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ECOLOGICAL VARIATION, AND GEOGRAPHIC DISTRIBUTION OF VEGETATION IN KARAK, NORTHWESTERN PAKISTAN

SIDDIQ ULLAH [1,3], FAZLE MALIK SARIM KHAN [1*], SHUJAUL MULK KHAN[2*], FAZAL MANAN[2], MARIA SHAH[2] AND TAUSEEF ULLAH[1]

[1]*Department of Chemical and Life Sciences, Qurtuba University, Peshawar, 25000, Pakistan*
[2]*Department of Plant Sciences, Quaid-i-Azam University, Islamabad, 45320, Pakistan*
[3]*Directorate of Non-Timber Forest Products, Forest Department, KP, Pakistan*
** Correspondence author's email: fazlemalik19@gmail.com & smkhan@qau.edu.pk*

Abstract

The plants' life form, leaf sizes, and distribution pattern reflect an area's overall ecological condition, including climate, land masses, and anthropogenic pressures. The current study evaluated the phyto-diversity, life form, leaf sizes, and geographical distribution of the Karak vegetation in the northwestern belt of Pakistan. The flora of the study area comprised of 177 species of flowering plants, of which 142 were dicots and 35 were monocots. The dominant families were Poaceae (27 species), followed by Asteraceae (18 species), Papilionaceae (12 species), Juncaceae (9 species), Solanaceae (8 species), and Chenopodiaceae (7 species). Habit-wise, herbs were represented by 122, shrubs by 31, and trees by 24 species. Moreover, the study area was dominated by therophytes (81 species), hemicryptophytes (30 species), microphanerophytes (24 species), and nanophanerophytes (18 species). Leaf size classes were dominated by microphyll (65 species), nanophyll (49 species), leptophyll (35 species), and mesophyll (24 species), whereas *Periploca aphylla, Capparis decidua*, and *Cuscuta reflexa* were aphyllous in the study area. Phytogeographically, this is a mixture of Saharo-Sindian and Irano-Turanian elements. The dominance of microphylls and nanophylls shows that the area is under biotic pressure and has arid climatic conditions. Further research is needed to identify climate-smart plant species for habitat restoration.

Key words: Ecological variation, Phyto-diversity, Phytogeographic distribution, Distribution pattern, Karak.

Introduction

Plant diversity plays a crucial role in maintaining ecosystem function and resilience. In various ecosystems, plant diversity contributes significantly to ecological stability, resource utilization, and overall environmental health (Khan *et al.*, 2013; Iqbal *et al.*, 2021a; Manan *et al.*, 2022). In any geographic area, plant diversity is used to assess climatic conditions, topography, and anthropogenic pressure in that area (Abbas *et al.*, 2016; Aneva *et al.*, 2020; Ullah *et al.*, 2025). Usually, in harsh climates and anthropogenic pressure, xerophytic vegetation is found with microphylls and nanophylls leaves. Furthermore, the relation of plant diversity to environmental and climatic variables is very complex, which dictates the geographic distribution of vegetation. Jiménez-Alfaro *et al.* (2016) highlight that vegetation diversity is closely bound to climate-energy interactions and habitat heterogeneity. They highlighted the value of merging plant data into biodiversity models, as this can reveal potential changes in biodiversity patterns that ecosystems respond to shifting environmental conditions. With changes in the environmental conditions, the Phyto-diversity changes with time; therefore, the floristic list of an area is necessary for human wellbeing, economic survival, ecosystem activity, and establishment (Khan *et al.*, 2013; Shaheen *et al.,* 2012; Iqbal *et al.*, 2021a; Asmat *et al.*, 2022; Manan *et al.*, 2022; Manan *et al.*, 2022; Ullah *et al.*, 2024; Bibigul *et al.*, 2025). Moreover, the distribution pattern of a plant species provides a range of distribution, climatic, and topographic preferences. Therefore, it is necessary to assess the accurate phytogeographic distribution of plant species in an area (Jiménez-Alfaro *et al.*, 2016; Haq *et al.*, 2020; Manan *et al.*, 2020).

The plant life form and leaf sizes give a clear climatic picture of an area. It determines the weather patterns, especially rainfall and temperature, and their yearly distribution. In the long term, climatic conditions bring about phytogeographic consistency among the plants (Ali & Qaiser, 1986; Khan *et al.*, 2011b; Khan *et al.*, 2012; Qaiser *et al.*, 2025). The relationship between life form and leaf size, with climate dynamics, provides valuable insights into the ecological character of an area, representing its biodiversity and prevailing climatic conditions. Variations in plant species diversity underscore environmental contexts shaped by geology, soil types, and microclimates (Manan *et al.*, 2022; Khan *et al.*, 2025). Analyzing life-form spectra shows local phytoclimatic patterns and environmental pressures (Khan *et al.*, 2011b; Messias *et al.*, 2011; Manan *et al.*, 2022). Furthermore, specific floristic compositions correlate with environmental parameters and land use factors, influencing vegetation dynamics (Anwar *et al.*, 2019; Sasaki *et al.*, 2005). The distribution of various life-forms, including phanerophytes and hemicryptophytes, demonstrates adaptations to climate and the influences of human activities (Khan *et al.*, 2017; Manan *et al.*, 2022).

The plant species' life form and leaf form changes can be attributed to biotic and abiotic factors. The study area is under heavy biotic and abiotic pressure, representing a varied flora. Therefore, the current research study was conducted to i) explore the floristic diversity of the study region, ii) identify the life form and leaf sizes of the study area plants, and iii) assess the phytogeographic distribution and ecological variation in the study area. The results of this study might be helpful for ecologists, conservationists, plant geographers, and ethnobotanists to understand the floristic diversity of the study region. The methodology used in this study can be applied to any ecosystem globally for floristic studies and to assess the phytogeographic distribution of an area.

Materials and Methods

Study area: The research area is located from 32˚.51′ to 33˚.30′ N latitude and 70˚.29' to 71˚.28' E longitude. It is surrounded by Tehsil Banda Daud Shah in the north, Tehsil Takht Nasrati in the southeast, and Bannu in the southwest (Fig. 1). The study area has very harsh climatic conditions; the summer season is very hot, and the winter season is cold (Javed *et al.*, 2019). The temperature ranges between 35˚C to 45˚C in June and July, while in winter the temperature ranges between 5˚C to 10˚C. In winter, it rains for weeks, while in summer, rain is characterized by thunderstorms creating flash floods in the streams. The soil is generally sandy, clay, or stony, and rarely loamy (Javed *et al.*, 2019).

Field survey: Regular field surveys were conducted throughout the study area to collect plants (Khan *et al.*, 2013; Manan *et al.*, 2022). The field visits were conducted in spring, summer, and autumn sessions in 2022-23, to ensure the collection of all types of plants. Plant specimens were collected, tagged with prepared tag cards, and then pressed with a plant presser. After that, the plant specimens were shade-dried and poisoned with mercuric chloride and ethyl alcohol solution. Then the plants were fixed on the standard herbarium sheets, having the size of 17.5″ × 11.5″ (Khan *et al.*, 2013; Mehmood *et al.*, 2015).

Plant specimen identification: The plant species were identified from the Flora of Pakistan and available literature (Khan *et al.*, 2013; Manan *et al.*, 2020; Manan *et al.*, 2022). The accepted and authoritative names of the plants were confirmed from the "World Flora Online" (https://wfoplantlist.org/) and the Flora of Pakistan (http://www.efloras.org/ flora_page.aspx?flora_id=5). A comprehensive floristic checklist was prepared, including their local names and other parameters. The voucher specimens were deposited in the general laboratory, Department of Chemical and Life Sciences, Qurtuba University, Peshawar.

Phytogeographic distribution: The phytogeographic distribution of plant species provides valuable information about the native origin of a plant species and its distribution range. This distribution also provides information about the plant's tolerance toward temperature and precipitation. All the plant species phytogeographic distribution is assessed through the Flora of Pakistan (http://www.efloras.org/ flora_page.aspx?flora_id=5).

Life form classification: Raunkiaer, (1934) method was used, and all the collected species of flowering plants were classified into the following classes (Table 1).

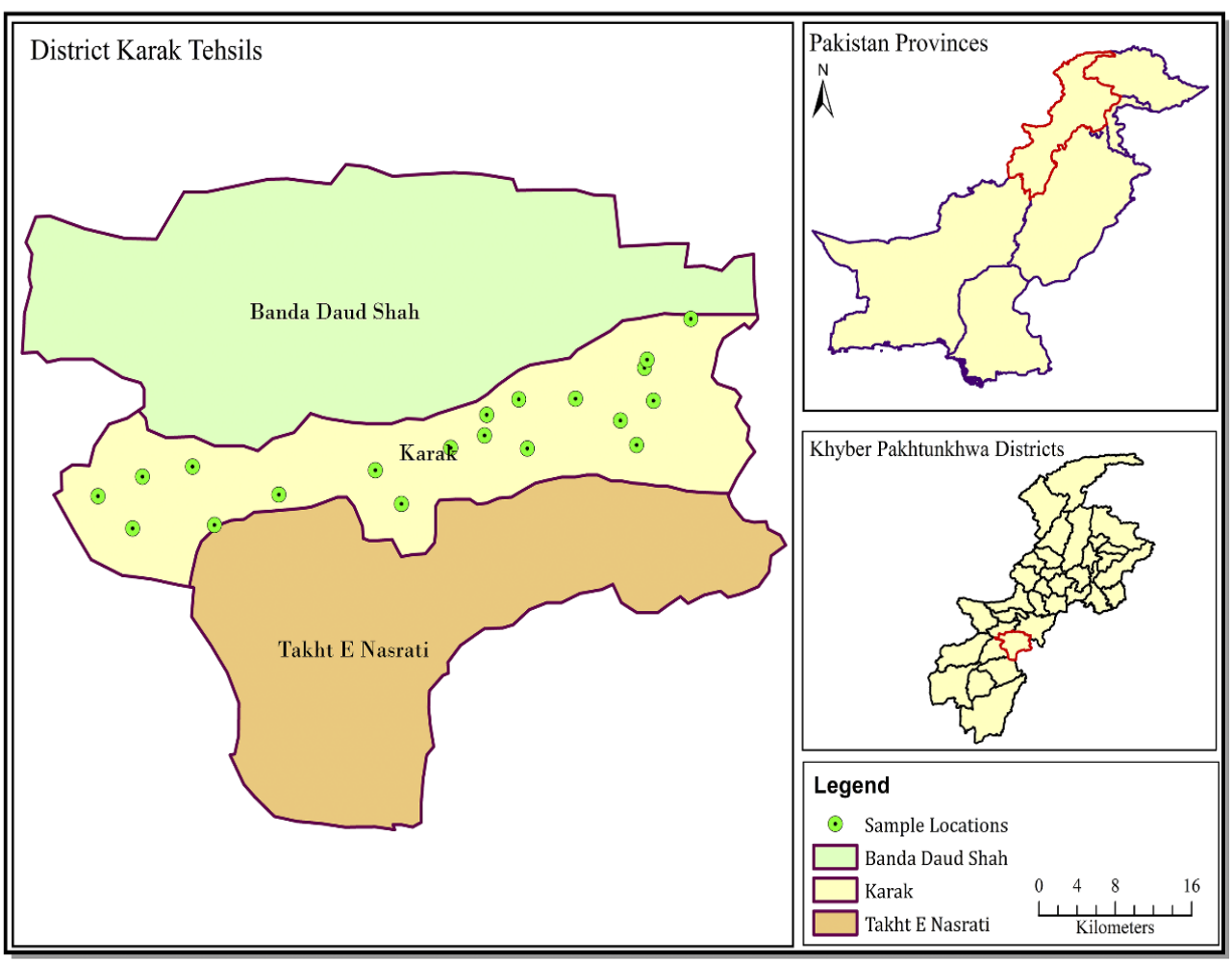

Fig. 1. GIS-generated map of the study area.

Table 1. Raunkiaer, (1934) life form classes.

S. No.	Life form	Description
01	Therophytes (Th)	This life form class includes those plants that complete their life cycle in one growing season.
02	Geophytes (Geo)	These plants bear their perennating buds below the surface of the soil. They include plants with tubers, corms, and rhizomes.
03	Hemicryptophytes (Hem)	This class included plants whose perennial buds are located above ground, where they are protected by soil and leaves.
04	Chamaephytes (Ch)	Plant species, whose perennial shoots or buds are located on the ground or at a height of 25 cm above the ground, were classified in this category.
05	Phanerophytes (Ph)	The plants in which perennating buds are carried well up in the air and are exposed to climatic conditions. This class includes trees and shrubs with perennating buds at least 25 cm above the soil surface. Phanerophytes are further classified as: nanophanerophytes (Np), microphanerophytes (Mp), mesophanerophytes (Mp), megaphanerophytes (Mp)

$$\text{Raunkiaer life form spectrum: } \frac{\text{No. of plant species of a particular life form class}}{\text{Total no. of all plant species in a strand}} \times 100$$

Leaf size classes: Based on the Raunkiaer, (1934) leaf size classes, we classified the study area vegetation into the following classes.

a. Leptophyll (Lep): leaf size is 25 mm^2
b. Nanophyll (Nan): leaf size is 225 mm^2
c. Microphyll (Mic): leaf size is 2025 mm^2
d. Mesophyll (Mes): leaf size is 18225 mm^2
e. Megaphyll (Meg): leaf size is 164025 mm^2

$$\text{Raunkiaer life size spectrum: } \frac{\text{No. of individuals of a species of a particular leaf size class}}{\text{Total no. of all plant species in a strand}} \times 100$$

Results

Species composition: The reported species of flowering plants were classified based on habit. The dominant habit was herbs (122 species), followed by shrubs (31 species), and trees (24 species) (Fig. 2). We collected 177 species of flowering plants, comprising 142 dicots and 35 monocots. Poaceae was the dominant family (27 species), followed by Asteraceae (18 species), Papilionaceae (12 species), Solanaceae (9 species), Juncaceae with (8 species), Solanaceae (8 species), Chenopodiaceae (7 species). Rest of the families were represented by fewer than 7 species (Fig. 3).

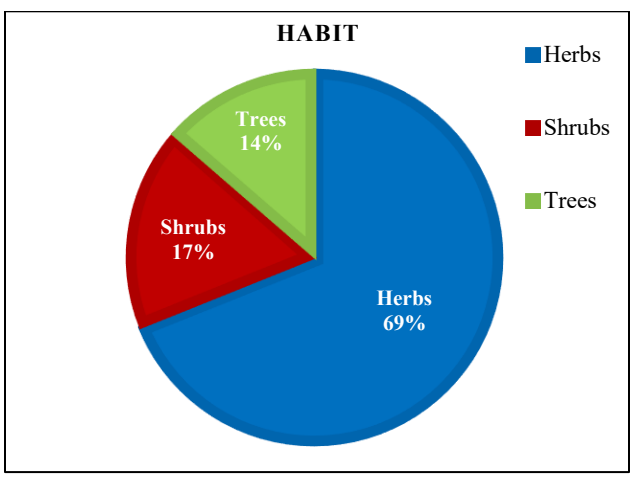

Fig. 2. Habit the plant species, reported from the study area.

Life form: Based on Raunkiaer's classification system of life forms, 81 plant species were therophytes followed by hemicryptophytes (30 species), microphanerophytes with (24 species), Chamaephytes (19 species), nanophanerophytes with (18 species), and parasites were (3 species), while geophytes were represented by (2 species) (Fig. 4).

Leaf size: Microphyll was the dominant leaf size class with 65 species, followed by nanophyll (49 species), leptophyll (35 species), mesophyll (24 species), and megaphyll (1 species). *Periploca aphylla*, *Capparis decidua,* and *Cuscuta reflexa* were Aphyllous in the research area (Fig. 5).

Discussion

The flora of an area provides habitat, shelter, medicine, ecological services, and overall regulates the climatic conditions of that area. Therefore, the floristic study of an area is necessary for documentation of biodiversity, conservation planning, and resource management (Khan *et al.*, 2011a; Khan *et al.*, 2013; Khan *et al.*, 2020; Rahman *et al.*, 2020; Iqbal *et al.*, 2021b; Manan *et al.*, 2022). The phyto-diversity of an area can be affected by both biotic and abiotic factors, which lead to deforestation, habitat degradation, and changes in the overall pattern of plant distribution. The study area is an arid zone in northwestern Pakistan with a harsh climate. Due to the arid climatic conditions, the plants in the study area have sparse distribution, small leaf size, and stunted growth, which are xerophytic characteristics exhibited by the plants of the harsh and arid climate (Khan *et al.*, 2013; Mehmood *et al.*, 2015; Abbas *et al.*, 2019; Noreen *et al.*, 2019; Rasheed *et al.*, 2022). Moreover, the climatic conditions of an area are reflected by the life form and leaf size spectrum of plants. Raunkiaer, (1934), claimed that life forms and leaf forms present in a region define its habitat and climatic conditions; however, biological disturbances might change the distribution of life forms. These features are thought to be markers of biotic interaction as well as degradation of the climate and habitat. Biological spectrum is similar in those areas where climatic conditions are similar (Khan *et al.*, 2013; Manan *et al.*, 2022; Shah *et al.*, 2025).

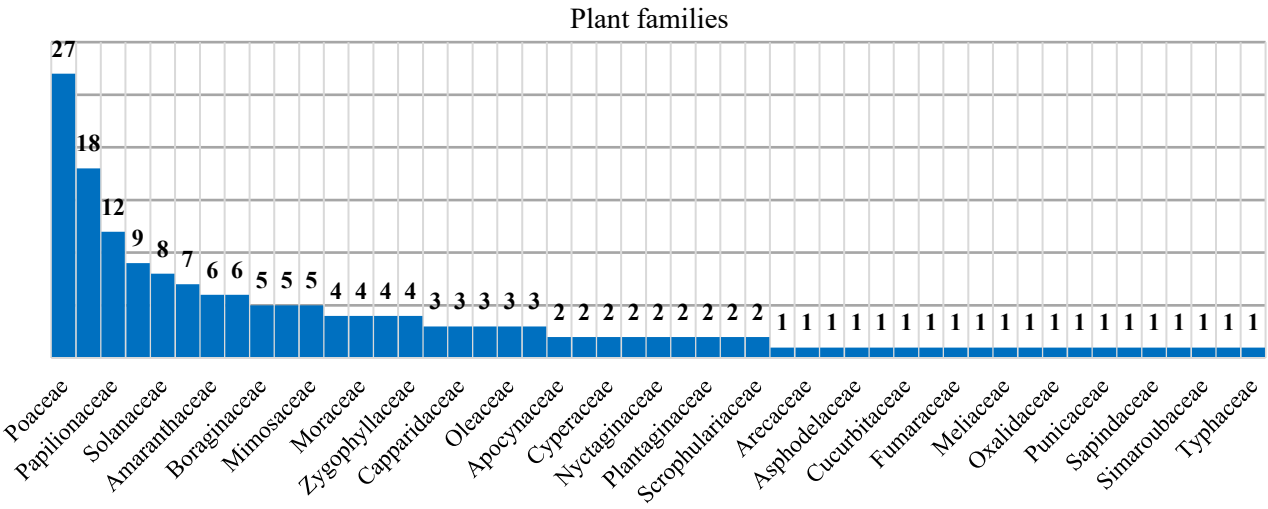

Fig. 3. Plant families reported from the study area.

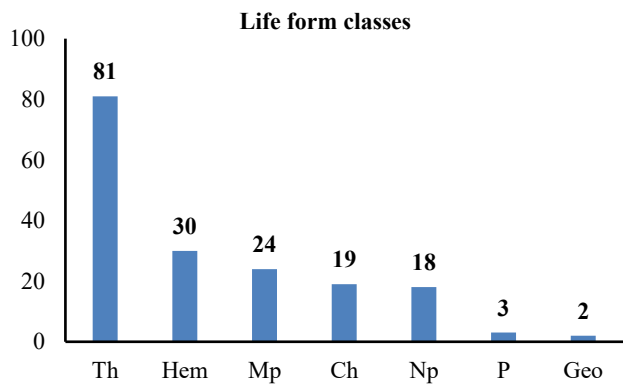

Fig. 4. Life form classes of plants of the study region.

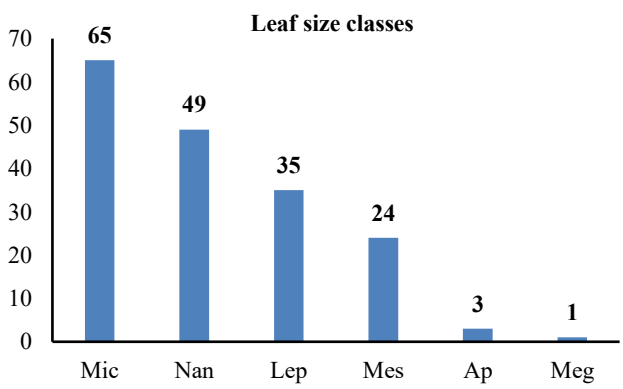

Fig. 5. Leaf form spectrum of the study region flora.

In our study, therophytes were the dominant plants, followed by hemicryptophytes and microphanerophytes, which shows that the study area climate is dry and under anthropogenic pressure. The vegetation of the study area is dominated by therophytes and dry subtropical deciduous forest species, comprising *Senegalia modesta*, *Ziziphus mauritiana*, and *Prosopis farcta*. Moreover, the high proportion of therophytes is also attributed to anthropogenic activities (Barbero *et al.*, 1990). The large number of therophytes and smaller number of phanerophytes give the impression of a response to hot, dry weather, topographic differences, human and consumer disturbance. According to Manan *et al*., (2022), therophytes are adapted to dry areas and a deficiency of rain because such plants spend more life span in the form of seeds. Our results are supported by national and international research studies, which further strengthen our results. According to these studies, the dominance of therophytes and small leaf sizes is attributed to the dry and harsh climate of the area, including anthropogenic activities (Badshah *et al.*, 2013; Abbas *et al.*, 2017; Manan *et al.*, 2020; Zhao *et al.*, 2021; Rasheed *et al.*, 2022; Ullah *et al.*, 2024; Shah *et al.*, 2025). Therophytes have been found to appear for a short period and finish their life cycle before the start of the dry desiccating season because of the severe environment in the study area. It has been shown that hemicryptophytes shrink their bodies to protect themselves from the strains of heat waves and overgrazing. According to Ahmed *et al.* (2011), geophytes emerge in the spring before going dormant as underground perennating buds.

Leaf size spectrum showed that microphyll was the dominant leaf size class (65 species) followed by nanophyll (49 species), Leptophyll (35 species), and mesophyll (24 species), while three species, i.e., *Periploca aphylla, Capparis decidua* and *Cuscuta reflexa* were aphyllous in research area, reflecting the dry and hot conditions of the study area (Table 2). The abundance of microphyll and nanophyll species expressed hot desert conditions. Different researchers i.e., have reported the richness of microphyll and nanophyll as they represent the hot, dry environment. Amjad *et al.*, (2017) also reported similar results and strengthened our research findings. Plants with tiny leaves are an indication of the arid and harsh climate. Different researchers have revealed that changes in leaf size spectra of flora are related to the prevailing micro-macro climates (Al-Yemeni & Sher, 2010; Ilyas *et al.*, 2013). Amjad *et al.*, (2016) reported the abundance of microphylls and monophylls leaf size classes, which gives strength to our current findings. Leaf size spectra do not indicate the climate of the region, but together with other physiognomic characteristics, influence and affect leaf adaptation. Leaf zone or climate determination is more accurate when leaf size classes and morpho-anatomic data are included. The three sustainable development goals, i.e., life on land, climate action, and good health and wellbeing, are also covered in this study. Further research is recommended to assess the edapho-physiological pattern of the underlying mechanisms of the current vegetation to manage and conserve it in the future. Moreover, climate-smart plantations are necessary for habitat restoration in the study area.

Table 2. Floristic list, phytogeographic distribution, life form, and leaf form of the study region plants.

S. No.	Scientific name	Local name	Family name	Habit	Life form	Leaf size	Geographical distribution
	A. Monocot families						
1.	*Nannorrhops ritchieana (*Griff.) Aitchison	Mazara	Arecaceae	H	Np	Meg	Pakistan (Sind, west Punjab, Mekran, Peshawar valley, Kohat, and trans Indus territory), Afghanistan, and Southern Persia.
2.	*Asparagus adscendens* Roxb.	Shal boti	Asparagaceae	H	Ch	Mic	Pakistan (Kohat, Malakand, Rawalpindi, Waziristan); Kashmir and Kumaon of India.
3.	*Asphodelus tenuifolius* Cav.	Pyazakye	Asphodelaceae	H	Th	Lep	Southwest Europe, North Africa, Southwest Asia, India, and Pakistan.
4.	*Cyperus rotundus* L.	Graez deela	Cyperaceae	H	Hem	Lep	Tropical and subtropical areas of all continents.
5.	*Cyperus niveus* Retz.	Oba deela	Cyperaceae	H	Hem	Lep	From Eastern Iran to Myanmar; and, in Eastern Africa.
6.	*Juncus inflexus* L.	Darga boti	Juncaceae	H	Hem	Lep	Europe and Asia, North Africa; introduced elsewhere.
7.	*Typha latifolia* L.	Deely	Typhaceae	H	Geo	Mes	Central and Southeast Asia and Europe.
8.	*Aristida adscensionis* L.	Speen osha	Poaceae	H	Hem	Mic	Pakistan (Sind, Punjab, Baluchistan, Khyber Pakhtunkhwa (KP), Kashmir, and Gilgit) and throughout the tropical regions
9.	*Aristida cyanantha* Steud.	Sarblezda	Poaceae	H	Th	Nan	Pakistan, Kashmir, Northwest India, Nepal and Afghanistan.
10.	*Avena fatua* L.	Karyna boty	Poaceae	H	Th	Nan	Pakistan, Europe, Central and Western Asia; spread to other countries as well.
11.	*Cenchrus biflorus* Roxb.	Kawrashky	Poaceae	H	Hem	Lep	Pakistan, tropical Africa, spread from Arabia to India.
12.	*Cenchrus setiger* Vahl	Bamblakh	Poaceae	H	Hem	Lep	Pakistan, tropical East Africa, Arabia, and India; introduced in many tropical countries.
13.	*Cenchrus ciliaris* L.	Wosha	Poaceae	H	Hem	Lep	Pakistan, throughout Africa, spread from Arabia, the Middle East to India; widely introduced elsewhere in the Old World.
14.	*Cymbopogon jwarancusa* (Jones ex Roxb.) Schult.	Sargara boty	Poaceae	H	Hem	Nan	Pakistan (Sind, Punjab, Baluchistan, KP, Kashmir, and Gilgit); West India and Nepal.
15.	*Chrysopogon aucheri* (Boiss.) Stapf	Targeshee	Poaceae	H	Th	Lep	Pakistan, Arabia, Egypt, Iran, Afghanistan, and northern India.
16.	*Cynodon dactylon* (L) Pres.	Barawa	Poaceae	H	Hem	Lep	Found in tropical and warm-temperate regions worldwide.
17.	*Dactyloctenium aegyptium* (L.) Willd.	Barawaa	Poaceae	H	Th	Mic	Pakistan, widely distributed in the tropical and warm temperate regions of the Old World and America.
18.	*Desmostachya bipinnata* (L.) Stapf.	Berweza	Poaceae	H	Hem	Nan	Pakistan, Kashmir, north and tropical Africa, the Middle East, India and China.
19.	*Dichanthium annulatum* (Forssk.) Stapf	Barwaa	Poaceae	H	Hem	Nan	Pakistan, Kenya, Tanzania, and Senegal, from the Middle East to Indonesia; Southern Africa, Tropical America, and Australia.
20.	*Echinochloa colona* (L.) Link.	Shambokha	Poaceae	H	Th	Mic	Pakistan, the tropical and sub-tropical regions of the world.
21.	*Chloris flagellifera* (Nees) P.M. Peterson	Khawar	Poaceae	H	Hem	Nan	Pakistan, Northwest India to North Africa.
22.	*Eleusine indica* (Linn.) Gaertn.	Khawar	Poaceae	H	Hem	Nan	Pakistan, as well as tropical and subtropical areas worldwide.
23.	*Eragrostis minor* Host	Speen boty	Poaceae	H	Th	Mic	Pakistan (Sind, Punjab, Baluchistan, KP, Gilgit & Kashmir); temperate and subtropical regions of the old world; spread into the tropics and New World.
24.	*Eragrostis minor* Host.	Bota	Poaceae	H	Th	Nan	Tropical and Sub-tropics.
25.	*Imperata cylindrica* (Linn.) Raeuschel.	Speen wosha	Poaceae	H	Th	Lep	Pakistan (Sind, Punjab, Baluchistan, KP, Gilgit & Kashmir); in the old-world tropics, extending to the Mediterranean and the Middle East, including Chile.
26.	*Pennisetum orientale* L. C. Rich.	Khawar	Poaceae	H	Hem	Nan	Pakistan (Sind, Punjab, Baluchistan, KP, Gilgit & Kashmir); North Africa, Arabia, Central and Southwest Asia; Nepal and India.
27.	*Phragmites karka* (Retz.) Trimn.ex. Steud	Kraak bota	Poaceae	H	Ch	Mes	Pakistan (Sind, Punjab, Baluchistan, KP, Gilgit & Kashmir); tropical Asia, tropical Africa, northern Australia, and Polynesia.
28.	*Poa annua* L.	Khawar	Poaceae	H	Th	Mic	Cosmopolitan, but avoiding hot climates and deserts.
29.	*Poa infirma* Kunth	Khawar	Poaceae	H	Th	Mic	Cosmopolitan, but avoiding hot climates and deserts.
30.	*Polypogon monspeliensis* (L.) Desf.	Bota	Poaceae	H	Th	Mic	Pakistan, northeast tropical and South Africa; Mediterranean region, east India and China; introduced and naturalized in most warm temperate countries.

Table 2. (Cont'd.).

S. No.	Scientific name	Local name	Family name	Habit	Life form	Leaf size	Geographical distribution
31.	*Tripidium bengalense* (Retz.) H.Scholz	Kaee kana	Poaceae	S	Ch	Mes	Pakistan (Sind, Punjab and KP), North and Northwest India, Afghanistan.
32.	*Saccharum spontaneum* L.	Kana	Poaceae	S	Ch	Mes	Pakistan, widely distributed in the warmer regions of the old world.
33.	*Sorghum bicolor* (L.) Moench	Jowar	Poaceae	H	Hem	Mic	Sind, Punjab, Lower Baluchistan and the Punjab foothills.
34.	*Setaria viridis* (L.) P. Beauv.	Thurka	Poaceae	H	Th	Mic	Pakistan (Punjab, Baluchistan, KP, Gilgit & Kashmir); in the Old World; also introduced into new world.
35.	*Tetrapogon villosus* Desf..	Surmal	Poaceae	H	Th	Mic	Pakistan (Sind, Punjab, Baluchistan, KP, Gilgit & Kashmir); tropical Africa east India and west & North Africa and the Canary Islands.
	B. Dicot families						
36.	*Achyranthes aspera* L.	Aghzai	Amaranthaceae	H	Th	Nan	Pakistan, Indian sub-continent, mostly tropical region of the world.
37.	*Amaranthus albus* L.	Khso beeta	Amaranthaceae	H	Th	Nan	Distributed in warm regions of the world.
38.	*Amaranthus spinosus* L.	Khso soba	Amaranthaceae	H	Th	Nan	Has American origin, but now cosmopolitan weed in the high temperature regions of the world.
39.	*Amaranthus blitum* L.	Ranzaka	Amaranthaceae	H	Th	Nan	Found throughout the tropical and subtropical regions of the world.
40.	*Digera muricata* (L.) Mart.	Sur golye	Amaranthaceae	H	Th	Mic	South Asia, from tropical Arabia and the Yemen to Afghanistan, India, Malaysia, Ceylon, and Indonesia.
41.	*Pupalia lappacea* (L.) Juss.	Kwrashky	Amaranthaceae	H	Th	Mic	Distributed in tropical and Subtropical areas of the Old World. In Asia, it occurs from Arabia to India, Malaya, Indonesia, the Philippines, and New Guinea; also, in Egypt and throughout tropical Africa to S. Africa and Madagascar; and Australia.
42.	*Anethum graveolens* L.	Khawar	Apiaceae	H	Th	Mic	Asia, Europe, and the USA.
43.	*Daucus carrota* L.	Gajara	Apiaceae	H	Th	Lep	Cosmopolitan
44.	*Torilis leptophylla* Reichb. f.	Shpaza boty	Apiaceae	H	Th	Lep	Europe, Central and Southern Asia, Africa, and introduced in the USA.
45.	*Rhazya stricta* Dcne	Ganderye	Apocynaceae	S	Ch	Mic	Arabia, India, Pakistan, and Afghanistan.
46.	*Nerium oleander* L.	Gawal bota	Apocynaceae	S	Th	Mic	Pakistan, the Mediterranean region, to North Asia.
47.	*Calotropis procera* (Aiton) Dryand.	Spelmaka	Asclepiadaceae	S	Ch	Mes	Pakistan, India, and Afghanistan.
48.	*Periploca aphylla* Decne.	Barara boty	Asclepiadaceae	S	Np	Ap	Pakistan, India, Afghanistan, Iran, Iraq, Egypt, Arabia, and Jordan.
49.	*Carthamus tinctorius* L.	Kata sare	Asteraceae	H	Th	Nan	North America, China, Asia, Africa, Pakistan
50.	*Carthamus oxyacantha* M.Bieb.	Kunzalye	Asteraceae	H	Th	Mic	Africa, Asia, Pakistan, UAE, Afghanistan, Iran, and America.
51.	*Calendula arvensis* M.Bieb.	Sheen bota	Asteraceae	H	Th	Nan	North America, North-South. Africa, Europe, and Asia.
52.	*Centaurea iberica* Trevir. ex. spreng.	Katsory beta	Asteraceae	H	Th	Nan	Afghanistan, Kashmir, Kyrgyzstan, Kazakhstan, Pakistan, Tajikistan, Russia, Turkmenistan, Uzbekistan; SW Asia, Europe.
53.	*Erigeron canadensis L.*	Kharhashee	Asteraceae	H	Th	Mic	Native to North America, and now distributed widely in South America, Europe, Asia, and Africa.
54.	*Echinops echinatus* Roxb.	Aghzaye	Asteraceae	H	Th	Mic	More or less throughout India, Afghanistan and Northwestern Pakistan (Aslam *et al.,* 2015).
55.	*Laphangium affine* (D.Don) Tzvelev	Khawar	Asteraceae	H	Hem	Mic	Distributed chiefly in temperate regions.
56.	*Helianthus annuus* L.	Mye gawal	Asteraceae	H	Th	Mes	Native to North America and cultivated across the globe
57.	*Hertia intermedia* Kuntze	Beeta	Asteraceae	H	Ch	Lep	Iran, Afghanistan, and Pakistan.
58.	*Iphiona grantioides* (Boiss.) Anderb.	Zair gawal	Asteraceae	H	Th	Nan	This species is distributed in India, Iran, Oman, and Pakistan (Yadav *et al.,* 2022).
59.	*Lactuca serriola* L.	Khawar	Asteraceae	H	Th	Nan	South Africa, Northeast Asia, Australia, North America, Pacific islands (New Zealand), the Russian Far East, and South America.
60.	*Launaea procumbens* (Roxb.) Ramayya & Rajagopal	Thareeza	Asteraceae	H	Th	Mes	China, Afghanistan, India, Kashmir, Kazakhstan, Myanmar, Nepal, Pakistan, Turkmenistan, Tajikistan, Uzbekistan; Southeast Asia.
61.	*Pulicaria glaucescens* Jaub. & Spach	Zmay bota	Asteraceae	S	Np	Lep	Mediterranean to Southwest Asia.
62.	*Pluchea arguta* Boiss.	Bota	Asteraceae	S	Np	Mic	Iran, Pakistan, and India.
63.	*Himalaiella heteromalla* (D.Don) Raab-Straube	Khawar	Asteraceae	H	Th	Mic	Afghanistan, Iran, Africa, Pakistan, North India, Himalaya (Chitral to Bhutan).

Table 2. (Cont'd.).

S. No.	Scientific name	Local name	Family name	Habit	Life form	Leaf size	Geographical distribution
64.	*Sonchus asper* (L.) Hill	Kandyari	Asteraceae	H	Th	Mic	Madagascar and Africa
65.	*Taraxacum officinale* F.H. Wigg.	Thareeza	Asteraceae	H	Th	Mic	Distributed weed of temperate areas.
66.	*Xanthium strumarium* Lour.	Gorgoraish	Asteraceae	H	Th	Nan	North America, China, Africa, Asia, India and Pakistan
67.	*Arnebia guttata* Bunge	Bota	Boraginaceae	H	Th	Mic	Mediterranean, tropical Africa, and the Himalayas.
68.	*Cordia myxa* L.	Lashora	Boraginaceae	T	Mp	Mes	Pakistan, India, and Sri Lanka.
69.	*Heliotropium europaeum* L.	Polye booty	Boraginaceae	H	Th	Mic	Trans Jordan, Syria, Iraq, Afghanistan, Pakistan, India, Iran, and Russia
70.	*Euploca strigosa* (Willd.) Diane & Hilger	Bota	Boraginaceae	H	Th	Mic	Afghanistan, Pakistan, eastward to Nepal, Burma, and Malaya.
71.	*Onosma hispida* Wall. & G.Don	Ghwyo bota	Boraginaceae	H	Hem	Mic	Parts of Iran west to Syria, Turkey to Europe, Turkestan, Altai, Afghanistan, Tibet, China, and India
72.	*Brassica rapa* L.	Tapar	Brassicaceae	H	Th	Nan	Distributed from Europe; now present in Central Asia; introduced elsewhere.
73.	*Brassica oleracea* L.	Gopye	Brassicaceae	H	Th	Nan	Europe, China, India, Afghanistan, and Pakistan
74.	*Lepidium didymum* L.	Bota	Brassicaceae	H	Th	Mic	Native to the South America, but now widely introduced almost throughout the world.
75.	*Strigosella africana* (L.) Botsch.	Bota	Brassicaceae	H	Th	Nan	Asia, S. Europe, N. Africa, and China.
76.	*Strigosella strigosa* (Boiss.) Botsch.	Khwar	Brassicaceae	H	Th	Mic	Afghanistan, Iran, and Pakistan
77.	*Sisymbrium irio* L.	Oraye bota	Brassicaceae	H	Th	Nan	Europe, Asia, and North Africa
78.	*Capparis decidua* (Forssk). Edgeworth	Keeraa	Capparidaceae	T	Mp	Ap	North and Tropical Africa, Arabia, eastward to India, Pakistan, and Iran
79.	*Capparis spinosa* L.	Berri	Capparidaceae	S	Ch	Mic	South Europe, eastward to Australia.
80.	*Cleome viscosa* L.	Prewata	Capparidaceae	H	Th	Mic	Almost everywhere in the tropical regions of the world
81.	*Maytenus royleanus* Wall.	Skharagzye	Celastraceae	S	Np	Mic	Pakistan, E. Afghanistan, and India.
82.	*Atriplex lasiantha* Boiss.	Khso soba	Chenopodiaceae	H	Th	Mic	Syria, Lebanon, Jordan, Palestine, Turkey to Pakistan.
83.	*Chenopodium album* L.	Soba	Chenopodiaceae	H	Th	Nan	Cosmopolitan
84.	*Chenopodium murale* L.	Soba	Chenopodiaceae	H	Th	Lep	Cosmopolitan
85.	*Bassia prostrata* (L.) Beck	Bota	Chenopodiaceae	H	Np	Nan	North America, Eurasia, Africa, Pakistan; nearly worldwide.
86.	*Spinacia oleracea* L.	Saag bota	Chenopodiaceae	H	Th	Mic	Probably originated from Western Asia; cultivated all over the world probably.
87.	*Suaeda vera* Forssk. ex J.F.Gmel.	Piwerka	Chenopodiaceae	H	Ch	Lep	Africa, Canary Islands, Cape Verde, Jordan, Iraq, Afghanistan, India, Kenya, and Ceylon; the Arabian Peninsula.
88.	*Haloxylon griffithii* (Moq.) Boiss.	Balanza	Chenopodiaceae	S	Th	Mes	Pakistan, Afghanistan, and throughout Central Asia.
89.	*Convolvulus arvensis* L.	Prewaty	Convolvulaceae	H	Th	Nan	Distributed throughout the temperate and tropical regions worldwide, except Australia.
90.	*Convolvulus prostratus* Forssok	Prewaty	Convolvulaceae	H	Th	Lep	Egypt to Pakistan and India.
91.	*Evolvulus alsinoides* L.	Ghra prwata	Convolvulaceae	H	Th	Nan	Southern U.S.A. through Central and South America, Africa, Iran, Pakistan, India, Ceylon, and Malaysia.
92.	*Citrullus colocynthis* L. Schrad.	Maragonary	Cucurbitaceae	H	Th	Mic	Northern Tropical Africa, Atlantic Islands, North-West India, Pakistan, and Australia
93.	*Cuscuta reflexa* Roxb.	Chambal	Cuscutaceae	H	P	Ap	Afghanistan, from northern India to Yunnan (China), Java, and Ceylon.
98.	*Euphorbia granulate* Forssk.	Prewata	Euphorbiaceae	H	Hem	Lep	Eastward to Central Asia and Northern India, from North Africa to Tropical Africa
99.	*Euphorbia helioscopia* L.	Prewata	s	H	Th	Nan	Distributed in Europe, North Africa, and Asia, and extended to North America
100.	*Euphorbia dracunculoides* Lam.	Bobraye	Euphorbiaceae	H	Th	Lep	Egypt, Kuwait, Iraq, Arabia, India, Afghanistan, Tropical Africa, and the Mascarenes.
101.	*Euphorbia prostrata* Aiton	Prewata	Euphorbiaceae	H	Th	Lep	Native to tropical and subtropical America, it spread into many parts of the Old World.
102.	*Ricinus communis* L.	Arrand beta	Euphorbiaceae	S	Hem	Mes	Native to NE Tropical Africa, now spread throughout the tropics, subtropics, and warm temperate regions, and becoming naturalized.
103.	*Fumaria indica (*Haussk.) Pugsley	Shatra beta	Fumaraceae	H	Th	Nan	India, Pakistan, Afghanistan & Central Asia; introduced elsewhere.
104.	*Ajuga integrifolia* Buch. Ham. ex D.Don	Bota	Lamiaceae	H	Hem	Mic	Pakistan, Afghanistan, Kashmir, the Himalayas, to Bhutan, China, Burma, and Malaysia.

Table 2. (Cont'd.).

S. No.	Scientific name	Local name	Family name	Habit	Life form	Leaf size	Geographical distribution
105.	*Mentha arvensis* L.	Welana	Lamiaceae	H	Hem	Mic	Tropical Asia and throughout Eurasia.
106.	*Mentha longifolia* (L.) L.	Welana	Lamiaceae	H	Hem	Mic	Europe and Asia (except the Far East and SE Asia), Southern Africa.
107.	*Ocimum basilicum* L.	Bobraye	Lamiaceae	S	Ch	Nan	Asia, Africa, sub-tropical and SE Asia.
108.	*Otostegia limbate* Benth ex Hook.F.	Agzye bota	Lamiaceae	H	Np	Mic	Pakistan, Kashmir (endemic).
109.	*Salvia aegyptiaca* L.	Botaa	Lamiaceae	H	Np	Mic	Cape Verde Islands, Canary Islands, NW Africa, Sudan, Arabian Peninsula, Ethiopia, Afghanistan, Iran, Pakistan, and India.
110.	*Salvia moorcroftiana* Wallich ex Benth.	Boty	Lamiaceae	H	Th	Mes	Afghanistan, Nepal, Pakistan, Kashmir, North India
111.	*Salvia santolinifolia* Boiss.	Pandarvash	Lamiaceae	H	Th	Nan	Afghanistan, Iran, Pakistan.
112.	*Abutilon bidentatum* (Hochst.) A.Rich.	Boota	Malvaceae	S	Ch	Nan	Pakistan, India, Tropical Africa and Arabia.
113.	*Abutilon indicum* (L.) Sweet.	Boota	Malvaceae	H	Th	Nan	Tropics and subtropics regions of the Old and New World.
114.	*Malva neglecta* Wallr.	Boota	Malvaceae	H	Th	Mic	Worldwide but of Old-World origin. Naturalized in America.
115.	*Malva parviflora* L.	Boota	Malvaceae	H	Th	Mic	Europe, Africa, and Asia
116.	*Melia azedarach* L.	Bakanra	Meliaceae	T	Mp	Nan	Wild in W. Himalaya, parts of Iran, Burma, China, Turkey, India & W. Pakistan.
117.	*Tinospora cordifolia* (Willd.) Hook.f. & Thomson	Prewata	Menispermaceae	S	Mp	Lep	Tropical and subtropical Pakistan, Burma, India, and Sri Lanka.
118.	*Senegalia modesta* (Wall.) P.J.H.Hurter	Palosy bota	Mimosaceae	T	Mp	Lep	Pakistan (KP, Baluchistan, Punjab); some parts of India and Afghanistan.
119.	*Vachellia nilotica* (L.) P.J.H.Hurter & Mabb.	Keekar	Mimosaceae	T	Mp	Lep	Tropics and subtropics, especially in Africa, Asia, Pakistan, and Australia
120.	*Albizia lebbeck* (L.) Benth.	Sreen bota	Mimosaceae	T	Mp	Lep	W. Pakistan; Tropical Asia; N. Australia and Tropical Africa.
121.	*Prosopis farcta* (Banks & Sol.) J.F.Macbr	Keekarye	Mimosaceae	T	Mp	Lep	W. Pakistan, Afghanistan, Persia, Iraq, Arabia, Syria, Palestine, Trans Jordan, Cyprus, the Russian Caucasus, and Central Asia.
122.	*Neltuma juliflora* (Sw.) Raf.	Keekarye	Mimosaceae	T	Mp	Lep	Tropical and subtropical regions.
123.	*Ficus carica* L.	Inzar bota	Moraceae	T	Mp	Mes	India, Iran, Russia, Pakistan, Europe N. Africa, Middle Eastern countries.
124.	*Ficus palmata* Forssk.	Inzar	Moraceae	T	Mp	Mes	Nepal, Pakistan, N.W. India, Iran, Afghanistan, Arabian Peninsula, Somalia, Sudan, South Egypt, Ethiopia.
125.	*Morus alba* L.	Toot	Moraceae	T	Mp	Mes	Native of China, distributed in China, Japan, Malaya, Burma, Indo-Pak, North Africa, South & Central Europe; introduced in the New World.
126.	*Morus nigra* L.	Tor toot	Moraceae	T	Mp	Mes	N.W. Pakistan, Asia Minor, Central and South Europe, North Africa, Central Asia; introduced to the USA.
127.	*Eucalyptus globulus* Labill.	Lochye	Myrataceae	T	Mp	Nan	A native of Australia, cultivated and naturalized in Asian tropics and subtropics
128.	*Eucalyptus lanceolatus* L.	Lochye	Myrataceae	T	Mp	Nan	Pakistan, Iran, Somalia, Nepal, South Egypt, Ethiopia, Sudan, India, and Afghanistan.
129.	*Boerhavia procumbens* Banks ex Roxb.	Pandrawash	Nyctaginaceae	H	Hem	Nan	Pakistan, S. Asia, and India.
130.	*Mirabilis jalapa* L.	Ghwal bota	Nyctaginaceae	S	Ch	Mes	Native to South America; widely cultivated and distributed in tropical areas.
131.	*Jasminum officinale* L.	Raat ki rani	Oleaceae	S	Np	Mic	Mediterranean, Caucasus, Northern Persia, Eastern Afghanistan, Hindukush, India, Pakistan, China
132.	*Chrysojasminum humile* (L.) Banfi	Raat ki rani	Oleaceae	S	Np	Mic	Subtropical northwest, Himalaya.
133.	*Olea ferruginea* Wall. ex Aitch.	Zaitoon bota	Oleaceae	T	Mp	Mic	Pakistan, Afghanistan, and Kashmir.
134.	*Cistanche phelypaea* (L.) Cout.	Khar bota	Orobanchaceae	H	P	Lep	North Africa, Arabia, West Asia to Pakistan, India and Central Asia
135.	*Orobanche ramosa* L.	Zair bota	Orobanchaceae	H	P	Nan	North Africa, Arabia, Mediterranean region to Pakistan and Himalayas.
136.	*Oxalis corniculata* L.	Tharwaka	Oxalidaceae	H	Geo	Nan	Cosmopolitan
137.	*Alhagi maurorum* Medik.	Boota	Papilionaceae	S	Hem	Mes	Iran, Afghanistan, Pakistan, Kashmir, Russia, Iraq, Turkey, N. Africa and Cyprus
138.	*Arachis hypogaea* L.	Mampala	Papilionaceae	H	Th	Mic	Native of Brazil, widely cultivated throughout the Tropics.
139.	*Astragalus amherstianus* Benth.	Khar sasaa	Papilionaceae	S	Ch	Lep	Pakistan (Punjab, KP, Baluchistan); Kashmir, and India.
140.	*Astragalus psilocentros* Fisch.	Katysora	Papilionaceae	H	Ch	Lep	Pakistan (Punjab, KP), and India (Garhwal).

Table 2. (Cont'd.).

S. No.	Scientific name	Local name	Family name	Habit	Life form	Leaf size	Geographical distribution
141.	*Dalbergia sissoo* Roxb. ex-DC.	Shaway bota	Papilionaceae	T	Mp	Mic	Pakistan; India Afghanistan, Persia, and Iraq
142.	*Lathyrus aphaca* L.	Matar	Papilionaceae	H	Th	Nan	Pakistan, Kashmir, India, Europe, N. Africa, and Asia.
143.	*Lespedeza juncea* (L.f.) Pers.	Khara bota	Papilionaceae	S	Ch	Nan	Pakistan, Kashmir, and India (Chamba).
144.	*Medicago laciniata* (L.) Mill.	Spaiztara	Papilionaceae	H	Th	Nan	Distributed in Pakistan, India, C. Asia, N. Africa and Europe
145.	*Medicago polymorpha* L.	Maina	Papilionaceae	H	Th	Nan	Pakistan, widely distributed throughout the world.
146.	*Melilotus indicus* (L.) All.	Bota	Papilionaceae	H	Th	Nan	Introduced in warm temperate regions, Pakistan, India, the Orient, and Europe
147.	*Vicia sativa* L.	Bota	Papilionaceae	H	Th	Nan	India, India, Pakistan, Kashmir, Russia, Europe, and the Far East.
148.	*Plantago lanceolata* L.	Aspeghol	Plantaginaceae	H	Th	Nan	South Asia to the Tien Shan mountains, Europe, North Africa, and introduced throughout the world
149.	*Plantago ovata* Forssk.	Aspeghol	Plantaginaceae	H	Th	Nan	Mediterranean regions to the deserts of Kizil Kum, Afghanistan, and Pakistan.
150.	*Punica granatum* L.	Anaar	Punicaceae	T	Mp	Mic	Widespread in cultivation
151.	*Rumex dentatus* L.	Khawar	Polygonaceae	H	Hem	Mes	SE Europe, N Africa, Asia. In Pakistan, it is only represented by the subspecies, Klotzschianus (Meisn.).
152.	*Ranunculus arvensis* L.	Zyer gawal	Ranunculaceae	H	Th	Mic	Europe, Siberia, Western, Asia (India and the Himalaya).
153.	*Ranunculus muricatus* L.	Gawal	Ranunculaceae	H	Th	Mic	S. Europe, Atlantic, Asia, Caucasus, Crimea, S. Siberia, Pakistan, and India.
154.	*Ranunculus sceleratus* L.	Gawal bota	Ranunculaceae	H	Th	Mic	All parts of Europe, North Africa, and Asia.
155.	*Sageretia thea* (Osbeck) M.C.Johnst.	Sharakhzai	Rhamnaceae	S	Np	Nan	Pakistan, India, Nepal, Afghanistan, Iran, China, Arabia, N.E. Africa
156.	*Ziziphus mauritiana* Lam.	Bera	Rhamnaceae	T	Mp	Mic	Pakistan, Afghanistan, India, China, Ceylon, Australia, and Tropical Africa.
157.	*Ziziphus nummularia* (Burm.f.) Wight & Arn.	Bera	Rhamnaceae	T	Np	Mic	Palestine, Pakistan, Afghanistan, Iraq, Iran, and India.
158.	*Ziziphus xylopyrus* (Retz.) Willd.	Ghra bera	Rhamnaceae	T	Mp	Mic	Afghanistan, Pakistan, India, Iran and Asia.
159.	*Eriobotrya japonica* (Thunb.) Lindl	Alookat	Rosaceae	T	Mp	Mes	Sub-tropical regions, China, Pakistan, Afghanistan, Eeast Asia
160.	*Rosa indica* L.	Gulap gawal	Rosaceae	S	Np	Mic	West China, Nepal, India, and Pakistan.
161.	*Salvadora oleoides* Decne.	Miswak	Salvadoraceae	S	Np	Mic	West Pakistan, India and Aden.
162.	*Dodonaea viscosa* Jacq.	Zeraveena	Sapindaceae	S	Np	Mic	Australia, China, South Africa, North America, India, Pakistan
163.	*Sideroxylon mascatense* (A.DC.) T.D.Penn.	Gurgwara	Sapotaceae	T	Mp	Mic	Pakistan, Afghanistan, and Africa.
164.	*Nanorrhinum ramosissimum* (Wall.) Betsche	Zyer gul	Scrophulariaceae	H	Hem	Nan	West China, Nepal, India and Pakistan.
165.	*Verbascum thapsus* L.	Drashal bota	Scrophulariaceae	H	Th	Mes	China, Asia, and Europe, naturalized throughout the Northern Hemisphere
166.	*Ailanthus altissima* (Mill.) Swingle	Bakanra	Simaroubaceae	T	Mp	Mes	The taxon is widely cultivated in temperate and subtropical regions of the world.
167.	*Capsicum annum* L.	Mrach bota	Solanaceae	H	Ch	Mic	Tropical America. It is cultivated in Pakistan.
168.	*Datura metel* L.	Barbaka	Solanaceae	S	Np	Mes	Native of the Americas, long introduced and naturalized in Asia.
169.	*Withania coagulans* (Stocks) Dunal	Shapyanga	Solanaceae	S	Ch	Mic	Iran, Afghanistan, Pakistan, and India.
170.	*Withania somnifera* (L.) Dunal	Pyashangy	Solanaceae	S	Ch	Mic	Mediterranean, Turkey, Iran, Canary Islands, Africa, Iraq, Palestine, Syria, Arabia, Pakistan, India,
17.	*Tamarix aphylla* (L.) H.Karst.	Ghaz bota	Tamaricaceae	T	Mp	Lep	Africa, Middle East, India, Afghanistan and Pakistan.
172.	*Vitex negundo* L.	Marmanday	Verbenaceae	S	Np	Mic	Pakistan, India, W. Asia and North Africa.
173.	*Vitex trifolia* L.	Bota	Verbenaceae	S	Np	Mic	Tropical and Sub-tropical regions of Asia and Australia.
174.	*Zygophyllum creticum* (L.) Christenh. & Byng	Sperlaghzye	Zygophyllaceae	H	Th	Lep	From the Mediterranean region, southwest Africa, Chile, and the southwest United States, to southwest Asia and the subcontinent of Indo-Pakistan
175.	*Peganum harmala* L.	Speelanee	Zygophyllaceae	H	Hem	Lep	India, Tibet, and Pakistan westwards to North Africa, Europe, and Russia.
176.	*Tribulus pentandrus* Forsk.	Malkeenday	Zygophyllaceae	H	Hem	Lep	Pakistan, India, Iran, Southwest Arabia, Iraq, tropical and North Africa, South Africa, and Madagascar.
177.	*Tribulus terrestris* L.	Markonda	Zygophyllaceae	H	Hem	Lep	Asia (Tropical & subtropical countries), South Europe, Africa, and North Australia.

Conclusion

This study concludes that the dominating life forms are therophytes, hemicryptophytes, and megaphanerophytes, while the dominant leaf size classes are microphylls, nanophylls, leptophylls, and mesophylls. The predominance of therophytes and microphylls suggests that there is significant anthropogenic pressure and rapid deforestation in the studied area. The flora reflects that the weather conditions are dry and harsh. The study area needs special plantation and conservation strategies to protect the flora from natural and anthropogenic challenges in the scenario of climate change. Climate-smart plantations are necessary for habitat restoration in the study area.

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