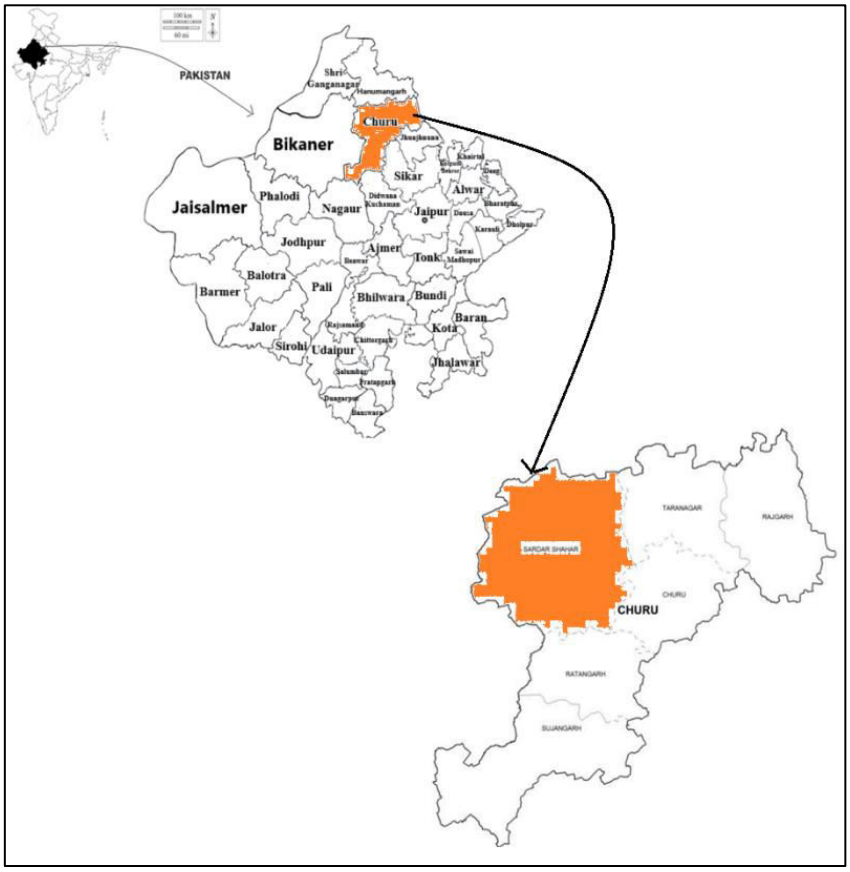

Fig 1: Map of Study Area

The district extends over an area of approximately 13,835 square kilometers and is geographically positioned between 28°14′ N latitude and 74°58′ E longitude, with an average elevation of about 286 meters above mean sea level.

Assessment of Floral Biodiversity: The collected plant specimens from each study site were carefully examined for accurate identification and classification. Field identification was initially done using regional floras, herbarium references, and local plant guides such as *Flora of Rajasthan* and *Flora of the Indian Desert*. Each species was cross-verified with standard taxonomic keys and authenticated through comparison with reference specimens deposited at recognized herbaria (e.g., Botanical Survey of India, Jodhpur). For each species, detailed morphological data were recorded. Digital photographs were taken in situ to document phenological stages and habitat conditions. All plant taxa were systematically arranged according to the classification system. The documentation process included recording the botanical name, family, local name.

III. RESULTS

The observation of the study based on the given table 1 reveals a remarkable diversity of plant species distributed across multiple families within the study area. A total of 81 plant species were recorded, representing a broad spectrum of angiospermic taxa that encompass trees, shrubs, herbs, climbers, and grasses. The composition of these species indicates a rich floristic assemblage and highlights the adaptability of vegetation to the local climatic and edaphic conditions of the study region. The Fabaceae family is the most dominant in the study area, represented by 14 species such as *Acacia nilotica*, *Albizia lebbeck*, *Cassia fistula*, *Dalbergia sissoo*, *Prosopis cineraria*, *Prosopis juliflora*, and *Tamarindus indica*. Members of this family are ecologically significant as they enrich the soil through nitrogen fixation and are commonly found in semi-arid regions due to their drought-resistant nature. Their prevalence indicates the xerophytic and semi-arid character of the local vegetation.

The Apocynaceae family is another major contributor with six species including *Calotropis procera*, *Catharanthus roseus*, *Rauvolfia serpentina*, and *Tabernaemontana divaricata*. These species are predominantly medicinal and ornamental, reflecting the ethnobotanical importance of the local flora. The presence of *Calotropis procera* and

Leptadenia pyrotechnica also signifies adaptation to arid conditions and sandy soils. Other well-represented families include Cucurbitaceae (four species), Euphorbiaceae (three species), Moraceae (three species), Myrtaceae (three species), and Rutaceae (three species). The Cucurbitaceae species such as *Citrullus colocynthis*, *Cucumis melo*, and *Momordica balsamina* are typical of dry and sandy habitats, indicating the agricultural and wild diversity of edible and medicinal cucurbits. The Euphorbiaceae members like *Euphorbia hirta*, *Jatropha pandurifolia*, and *Ricinus communis* are commonly found in wastelands and are known for their latex-bearing and medicinal properties. Woody families such as Moraceae, Myrtaceae, and Rutaceae represent large trees and fruit-bearing species like *Ficus benghalensis*, *Psidium guajava*, *Syzygium cumini*, *Citrus limon*, and *Murraya koenigii*. Their occurrence indicates the presence of stable soil and relatively favorable microclimatic conditions for perennial growth. Some families are represented by only one or two species, such as Acanthaceae (*Barleria prionitis*), Amaryllidaceae (*Crinum latifolium*), Arecaceae (*Phoenix dactylifera*), Asphodelaceae (*Aloe barbadensis*), Gentianaceae (*Enicostemma hyssopifolium*), and Salvadoraceae (*Salvadora persica*). Though few in number, these taxa are ecologically and ethnobotanically significant. For instance, *Aloe barbadensis* and *Salvadora persica* are valued for their medicinal and oral hygiene applications, respectively, while *Phoenix dactylifera* is an important arid-zone fruit tree species.

The presence of grass species such as *Cynodon dactylon* and *Saccharum munja* (Poaceae family) indicates the existence of open grasslands and sandy plains, typical of semi-arid environments. Similarly, the occurrence of succulent and xerophytic species like *Bryophyllum pinnatum*, *Capparis decidua*, and *Balanites aegyptiaca* further confirms the adaptation of vegetation to harsh climatic conditions with limited moisture availability. Many species such as *Azadirachta indica* (Neem), *Tinospora cordifolia* (Giloy), *Withania somnifera* (Ashwagandha), and *Ocimum sanctum* (Tulsi) are well-known for their medicinal value, suggesting that the local flora plays an important role in traditional health practices and indigenous pharmacopoeia. In addition, ornamental and shade-providing species like *Delonix regia* (Gulmohar), *Tecoma stans* (Yellow Bells), and *Polyalthia longifolia* (Ashoka tree) indicate the use of vegetation for aesthetic and environmental enhancement. Overall, the table demonstrates that the vegetation of the study area exhibits a balanced mix of natural, cultivated, medicinal, and ornamental species, with dominant representation of Fabaceae and Apocynaceae, along with a wide range of other families adapted to the semi-arid conditions. This diversity underscores the ecological resilience, ethnobotanical richness, and adaptive strategies of plant species thriving in the climatic setting of the study area.

Table 1: List of observed plant species in study area

S. No.	Family	Botanical Name	Common Name
1	Acanthaceae	*Barleria prionitis* L.	Bajradanti
2	Amaranthaceae	*Achyranthes aspera* L.	Latjeera / Apamarg
3		*Chenopodium album* L.	Bathua
4	Amaryllidaceae	*Crinum latifolium* L.	Sudarshan
5	Annonaceae	*Polyalthia longifolia* (Sonn.) Thwaites	Ashoka Tree
6	Apocynaceae	*Calotropis procera* (Aiton) W.T. Aiton	Aak / Madar
7		*Carissa congesta* Wight	Karonda
8		*Catharanthus roseus* (L.) G. Don	Sadabahar
9		*Leptadenia pyrotechnica* (Forssk.) Decne.	Khimp

10		*Nerium indicum* Mill.	Kaner
11		*Rauvolfia serpentina* (L.) Benth. ex Kurz	Sarpagandha
12		*Tabernaemontana divaricata* (L.) R.Br. ex Roem. & Schult.	Chandni / Tagar
13		*Tylophora indica* (Burm.f.) Merr.	Antamul
14	Arecaceae	*Phoenix dactylifera* L.	Khajoor / Date Palm
15	Aristolochiaceae	*Aristolochia bracteolata* Lam.	Kiramar
16	Asparagaceae	*Asparagus racemosus* Willd.	Shatavari
17		*Sansevieria cylindrica* Bojer ex Hook.	Snake Plant
18	Asphodelaceae	*Aloe barbadensis* Mill.	Aloe vera / Ghee kumari
19	Asteraceae	*Artemisia scoparia* Waldst. & Kit.	Bana
20	Bignoniaceae	*Tecoma stans* (L.) Juss. ex Kunth	Yellow Bells
21		*Tecomella undulata* (Sm.) Seem.	Rohida
22		*Cordia myxa* L.	Lasura
23	Capparaceae	*Capparis decidua* (Forssk.) Edgew.	Kair
24	Caricaceae	*Carica papaya* L.	Papaya
25	Cleomaceae	*Cleome gynandra* L.	Hulu
26	Combretaceae	*Quisqualis indica* L.	Madhumalti / Rangoon Creeper
27	Convolvulaceae	*Evolvulus alsinoides* (L.) L.	Shankhpushpi
28	Crassulaceae	*Bryophyllum pinnatum* (Lam.) Oken	Patherchata

29	Cucurbitaceae	*Citrullus colocynthis* (L.) Schrad.	Tumba
30		*Cucumis melo* L.	Kachri
31		*Lagenaria siceraria* (Molina) Standl.	Kashiphal / Lauki
32		*Momordica balsamina* L.	Karela / Bitter Gourd
33	Cyperaceae	*Cyperus triceps* Rottb.	Nirbasi
34	Euphorbiaceae	*Euphorbia hirta* L.	Waldhuni
35		*Jatropha pandurifolia* Andr.	Coral Plant
36		*Ricinus communis* L.	Arandi / Castor Plant
37	Fabaceae	*Acacia nilotica* (L.) Delile	Desi babul
38		*Acacia senegal* (L.) Willd.	Kumta / Kumat
39		*Albizia lebbeck* (L.) Benth.	Siris
40		*Bauhinia variegata* L.	Kachnaar
41		*Cassia fistula* L.	Amaltas
42		*Dalbergia sissoo* Roxb.	Shisham
43		*Delonix regia* (Bojer) Raf.	Gulmohar
44		*Hardwickia binata* Roxb.	Anjan
45		*Leucaena leucocephala* (Lam.) de Wit	Safed Babool / Subabul
46		*Parkinsonia aculeata* L.	Vilayati Kikar
47		*Prosopis cineraria* (L.) Druce	Khejri (State Tree)
48		*Prosopis juliflora* (Sw.) DC.	Vilayati Babool

49		*Pongamia pinnata* (L.) Pierre	Karanja
50		*Senna alexandrina* Mill.	Sonamukhi / Senna
51		*Tamarindus indica* L.	Imli
52	Gentianaceae	*Enicostemma hyssopifolium*	Chota Chirayata
53	Lamiaceae	*Ocimum sanctum* L.	Tulsi
54	Lythraceae	*Lawsonia inermis* L.	Mehndi / Henna
55		*Punica granatum* L.	Anar / Pomegranate
56	Malvaceae	*Hibiscus rosa-sinensis* L.	Gurhal
57	Meliaceae	*Azadirachta indica* A. Juss.	Neem
58	Menispermaceae	*Tinospora cordifolia* (Willd.) Miers	Giloy / Neem Giloy
59	Moraceae	*Ficus benghalensis* L.	Bargad / Banyan Tree
60		*Ficus religiosa* L.	Peepal
61		*Morus alba* L.	Shahtut / Mulberry
62	Moringaceae	*Moringa oleifera* Lam.	Sahjan / Drumstick Tree
63	Myrtaceae	*Eucalyptus obliqua* L'Her.	Safeda
64		*Psidium guajava* L.	Amrud / Guava
65		*Syzygium cumini* (L.) Skeels	Jamun
66	Papaveraceae	*Argemone mexicana* L.	Satyanasi
67	Phyllanthaceae	*Emblica officinalis* Gaertn.	Amla
68	Poaceae	*Cynodon dactylon* (L.) Pers.	Dub / Bermuda grass
69		*Saccharum munja* Roxb.	Sarkanda / Moonj

70	Rhamnaceae	*Ziziphus mauritiana* Lam.	Ber
71	Rutaceae	*Aegle marmelos* (L.) Correa	Bael
72		*Citrus limon* (L.) Osbeck	Nimboo
73		*Murraya koenigii* (L.) Spreng.	Curry Leaf Tree
74	Salvadoraceae	*Salvadora persica* L.	Pilu / Miswak
75	Simaroubaceae	*Ailanthus excelsa* Roxb.	Ardu / Aralu
76	Solanaceae	*Cestrum nocturnum* L.	Raat ki Rani
77		*Datura stramonium* L.	Dhatura
78		*Withania somnifera* (L.) Dunal	Ashwagandha
79	Tamaricaceae	*Tamarix aphylla* (L.) Karst.	Faras
80	Zygophyllaceae	*Balanites aegyptiaca* (L.) Delile	Hingota
81		*Tribulus terrestris* L.	Gokhru / Bhankari

The present study revealed a rich morphological diversity among the 81 plant species recorded from the study area, representing a wide range of life forms such as trees, shrubs, herbs, climbers, and grasses. The detailed observations presented in the table highlight the distinct structural adaptations and morphological traits of each species, reflecting their ecological adjustments to the semi-arid climatic conditions and diverse habitats of the region. A large proportion of the recorded species are woody trees and shrubs, which dominate the local vegetation and provide structural stability to the ecosystem. Prominent examples include *Polyalthia longifolia*, *Azadirachta indica*, *Prosopis cineraria*, *Dalbergia sissoo*, *Ficus benghalensis*, and *Syzygium cumini*. These species are characterized by features such as thick bark, leathery or pinnate leaves, and deep root systems, which enable them to withstand drought and high temperatures. The presence of evergreen species like *Polyalthia longifolia* and *Eucalyptus obliqua* alongside deciduous species such as *Cassia fistula* and *Tamarindus indica* indicates a balanced representation of both perennial and seasonally adaptive taxa.

Several shrubs and undershrubs in the list, including *Barleria prionitis*, *Carissa congesta*, *Catharanthus roseus*, *Rauvolfia serpentina*, *Tabernaemontana divaricata*, and *Lawsonia inermis*, exhibit adaptations like spines, milky latex, and small or glossy leaves, which reduce transpiration and provide protection from herbivory. Many of these, such as *Calotropis procera* and *Leptadenia pyrotechnica*, are xerophytic species well-suited to sandy and arid environments, with succulent or green photosynthetic stems replacing leaves to minimize water loss. The table also highlights several succulent and semi-succulent species, such as *Aloe barbadensis*, *Bryophyllum pinnatum*, and *Sansevieria cylindrica*, which possess thick, fleshy leaves for water storage — a clear adaptation to the dry climate. Similarly, *Capparis decidua* and *Balanites aegyptiaca* are leafless or spiny trees and shrubs that rely on modified green stems for photosynthesis, illustrating efficient xerophytic strategies.

The presence of herbaceous plants such as *Achyranthes aspera*, *Chenopodium album*, *Cleome gynandra*, *Euphorbia hirta*, and *Enicostemma hyssopifolium* represents the seasonal flora that flourishes during favorable moisture

conditions. These species typically show features like small flowers, simple leaves, and shallow root systems, which allow rapid growth and reproduction during short wet periods. Climbers and twiners, such as *Tylophora indica*, *Aristolochia bracteolata*, *Quisqualis indica*, and *Tinospora cordifolia*, demonstrate morphological modifications for support, including slender stems and tendrils. Their distribution in the area suggests the availability of supporting vegetation or structures in semi-natural and cultivated landscapes. Among the grasses and sedges, *Cynodon dactylon* and *Saccharum munja* exhibit narrow linear leaves and underground rhizomes or stolons, which help them survive grazing and regenerate after desiccation. The Cyperaceae member, *Cyperus triceps*, displays the characteristic triangular stems and umbellate inflorescences typical of sedges found in moist depressions or near water bodies, showing that microhabitat diversity also exists in the study region.

The study also recorded several fruit-bearing and economically important species, including *Carica papaya*, *Cucumis melo*, *Punica granatum*, *Psidium guajava*, *Murraya koenigii*, *Citrus limon*, and *Ziziphus mauritiana*. These species are easily recognizable by their fleshy or drupe-like fruits with abundant seeds, reflecting both natural occurrence and human cultivation influences in the region. Additionally, aromatic and medicinal plants such as *Ocimum sanctum*, *Artemisia scoparia*, *Withania somnifera*, and *Tinospora cordifolia* were well represented. These species possess distinctive morphological features like glandular hairs, aromatic leaves, and specialized stem structures, which are associated with their pharmacological properties and ecological defenses.

The Fabaceae family species, including *Acacia nilotica*, *Albizia lebbeck*, *Cassia fistula*, and *Pongamia pinnata*, are particularly noteworthy for their bipinnate leaves, spiny branches, and leguminous pods, adaptations that contribute to drought resistance and nitrogen fixation in the soil. Similarly, *Prosopis cineraria* and *Prosopis juliflora* exhibit deep taproots and small leaflets, allowing them to dominate dry and sandy habitats. Species such as *Aegle marmelos*, *Citrus limon*, and *Murraya koenigii* represent Rutaceae members with fragrant flowers, spiny branches, and aromatic leaves, while *Salvadora persica* and *Tamarix aphylla* are salt-tolerant species adapted to saline or alkaline soils. The morphological adaptations of these taxa underscore their ecological importance in arid and semi-arid ecosystems. Overall, the morphological observations of the plant species in the study area reveal a diverse and ecologically balanced flora, comprising xerophytic, mesophytic, succulent, and hydrophilic elements. The dominance of thorny, spiny, and small-leaved species indicates adaptation to arid and semi-arid climatic conditions, while the presence of aromatic herbs, fruit trees, and ornamentals shows human interaction and cultural utilization of vegetation. Overall, the varied morphology observed among the 81 recorded species reflects not only taxonomic richness but also the adaptive versatility of the regional flora in response to environmental stresses and habitat diversity.

Table 2: Observed characteristics of plant species found in study area

S. No.	Botanical Name	Morphological Characteristics
1	*Barleria prionitis* L.	Erect, woody, spiny shrub; stems quadrangular; leaves opposite, elliptic; flowers tubular, yellow to orange; fruit a dehiscent capsule.
2	*Achyranthes aspera* L.	Erect, branched herb; stems cylindrical; leaves opposite, elliptic with entire margins; flowers small, greenish-white in terminal spikes; fruit utricle enclosing a single seed.
3	*Chenopodium album* L.	Erect, annual, branched herb; leaves alternate, mealy, ovate to triangular, irregularly toothed; flowers small, greenish, in dense clusters; fruit small, with a smooth black seed.
4	*Crinum latifolium* L.	Perennial bulbous herb with broad, strap-shaped leaves; scape erect; flowers large, funnel-shaped, white to pale pink in umbels; fruit capsule with many seeds.
5	*Polyalthia longifolia* (Sonn.) Thwaites	Tall, evergreen tree with slender columnar habit; leaves alternate, lanceolate, glossy; flowers small, greenish-yellow, axillary; fruit ellipsoid, black when ripe.

6	*Calotropis procera* (Aiton) W.T. Aiton	Perennial shrub or small tree with milky latex; leaves opposite, thick, elliptic; flowers large, waxy, lilac or white; fruit a follicle containing comose seeds.
7	*Carissa congesta* Wight	Evergreen, spiny shrub; branches rigid; leaves opposite, glossy, obovate; flowers white, fragrant, tubular; fruit a globose red berry.
8	*Catharanthus roseus* (L.) G. Don	Perennial subshrub; stems branched, glabrous; leaves opposite, elliptic, glossy; flowers solitary, pink or white with five lobes; fruit a pair of slender follicles.
9	*Leptadenia pyrotechnica* (Forssk.) Decne.	Xerophytic shrub with green, cylindrical, photosynthetic stems; leaves minute, caducous; flowers small, greenish, tubular; fruit slender follicles with silky-haired seeds.
10	*Nerium indicum* Mill.	Evergreen shrub or small tree with milky latex; leaves opposite or in whorls, lanceolate, leathery; flowers showy, funnel-shaped, pink or white; fruit paired follicles.
11	*Rauvolfia serpentina* (L.) Benth. ex Kurz	Erect, glabrous undershrub; leaves opposite, elliptic; flowers small, white, in terminal cymes; fruit a pair of globose drupes, turning black on ripening.
12	*Tabernaemontana divaricata* (L.) R.Br. ex Roem. & Schult.	Evergreen shrub with milky latex; leaves opposite, oblong, glossy; flowers white, pinwheel-like, fragrant; fruit a pair of orange follicles.
13	*Tylophora indica* (Burm.f.) Merr.	Twining or climbing herb; stems slender; leaves opposite, ovate, glabrous; flowers small, campanulate, purplish; fruit a pair of slender follicles.
14	*Phoenix dactylifera* L.	Tall, unbranched palm; trunk columnar, ringed; leaves pinnate, with numerous linear leaflets; flowers in spadices; fruit a fleshy drupe (date).
15	*Aristolochia bracteolata* Lam.	Perennial twining herb; leaves alternate, cordate, entire; flowers solitary, tubular, curved, brownish-yellow; fruit capsule with winged seeds.
16	*Asparagus racemosus* Willd.	Perennial climbing herb with tuberous roots; cladodes needle-like in clusters; true leaves reduced; flowers small, white; fruit a red berry.
17	*Sansevieria cylindrica* Bojer ex Hook.	Succulent perennial herb; leaves cylindrical, erect, fleshy, smooth; inflorescence a panicle of tubular, white fragrant flowers.
18	*Aloe barbadensis* Mill.	Perennial rosette-forming succulent; leaves thick, fleshy, lanceolate with spiny margins; inflorescence racemose with tubular yellow or orange flowers.
19	*Artemisia scoparia* Waldst. & Kit.	Aromatic, perennial herb; stems branched, pubescent; leaves alternate, pinnatisect, grey-green; flowers small, yellowish, in terminal heads.
20	*Tecoma stans* (L.) Juss. ex Kunth	Deciduous shrub or small tree; leaves pinnate with serrate leaflets; flowers large, tubular, bright yellow; fruit a long linear capsule with winged seeds.

21	*Tecomella undulata* (Sm.) Seem.	Medium-sized deciduous tree; bark rough, grayish; leaves simple, alternate, undulate margins; flowers large, tubular, orange-red, in terminal clusters; fruit long, flat capsule with winged seeds.
22	*Cordia myxa* L.	Medium deciduous tree; leaves alternate, ovate, pubescent, entire or toothed; flowers small, white, funnel-shaped in axillary clusters; fruit globose, yellowish, mucilaginous drupe.
23	*Capparis decidua* (Forssk.) Edgew.	Leafless, much-branched shrub; stems green, photosynthetic; leaves minute, caducous; flowers red, solitary, axillary; fruit smooth, red berry with numerous seeds.
24	*Carica papaya* L.	Fast-growing, unbranched herbaceous tree; leaves large, palmately lobed, on long petioles; flowers yellowish, unisexual; fruit large, oblong berry with numerous black seeds in pulp.
25	*Cleome gynandra* L.	Annual erect herb; leaves palmately compound with 3–5 leaflets; flowers white or pinkish in terminal racemes; fruit a long, slender capsule with many small seeds.
26	*Quisqualis indica* L.	Woody twining climber; leaves opposite, ovate, glabrous; flowers fragrant, tubular, turning white to pink to red with age; fruit five-angled, woody drupe.
27	*Evolvulus alsinoides* (L.) L.	Prostrate or spreading perennial herb; stems slender, hairy; leaves small, oblong; flowers solitary, blue, funnel-shaped; fruit a small capsule.
28	*Bryophyllum pinnatum* (Lam.) Oken	Fleshy, succulent herb; leaves opposite, ovate, crenate margins with plantlets; flowers pendulous, tubular, reddish; fruit capsule with many tiny seeds.
29	*Citrullus colocynthis* (L.) Schrad.	Prostrate trailing herb with tendrils; leaves deeply lobed, rough; flowers yellow, solitary; fruit globose, green-striped, hard-shelled berry.
30	*Cucumis melo* L.	Annual climbing or trailing herb; stems hairy with tendrils; leaves palmately lobed, rough; flowers yellow, unisexual; fruit large, fleshy berry (melon).
31	*Lagenaria siceraria* (Molina) Standl.	Climbing or trailing annual herb; leaves cordate, softly hairy; tendrils simple; flowers large, white; fruit bottle- or club-shaped berry, green to pale white.
32	*Momordica balsamina* L.	Climbing annual herb; stems slender, ridged; leaves palmately lobed; flowers yellow, solitary; fruit orange, warty, splitting open to reveal red-coated seeds.
33	*Cyperus triceps* Rottb.	Perennial sedge; stems triangular, erect; leaves basal, linear; inflorescence compound umbel with spikelets; fruit small, trigonous nutlet.
34	*Euphorbia hirta* L.	Annual, prostrate herb; stems reddish, hairy, with milky latex; leaves opposite, oblong, serrulate; flowers small, clustered in axillary cyathia; fruit small capsule.

35	*Jatropha pandurifolia* Andr.	Shrub or small tree; stems woody, exuding latex; leaves alternate, fiddle-shaped; flowers small, red, in cymes; fruit ovoid capsule with smooth seeds.
36	*Ricinus communis* L.	Large annual/perennial herb or shrub; stems hollow, glabrous; leaves palmate with 7–11 lobes; flowers monoecious in racemes; fruit spiny capsule with mottled seeds.
37	*Acacia nilotica* (L.) Delile	Thorny deciduous tree; bark dark; leaves bipinnate; flowers yellow, globose heads; fruit straight to curved pod with constrictions between seeds.
38	*Acacia senegal* (L.) Willd.	Small thorny tree; bark gray, peeling; leaves bipinnate with few pairs of pinnae; flowers creamy-white in spikes; fruit flat pod; exudes gum arabic.
39	*Albizia lebbeck* (L.) Benth.	Large deciduous tree; bark grayish; leaves bipinnate, large; flowers fragrant, white, in globose heads; fruit flat, straw-colored pod.
40	*Bauhinia variegata* L.	Medium-sized deciduous tree; leaves bilobed, resembling camel's foot; flowers large, pink-purple, showy; fruit long, flat, woody pod.
41	*Cassia fistula* L.	Medium-sized deciduous tree; leaves pinnate with 4–8 pairs of leaflets; flowers large, bright yellow, in long pendulous racemes; fruit a long cylindrical pod with many seeds in pulp.
42	*Dalbergia sissoo* Roxb.	Medium to large deciduous tree; leaves alternate, pinnate with 3 leaflets; flowers small, white, in axillary panicles; fruit a flat, thin, papery pod containing 1–4 seeds.
43	*Delonix regia* (Bojer) Raf.	Large deciduous tree with umbrella-like crown; leaves bipinnate, numerous small leaflets; flowers large, scarlet, showy with a white-marked petal; fruit long, flat woody pod.
44	*Hardwickia binata* Roxb.	Medium deciduous tree; leaves bifoliate, each leaflet obliquely oblong; flowers small, greenish-yellow in axillary racemes; fruit samara-like pod with a single seed.
45	*Leucaena leucocephala* (Lam.) de Wit	Small tree or shrub; leaves bipinnate with numerous small leaflets; flowers white, spherical heads; fruit long flat pod with many brown seeds.
46	*Parkinsonia aculeata* L.	Small thorny tree; branches pendulous, with spines at nodes; leaves bipinnate, rachis long and flattened; flowers yellow, in racemes; fruit linear pod.
47	*Prosopis cineraria* (L.) Druce	Thorny, deep-rooted tree; bark rough, dark; leaves bipinnate with small leaflets; flowers yellow, in axillary spikes; fruit cylindrical pod, constricted between seeds.
48	*Prosopis juliflora* (Sw.) DC.	Thorny shrub or small tree; leaves bipinnate; flowers yellowish in spikes; fruit long, curved pod; invasive and drought-tolerant species.
49	*Pongamia pinnata* (L.) Pierre	Medium-sized deciduous tree; leaves imparipinnate with 5–7 leaflets; flowers pinkish-white, pea-shaped in racemes; fruit flattened pod with single seed.

50	*Senna alexandrina* Mill.	Erect or spreading shrub; leaves pinnate with 4–6 pairs of leaflets; flowers yellow in axillary racemes; fruit narrow, flattened pod; leaves and pods medicinal.
51	*Tamarindus indica* L.	Large evergreen tree; leaves pinnate with small oblong leaflets; flowers small, yellow with red streaks; fruit brown pod with sticky acidic pulp.
52	*Enicostemma hyssopifolium* (Willd.)	Small perennial herb; stems erect, quadrangular; leaves opposite, sessile, linear-lanceolate; flowers small, white, in axillary clusters; fruit a small capsule.
53	*Ocimum sanctum* L.	Erect aromatic herb or subshrub; stems quadrangular; leaves opposite, ovate, serrate, aromatic; flowers small, purple or white, in racemes; fruit nutlets.
54	*Lawsonia inermis* L.	Small branched shrub; leaves opposite, elliptic, entire; flowers small, fragrant, white or pink in panicles; fruit small, globose capsule with many seeds.
55	*Punica granatum* L.	Shrub or small tree; stems woody, spiny; leaves opposite, narrow, glossy; flowers large, red, tubular; fruit a large berry (pomegranate) with many juicy seeds.
56	*Hibiscus rosa-sinensis* L.	Evergreen shrub; leaves alternate, ovate, serrate; flowers large, axillary, red, funnel-shaped; fruit capsule with hairy seeds.
57	*Azadirachta indica* A. Juss.	Medium to large deciduous tree; bark rough, grey; leaves pinnate with serrate leaflets; flowers small, white, fragrant, in panicles; fruit smooth yellow drupe.
58	*Tinospora cordifolia* (Willd.) Miers	Large deciduous climbing shrub; stem succulent, with aerial roots; leaves cordate, alternate; flowers small, greenish-yellow; fruit red drupe.
59	*Ficus benghalensis* L.	Large evergreen tree; aerial prop roots forming trunks; leaves large, ovate, leathery; figs axillary, globose, turning red when ripe.
60	*Ficus religiosa* L.	Large deciduous tree; leaves cordate with long tapering tip; figs small, in pairs, purple when ripe; bark gray; aerial roots occasionally present.
61	*Morus alba* L.	Medium-sized deciduous tree; bark grayish-brown; leaves alternate, variable in shape, serrate, often lobed; flowers small, greenish in catkins; fruit a multiple drupe, white or pinkish when ripe.
62	*Moringa oleifera* Lam.	Fast-growing deciduous tree; leaves tripinnate with numerous small leaflets; flowers white, fragrant, in axillary panicles; fruit long, three-angled pod with winged seeds.
63	*Eucalyptus obliqua* L'Her.	Tall evergreen tree; bark rough and fibrous; leaves lanceolate, alternate, leathery, aromatic; flowers white, with numerous stamens; fruit woody capsule.

64	*Psidium guajava* L.	Small evergreen tree or large shrub; bark smooth, peeling; leaves opposite, elliptic, rough above, aromatic; flowers white, solitary or few, with many stamens; fruit globose berry, yellowish-green, containing numerous hard seeds in fleshy pulp (guava).
65	*Syzygium cumini* (L.) Skeels	Large evergreen tree; leaves opposite, elliptic, leathery, aromatic; flowers white, fragrant, in cymes; fruit ovoid, dark purple drupe (jamun).
66	*Argemone mexicana* L.	Annual prickly herb; stems branching, milky latex; leaves alternate, spiny, lobed, mottled with white veins; flowers bright yellow, solitary; fruit prickly capsule with numerous black seeds.
67	*Emblica officinalis* Gaertn.	Small to medium deciduous tree; leaves simple, linear, distichous giving pinnate appearance; flowers greenish-yellow in clusters; fruit globose, greenish-yellow, smooth, fleshy drupe.
68	*Cynodon dactylon* (L.) Pers.	Perennial creeping grass with stolons and rhizomes; leaves narrow, linear, gray-green; inflorescence of 3–5 digitate spikes; spikelets small, sessile; fruit caryopsis.
69	*Saccharum munja* Roxb.	Tall perennial grass; stems erect, solid; leaves linear, long, rough; inflorescence large, silvery-white panicle; spikelets paired; fruit small caryopsis.
70	*Ziziphus mauritiana* Lam.	Small thorny tree or shrub; branches zigzag, spiny; leaves alternate, ovate, glabrous above, pubescent beneath; flowers small, greenish-yellow; fruit globose, smooth drupe (ber).
71	*Aegle marmelos* (L.) Correa	Medium deciduous tree; branches armed with spines; leaves trifoliate; flowers greenish-white, fragrant; fruit large, hard-shelled berry with sweet aromatic pulp.
72	*Citrus limon* (L.) Osbeck	Small evergreen tree; branches spiny; leaves ovate, glossy, aromatic; flowers white, fragrant; fruit an ellipsoidal berry (lemon) with acid juice.
73	*Murraya koenigii* (L.) Spreng.	Small evergreen tree or shrub; leaves pinnate, aromatic; flowers small, white, fragrant; fruit small, black drupe containing single seed.
74	*Salvadora persica* L.	Small evergreen tree or shrub; branches drooping; leaves opposite, fleshy, elliptic; flowers small, greenish-white in panicles; fruit small, red drupe.
75	*Ailanthus excelsa* Roxb.	Tall deciduous tree; trunk straight; leaves large, pinnate with many leaflets, often glandular; flowers small, yellow-green in panicles; fruit samara with central seed.
76	*Cestrum nocturnum* L.	Evergreen shrub; stems smooth, woody; leaves simple, entire, glabrous; flowers tubular, white, fragrant at night; fruit white berry.
77	*Datura stramonium* L.	Annual, erect herb; stems hollow, branched; leaves ovate, coarsely toothed; flowers large, funnel-shaped, white or violet; fruit spiny capsule with numerous seeds.

78	*Withania somnifera* (L.) Dunal	Erect, branched undershrub; leaves simple, ovate, pubescent; flowers small, greenish-yellow, tubular; fruit red berry enclosed in persistent calyx.
79	*Tamarix aphylla* (L.) Karst.	Tall evergreen tree; branches slender, jointed; leaves minute, scale-like, appressed; flowers small, pink, in dense racemes; fruit small capsule.
80	*Balanites aegyptiaca* (L.) Delile	Spiny deciduous tree; bark greyish; leaves bifoliolate; flowers small, greenish-yellow; fruit ovoid, yellow-brown drupe with fibrous pulp.
81	*Tribulus terrestris* L.	Prostrate, spreading annual herb; stems hairy; leaves opposite, pinnate; flowers yellow, solitary, axillary; fruit hard, spiny capsule composed of several nutlets.

The observations based on the given figure 2 reveal the floristic composition and family-wise diversity of the plant species documented in the study area. A total of 81 species were recorded, belonging to 39 families, which indicates a rich and varied vegetation structure encompassing trees, shrubs, herbs, climbers, and grasses. The numerical distribution of species across families shows that some plant families are more dominant and ecologically successful than others, reflecting their adaptive strategies, ecological roles, and prevalence in the study region's semi-arid environment.

Among all the families, the Fabaceae family is the most dominant, represented by 15 species. This family includes important genera such as *Acacia*, *Albizia*, *Cassia*, *Dalbergia*, *Prosopis*, and *Pongamia*. Members of this family are well adapted to dry conditions through features such as deep root systems, small bipinnate leaves, and nitrogen-fixing ability, which enable them to thrive in nutrient-poor soils. The dominance of Fabaceae reflects the ecological significance of leguminous trees and shrubs in soil fertility improvement and their widespread occurrence in arid and semi-arid zones. The second most represented family is Apocynaceae, comprising 8 species, such as *Calotropis procera*, *Catharanthus roseus*, *Rauvolfia serpentina*, and *Tabernaemontana divaricata*. Most of these species are shrubs or small trees containing milky latex, which serves as a defense mechanism against herbivory and desiccation. The high representation of Apocynaceae indicates the abundance of medicinal and ornamental taxa with xerophytic adaptations suitable for the hot, dry climate of the study area.

Families like Cucurbitaceae and Bignoniaceae are represented by 4 and 3 species, respectively. The Cucurbitaceae members, such as *Citrullus colocynthis*, *Cucumis melo*, *Lagenaria siceraria*, and *Momordica balsamina*, are climbing or trailing herbs with tendrils and succulent stems, common in sandy soils and open areas. They signify the presence of annual herbaceous vegetation adapted to arid habitats. The Bignoniaceae family, which includes *Tecoma stans* and *Tecomella undulata*, consists mainly of ornamental and drought-tolerant shrubs or trees, emphasizing the coexistence of aesthetic and ecological vegetation types.

Several other families such as Euphorbiaceae, Moraceae, Myrtaceae, Rutaceae, and Solanaceae each have 3 species, showing moderate representation in the region. The Euphorbiaceae members, for example, produce latex and have xerophytic traits, while Moraceae and Myrtaceae families are composed of large woody trees like *Ficus benghalensis* and *Syzygium cumini*, which provide shade, habitat, and food for wildlife. The Rutaceae family includes aromatic and spiny trees or shrubs such as *Aegle marmelos* and *Citrus limon*, which reflect the ethnobotanical and economic importance of fruit-bearing species. Similarly, the Solanaceae family includes medicinal and toxic herbs like *Datura stramonium* and *Withania somnifera*, indicating the medicinal richness of the flora. Families represented by two species, such as Amaranthaceae, Asparagaceae, Lythraceae, Poaceae, and Zygophyllaceae, contribute significantly to the structural diversity of the vegetation. *Amaranthus* and *Chenopodium* species are annual herbs, typical of disturbed or cultivated areas, while Poaceae members (*Cynodon dactylon* and *Saccharum munja*) dominate grasslands and sandy plains. The Lythraceae family (*Lawsonia inermis*, *Punica granatum*) and Zygophyllaceae (*Balanites aegyptiaca*, *Tribulus terrestris*) include fruit-bearing and xerophytic taxa, respectively, both vital to local ecology and traditional use.

A large number of families—23 in total—are represented by only one species each, including Acanthaceae, Amaryllidaceae, Annonaceae, Arecaceae, Aristolochiaceae, Asphodelaceae, Asteraceae, Capparaceae, Caricaceae, Cleomaceae, Combretaceae, Convolvulaceae, Crassulaceae, Cyperaceae, Gentianaceae, Lamiaceae, Malvaceae, Meliaceae, Menispermaceae, Moringaceae, Papaveraceae, Phyllanthaceae, Rhamnaceae, Salvadoraceae, Simaroubaceae, and Tamaricaceae. The presence of these single representatives suggests a broad taxonomic diversity and the coexistence of multiple ecological niches within the study area. These families include a wide range of plant types — from succulent herbs like Aloe barbadensis (Asphodelaceae) and Aromatic herbs like Ocimum sanctum (Lamiaceae), to large trees such as Phoenix dactylifera (Arecaceae) and shrubs like Capparis decidua (Capparaceae). Each contributes uniquely to the ecosystem, whether through medicinal value, fruit production, soil stabilization, or ecological balance.

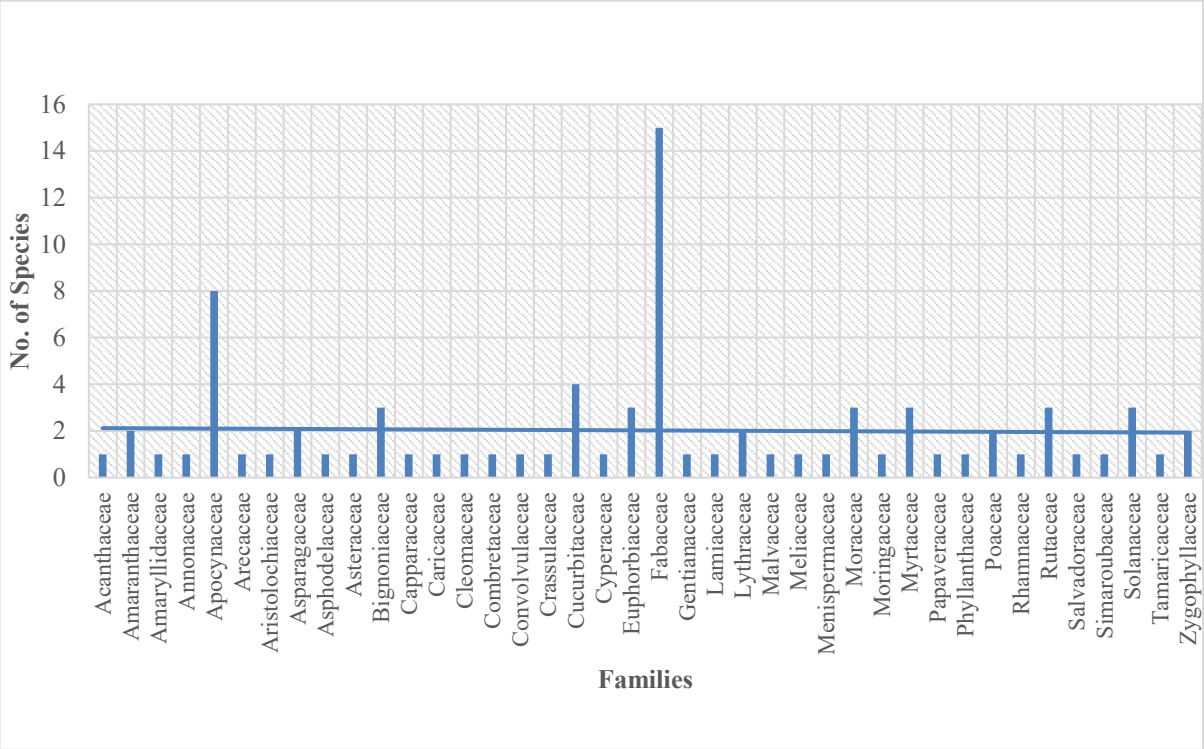

Fig 2: Number of species observed in different families

Overall, the data clearly indicate that while Fabaceae and Apocynaceae dominate numerically, the vegetation composition of the study area is highly diversified across a wide range of botanical families. The presence of both herbaceous and woody species, alongside succulents, climbers, grasses, and fruit trees, reveals a complex and balanced plant community that reflects both natural adaptation to semi-arid conditions and human influence through cultivation and ethnobotanical use. Thus, the family-wise distribution pattern underscores the ecological richness, adaptive diversity, and functional significance of the flora in the study region, where leguminous trees, xerophytic shrubs, and economically valuable species coexist, forming a stable and resilient plant ecosystem.

IV. DISCUSSION

This study presents the major findings obtained from the field investigation conducted in the study area. The analysis focuses on the diversity, morphological characteristics and family-wise composition of the recorded plant species. A total of 81 plant species belonging to various families were identified, representing trees, shrubs, herbs, climbers, and grasses. These findings highlight the floristic richness, ecological adaptations, and traditional uses of plants in the semi-arid environment of the study region. The study revealed a rich diversity of 81 angiospermic species, demonstrating a well-adapted vegetation structure in the study area. The Fabaceae family was the most dominant, represented by 14 species such as *Acacia nilotica*, *Albizia lebbeck*, *Cassia fistula*, and *Prosopis cineraria*. Members of this family play a vital role in nitrogen fixation, improving soil fertility and supporting vegetation in nutrient-poor, semi-arid soils. Their deep roots and compound leaves provide drought resistance and soil stability, reflecting their ecological and economic significance.

The Apocynaceae family ranked second with six species, including *Calotropis procera*, *Catharanthus roseus*, and *Rauvolfia serpentina*. These plants are mainly medicinal and ornamental, producing milky latex that aids in moisture retention and herbivore defense. Families like Cucurbitaceae (4 species), Euphorbiaceae (3 species), Moraceae (3 species), Myrtaceae (3 species), and Rutaceae (3 species) are also well represented. Many of these families include fruit-bearing and medicinal species that contribute to local food and healthcare systems. Several families, such as Acanthaceae, Amaryllidaceae, Arecaceae, Asphodelaceae, and Salvadoraceae, are represented by a single species each. Though few in number, these species, including *Aloe barbadensis* and *Salvadora persica*, are ecologically significant and widely used for medicinal and oral care purposes. The occurrence of grasses like *Cynodon dactylon* and *Saccharum munja* indicates open grassland ecosystems adapted to sandy plains. Overall, the vegetation displays a balanced mix of natural, cultivated, medicinal, and ornamental species, with dominance of drought-tolerant families such as Fabaceae and Apocynaceae, reflecting the ecological resilience of the flora.

The recorded species exhibited a wide range of morphological adaptations to survive in semi-arid conditions. Woody trees and shrubs such as *Azadirachta indica*, *Prosopis cineraria*, *Dalbergia sissoo*, and *Syzygium cumini* dominate the landscape, characterized by thick bark, leathery leaves, and deep roots that minimize water loss and enhance drought resistance. The coexistence of evergreen trees like *Eucalyptus obliqua* with deciduous species such as *Cassia fistula* and *Tamarindus indica* indicates functional diversity and seasonal adaptation. Shrubs such as *Barleria prionitis*, *Carissa congesta*, and *Catharanthus roseus* exhibit xerophytic traits like spines, glossy leaves, and latex production, while succulents such as *Aloe barbadensis*, *Bryophyllum pinnatum*, and *Sansevieria cylindrica* store water in fleshy tissues. *Capparis decidua* and *Balanites aegyptiaca* have modified green stems for photosynthesis, showing advanced xeromorphic adaptation. Herbaceous species like *Achyranthes aspera* and *Euphorbia hirta* thrive briefly during moist conditions, whereas climbers like *Tylophora indica* and *Tinospora cordifolia* rely on supporting vegetation for growth. Grasses such as *Cynodon dactylon* and *Saccharum munja* exhibit narrow leaves and rhizomatous growth, helping them withstand grazing and drought. The overall morphological diversity demonstrates the adaptive versatility and ecological stability of the region's flora under variable climatic conditions.

Meena and Khan (2023) recorded 173 plant species belonging to 117 genera and 50 families from parts of Churu district. While their reported number of species is higher, the present study aligns with their observations concerning the dominance of angiospermic taxa and the presence of xerophytic vegetation. Both studies agree on the importance of biodiversity conservation and stress the role of plant diversity in ecological stability and sustainable resource management.

Similarly, Meena (2025) identified 25 xerophytic plant species from Taranagar, including *Phog, Aak, Ghritkumari, Khejri, Neem,* and *Rohida*—all of which appear in the current study, thereby validating their regional dominance and ecological importance in desert vegetation. The vegetation pattern observed in the present study also correlates with Sharma (2022), who examined the flora of Tal Chhapar Wildlife Sanctuary in Churu. His classification of the area under the Tropical Thorn Forest type is consistent with the semi-arid and xerophytic nature of vegetation recorded here. Both studies emphasize drought-resistant plant species like *Tephrosia purpurea*, *Aerva persica*, and *Leptadenia pyrotechnica*, which are crucial for maintaining the ecological balance of desert ecosystems.

V. CONCLUSION

The present study provides a comprehensive account of the vegetation distribution, species diversity, and xerophytic adaptations of the Sardarshahar region in Churu District, Rajasthan, a part of the western semi-arid zone of India. The findings clearly indicate that the vegetation of the area is strongly shaped by harsh climatic conditions, including high temperature extremes, low and irregular rainfall, sandy and saline soils, and limited groundwater availability. As a result, the plant community is dominated by xerophytic species that exhibit well-developed morphological and physiological adaptations such as reduced leaf surface area, modified stems and leaves, protective structures, and extensive root systems that enable survival under prolonged drought conditions. Despite their importance, these plant resources face increasing pressure due to environmental stress and human activities. The documentation of vegetation diversity and xerophytic traits presented in this study provides baseline data that can support future ecological research, conservation planning, and sustainable management strategies.

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