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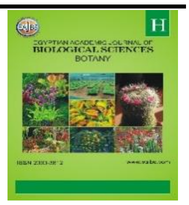

Revealing Ha'il's Urban Flora: A Native and Naturalized Plant Species Inventory in Wild and Human-Impacted Habitats, Ha'il Province, Saudi Arabia

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ABSTRACT

The current study documents the vascular wild plants found in ruderal, neglected, roadside, and horticulturally managed (garden) sites in and around Ḥaʾil City, Saudi Arabia. This comprehensive floristic list provides valuable insights and a correlative basis for the exotic plant diversity within the studied area of Ḥaʾil Province in the Kingdom of Saudi Arabia (KSA). This survey resulted in an extensive compilation of 243 vascular plant species belonging to 40 families and 160 genera. The taxonomic structure is dominated by dicotyledonous plants (196 species), along with three families comprising 47 species in the monocotyledons. The spectrum of life forms, calculated according to the system designed by Raunkiaer, is diverse, with a clear predominance of therophytes (141 species), followed by hemicryptophytes (37 species), chamaephytes (35 species), phanerophytes (20 species), one helophyte, and three parasitic plants in the flora, presenting varying percentages of phytogeographic affinities compared to those recorded in the flora as Saharo-Arabian. Notably, 29 species represent newly introduced floristic records for the Ḥaʾil region, of which 8 are new records for Saudi Arabia and are considered new alien plant species. The remaining 214 species include 189 indigenous species, of which 41 are newly introduced native species to Ha'il Province. This will enhance the understanding and knowledge of the exotic flora in Ḥaʾil Province, contributing new information regarding the regional flora and assisting with ecological management to mitigate the impact of the recorded invasive exotics.

INTRODUCTION

The flora of Saudi Arabia is among the wealthiest and most diverse collections of the entire Arabian Peninsula, containing substantial genetic plant resources (Zahran, 1982; Atiqur Rahman *et al*., 2004). Its floral elements are crucial to various ecosystems and significantly enhance the stability and balance of the regional environment (Thomas, 2024). It features a mix of Asian, African, and Mediterranean botanical influences (Collenette, 1999). The northeast and southwest regions are the most richly vegetated, supporting about 70% of the country's wild plants and animals. However, the central, northern, and eastern areas have fewer wild species per square kilometer. Additionally, Saudi Arabia has a relatively low number of endemic species compared to its adjacent countries, such as Yemen and Oman (Osman *et al*., 2014).

The flora of Saudi Arabia has been extensively documented in numerous research papers. Significant works include floristic accounts by Migahid (1978, 1996) and Batanouny

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& Baeshain (1983), which represent plant communities along the Medina-Badr Road through the Hijaz Mountains, as well as Chaudhary's contributions (1999, 2001). Additionally, there is an illustrated flora by Collenette (1985, 1999). Chaudhary and Al-Jowaid (2013) authored a comprehensive book entitled "Vegetation of the Kingdom of Saudi Arabia," and Osman *et al*. (2011) reported on the flora and vegetation of Ar'ar Valley. Mandaville (1990) also represented KSA flora, while Abd-El–Ghani (1997) focused on the flora of the Central Hijaz Mountains. Other related works include Alatar *et al*. (2012), which documented the flora of Wadi Al–Jufair in the Nejd region, and Abdein & Osman (2020), who studied Wadi Al–Hilali in the Northern Border region. Al-Namazi *et al*. (2021) concentrated on the Al-Baha region, and Alzamel (2022, 2024) included the Al Rayn and Wadi Al-Furayshah regions, respectively, all highlighting the impressive flora of the Kingdom. The studies began in Ha'il region, with Collenette & Tsagarakis (2001) providing a list of flora in the Aja Mountains. Al-Turki and Al-Olayan (2003) conducted an extensive review of the flora of Ha'il, while Alshammari and Sharawy (2010) studied the diversity of the Hema Faid region. This floristic survey documented 199 wild plant species, representing 161 genera across 54 families. El-Ghanim *et al*. (2010) conducted a detailed study on floristic composition and vegetation analysis in Ha'il province, where a total of 124 species, encompassing 34 families, were documented. Alshammari and Sharawy (2015) examined the flora of Wadi Al-Odair, identifying 99 species distributed among 91 genera belonging to 36 families within the sampled habitats. A total of 97 weed species, distributed among 81 genera and 27 angiosperm families, were recorded by Alghamdi *et al*. (2019) in a study on weed species found in wheat and alfalfa fields across the Ha'il Region. In contrast, Alghamdi *et al*. (2018) and Mseddi *et al*. (2021) investigated the flora of Salma Mountains. Their findings demonstrate considerable plant diversity, recording 150 species from 39 families, and a total of 163 species within the sampling sites, encompassing 101 genera across 41 botanical families, respectively. Nevertheless, fewer studies document alien plant species that may become invasive.

The Floristic Composition:

The Raunkiær life-form spectrum, recognized for its simplicity and broad applicability to various vegetation types (Adamson, 1939; Cain, 1950), remains one of the most widely utilized and enduring classifications of plant form. Its effectiveness is demonstrated in assessing the response of vegetation to environmental changes (Harrison *et al*., 2010; Marini *et al*., 2011) and in understanding biogeographical distribution patterns among plants (Danin & Orshan, 1990; Pignatti, 1994; Pavón *et al*., 2000; Irl *et al*., 2020). The Raunkiær (1934) system includes six primary life forms commonly associated with vascular plant groups: therophytes, hydrophytes, geophytes, hemicryptophytes, chamaephytes, and phanerophytes (Cain, 1950). It provides a fundamental framework for analyzing plant structures, classifying species based on the location and protection level of their perennating buds (seeds, tubers, rhizomes) against environmental stress. This facilitates understanding the positive impact of topographic and landform features on the distribution of these life forms (Kassas & Girgis, 1965; Zohary, 1973; Orshan, 1986; Fakhireh *et al*., 2012). Additionally, phytogeographical distribution is a foundational area of study in botany and ecology. This sub-discipline provides crucial data about the evolutionary history of floras, how environmental gradients such as climate, soil, and geology influence species composition in a specific area, and the various floristic regions along with their typical vegetation (Good, 1974; Takhtajan, 1986).

The global introduction of invasive plants poses a significant threat to biodiversity, ecosystem stability, and economic sustainability. Research indicates that introducing non-native plant species can severely endanger biodiversity in native habitats, second only to human influence. Their invasiveness jeopardizes indigenous plants and ecosystems, thereby risking global plant diversity (Manchester & Bullock, 2000). Defining these newly exotic species could assist in their future delimitation. Worldwide, exotic invasive species pose a significant problem for natural and human-modified habitats where they have been introduced, such as with *Senecio madagascariensis* (Poljuha & Sladonja, 2025). For native plant communities, these invaders often disrupt biotic communities, alter soil chemistry, and create ecological chaos.

Although several studies have advanced the control and detection of exotics in recently invaded systems, the ecological effects and competition dynamics between adventive flora and native flora are geographically contingent (Coulston, 2001; Hejda *et al*., 2009). In Saudi Arabia, despite extensive floristic and vegetation studies (e.g., Abohassan, 1980; Batanouny, 1984; Abd El-Rahman, 1986; König, 1986, 1988; Migahid, 1988; Abulfatih *et al*., 1989; Ghazanfar & Fisher, 1998; Collenette, 1999; Chaudhary, 1999-2001; Barth, 2002), there is a lack of quantitative information regarding the area covered and the level of infestation by exotic species. Relatively little is known about the invasibility of ecosystems based on the quantitative evaluation of exotic species invasions. Additionally, very little information exists on their introduction and spread (e.g., Forsskål, 1775; Schweinfurth, 1912; Blatter, 1919-1936; De Marco & Dinelli, 1974) throughout history.

The present study aims to provide a comprehensive floristic vegetation checklist to enhance our understanding of species diversity in an anthropogenically impacted area. It will also explore ruderal, roadside (neglected and disturbed places), and garden areas as cultivated spaces within the Ḥaʾil city region and its suburbs. This research will offer an updated checklist of the wild flora, including a comparative study of plant diversity, life-form spectrum, and phytogeographical relationships. Additionally, it will create an inventory that may serve as a crucial reference for developing and implementing well-planned ecological long-term monitoring programs to track vegetation changes and dynamics in response to ongoing environmental pressures. Furthermore, this study presents a potential opportunity to expand our knowledge and compare the exotic vegetation found in the Ḥaʾil Province area of Saudi Arabia.

MATERIALS AND METHODS

The Study Area:

The study area is Ḥaʾil city in Ḥaʾil province, located in the north-central part of Saudi Arabia (approximately 118,322 km², situated between 25° 35' N and 29° 00' N, and 39° 01' E and 44° 45' E). Ḥaʾil Province borders Al-Jouf and the Northern Borders Regions to the north, Tabuk and Al-Madinah Al-Munawwarah Provinces to the west, and Al-Qassim Province to the south (Fig. 1). Geologically, the province lies within the Arabian Shield, consisting of a Precambrian basement complex covered by Phanerozoic strata along its northern and eastern edges (Schultz & Whitney, 1986; Al-Turki & Al-Olayan, 2003). The city of Ḥaʾil itself (27° 31′ 25.1292″ N, 41° 41′ 47.8752″ E (LatLong.net, 2025) is positioned in the northwest of Saudi Arabia, nestled between the Shammar and Salma mountains, historically significant as the primary transshipment point on the pilgrimage trail from Iraq to Mecca, Ḥaʾil also acts as a crossroads for travels to and from the historic east–west and north–south pilgrimage routes, serving as a regional transit center for Umrah and Hajj journeys from Iraq, Jordan, and other locations (Britannica, 2025). This emphasizes the strategic importance of Ḥaʾil city, highlighting its potential role in supporting Saudi national objectives to enhance food security and develop the tourism sector (Invest Saudi, 2025; Saudipedia, a; b, 2025).

Climate:

Saudi Arabia is primarily characterized by a dry-hot climate, which is part of an arid region constituting about 5% of the world's arid area (Bashour *et al*., 1983). It predominantly falls under the "arid" category in Thornthwaite's classification and is categorized as "dry climates" by Köppen, except for Asir and Jazan, where the climate is humid (Al-Nafie, 2008). Ha'il region experiences distinct seasonal temperatures, with an average minimum of 10.1°C in winter and an average maximum of 31.8°C in summer, as documented by Zahran (1983), Al-Turki & Olyan (2003), El-Ghanim *et al.* (2010), Alshammari & Sharawy (2010), and Llewellyn *et al.* (2011). This study was conducted in Ha'il Province, located in the central Arabian Shield region of Saudi Arabia. The geological basement in the study area is Precambrian and is covered by Phanerozoic formations that unconformably overlay most of the Shield's northern and eastern margins. According to Ghanim *et al*. (2010), the Ha'il region experiences a winter-maximum precipitation regime, with the peak occurring in February (32 mm), yielding an annual mean of 104.4 mm/day. Furthermore, relative humidity exhibits significant seasonal variation, with very low values during the summer (14.15%) and conversely high levels in winter (57%). It has been reported that some areas in Saudi Arabia experience extreme weather events, such as recent heavy precipitation periods and wet spells documented by Al-Sherif *et al*. (2013).

A six-year floristic investigation (2019 – early 2025) assessed the plant species richness of roadside, ruderal, neglected, and garden sites in Ḥaʾil City, Ḥaʾil Province, Saudi Arabia. Plants were identified according to Chaudhary (1999–2001), Wood (1997), Collenette (1999), and Tackhólm (1974). The nomenclature and taxonomic status were reconciled with Plants of the World Online (POWO, 2025), the International Plant Names Index, the World Checklist of Vascular Plants (IPNI, 2025), and the World Flora Online (WFO, 2025). Life forms and phytogeographic regions were assigned based on Raunkiaer (1937) and the Analytical Flora database (2016). A distribution map for native or introduced species was created using data from GBIF Secretariat (2023), iNaturalist (2025), POWO (2025), Thomas (2024), and WFO (2025). Phytogeographical affinities were determined by analyzing relevant floristic and biogeographical literature (Ellenberg & Mueller-Dombois, 1969; Analytical Flora, 2025). Voucher specimens of the recorded species were deposited in the herbarium of the Department of Biology, Girls' Section, Faculty of Science, Ḥaʾil University, Saudi Arabia.

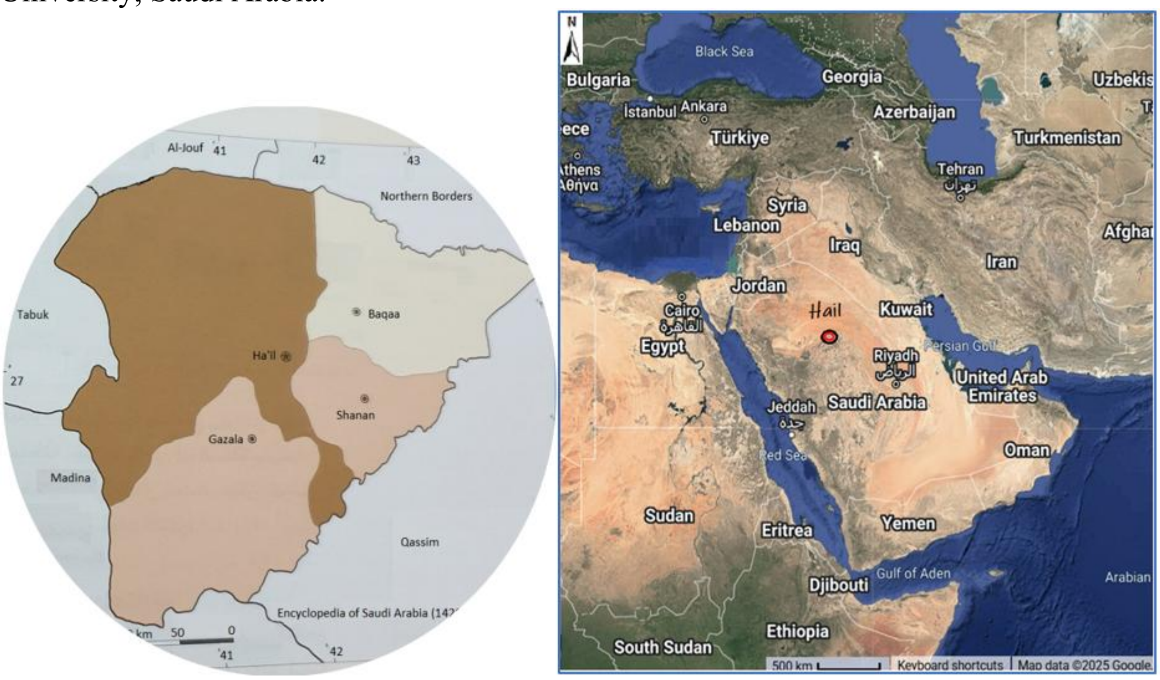

Fig. 1: Map depicting the location of the study area.

RESULTS AND DISCUSSION

The present findings represent the first survey of plant diversity in the roadside, neglected ruderal areas, and gardens of the Ḥaʾil region, significantly enhancing the species richness data of the region. The floristic list comprises 243 species distributed among 160 genera and 40 families. The taxonomic composition is dominated by dicotyledonous flora, with 36 families and 195 species, compared to monocotyledonous flora, which includes four families and 48 species. An analysis of species richness at the family level reveals that Poaceae is the plant family with the highest number of recorded species, with 45 (18.5%), followed by Asteraceae with 39 (16%), Brassicaceae with 23 (9.5%), and Amaranthaceae with 16 (6.6%). The families Fabaceae, Euphorbiaceae, and Caryophyllaceae each contain 15 (6.2%), 11 (4.5%), and 12 (4.9%) species, respectively. The family Zygophyllaceae is represented by nine species (3.7%), while Plantaginaceae and Convolvulaceae each account for seven species (2.9%). Two other families, Solanaceae and Polygonaceae, contain five species each (2.1%), and one family, Aizoaceae, has four species (1.6%). Five families are represented by three species (1.2%): Apiaceae, Apocynaceae, Boraginaceae, Resedaceae, and Tamaricaceae. In contrast, eight families, each representing two species (0.8%), include Cistaceae, Geraniaceae, Lamiaceae, Malvaceae, Oxalidaceae, Portulacaceae, Primulaceae, and Urticaceae, as shown in Figure 2 and Table 1.

On the other hand, 14 families were monotypic, each comprising a single species in the flora: Acanthaceae, Capparaceae, Cucurbitaceae, Nitrariaceae, Nyctaginaceae, Phyllanthaceae, Rhamnaceae, Rubiaceae, Rutaceae, Verbenaceae, Anacardiaceae, Asphodelaceae, Cyperaceae, and Typhaceae. These represented 35% of the families and 5.8% of the species encountered. Each family, accounting for 0.4% of the total species count, reflects the limited ability of many plant taxa to tolerate and adapt to the challenging environmental conditions prevalent in these areas (Pielou, 1975; Magurran, 1988; Al–Nafie, 2008; El–Ghanim *et al*., 2010; Al–Sherif *et al*., 2013). The monospecificity of these families (each having only one genus and one species) underscores the high taxonomic importance of this clade and the considerable taxonomic significance of this entity. Furthermore, its unique phytogeographic distribution and pivotal position within phylogenetic analyses (Rana & Ranade, 2009; Sarwar & Araki, 2010) amplify its scientific importance and may be threatened by extinction due to climate change and intensive human activities (Chaudhary & Khan, 2010). In terms of conservation, these areas must be protected and managed effectively to preserve their rich plant diversity resources.

The most common plant families in the current study were Poaceae, Asteraceae, Brassicaceae, Amaranthaceae, Fabaceae, and Caryophyllaceae. These results are consistent with earlier floristic studies of Saudi Arabia by Collenette (1999), Al–Nafie (2004), and Moawed & Ansari (2015), which also reported Poaceae, Asteraceae, and Fabaceae as major constituents of the kingdom's flora. Poaceae exhibited notable prevalence in species distribution within the identified plant families. The significance of this family, along with others that have high species richness, likely stems from the considerable number of species possessing arid-adapted traits (Batanouny & Baeshain, 1983). The presence of several singletons in families may relate to selective forces in the research area that could have diminished the success of less-adapted lineages (Pielou, 1975; Magurran, 1988; Al–Nafie, 2008; El–Ghanim *et al.,* 2010; Al–Sherif *et al.,* 2013).

Floristic studies conducted across various locations within the Kingdom of Saudi Arabia have consistently reported Poaceae, Asteraceae, Fabaceae, and Brassicaceae as the most frequently encountered plant families (Migahid, 1978; Collenette, 1985; Mandaville, 1990; Alshammari & Sharawy, 2015). Nevertheless, some investigations, such as those by Al–Turki & Al–Olayan (2003), have indicated a more restricted dominance of Asteraceae and Poaceae in specific regions of Saudi Arabia. The ecological dominance of Asteraceae and Poaceae in arid and semi-arid regions suggests that their adaptive properties may be responsible for successfully colonizing habitats within the Arabian Peninsula. Both families are ecologically widespread due to their resistance to adverse conditions and effective wind dispersal of seeds (Clayton, 1978; Jeffrey, 1978; van Rheede & van Rooyen, 1999). Grass species also utilize long, shallow root systems for efficient water uptake, grazing, and drought resistance (Stanley, 1999). In addition, Brassicaceae species, which are frequently therophytes, exhibit a recently discovered peculiar germination behavior, in which the pericarp trait functions to prevent germination of recently matured seeds while promoting non-dormant seeds; this offers an important advantage in unpredictable environments (Khan & Shah, 2013; Zhou *et al*., 2015).

The exceptional adaptability of the Poaceae family across diverse biomes, including rainforests, deserts, and cold mountain steppes, accounts for its global dominance and constitutes approximately 20% of the world's vegetation cover (Arabacı & Yıld, 2004; Dashora & Gosavi, 2013). Our results corroborate this widespread adaptability.

Analysis of life-form spectra indicated a dominance of therophytes (58%, 141 species), characteristic of desert vegetation, followed by hemicryptophytes (15.2%; 37 species), chamaephytes (14.4%; 35 species), phanerophytes (8.2%; 20 species), geophytes (2.5%; 6 species), parasites (1.2%; 3 species), and helophytes (0.4%; one species), (Fig. 3). The therophyte component of northern Saudi Arabian flora demonstrates prevalence through early flowering and seed production during the shorter growing season (Sans & Masalles, 1995). This transformation aligns with findings from other studies in the Ha'il region (Al-Turki & Al-Olayan, 2003; Sharawy & Al-Shammari, 2010; Al-Shammari & Sharawy, 2015; Alghamdi *et al*., 2019). The incidence of therophytes in an area is an ecological indicator of dry conditions and disturbed environments (Cain, 1950; Ricklefs, 1979; Smith, 1980). A high relative contribution of therophytes and a low contribution of phanerophytes confirm the existence of such climate and habitat conditions. According to several floristic surveys in Saudi Arabia, therophytes are often the most dominant life form, with chamaephytes following in relative abundance. This trend has also been reported in other areas, including Khulais (Al-Sherif *et al*., 2013), Wadi Arar (Osman *et al*., 2014), Riyadh (Al Shaye *et al*., 2020), and Ha'il (El-Ghanim *et al*., 2010). Similarly, vegetation studies from the foothills of the Hijaz Mountains have reported the prevalence of therophytes, chamaephytes, phanerophytes, and hemicryptophytes (Hofland *et al*., 2024). Very high floristic diversity is observed in the Tabuk region, with therophytes and chamaephytes being the most prevalent life forms. Midolo *et al.* (2023) mention that the greater prevalence of therophytes and chamaephytes in the Mediterranean and dry temperate regions, where adaptations to drier conditions are often observed in these life forms, contrasts with the dominance of hemicryptophytes in temperate Central Europe. As adaptive growth strategies reflecting ecological conditions (Mera *et al*., 1999), plant life forms act as indicators of climatic adaptability. Consequently, a region's vegetation composition reveals its prevailing climate (Batalha & Martins, 2002).

Climatic seasonality is crucial in shaping species' niche widths—the spectrum of climatic conditions a species encounters across its spatial and temporal range (Janzen, 1967; Quintero & Wiens, 2013). Elevated seasonality can lead to broader niche widths and larger geographical ranges for species, a phenomenon supported by prior research (Janzen, 1967; Addo-Bediako *et al*., 2000; Quintero & Wiens, 2013; Saupe *et al*., 2019). In arid areas, plant life primarily consists of therophytes and chamaephytes, reflecting a typical desert environment. Notably, the vegetation in many regions is not static but changes yearly depending on moisture availability (Siddiqui & Al-Harbi, 1995). Disturbance (Midolo *et al*., 2023) and microclimate (De Frenne *et al*., 2021) are key factors that likely explain the occurrence of different life forms within plant vegetation. Our results show that hemicryptophytes outnumber chamaephytes; this may be due to hemicryptophytes being characterized by perennating buds located at the ground surface (Leuschner & Ellenberg, 2017), which serves as an effective adaptive strategy for survival in herbaceous vegetation types subject to chilling and anthropogenic or natural disturbances such as mowing and grazing. In contrast, chamaephytes, with buds positioned no more than 25 cm above the ground surface, possess adaptations that enable them to exploit elevated surface temperatures and high wind speeds (Bliss, 1962), which could indicate ecological shifts due to climatic change and human impacts. Climate change induces significant modifications in the spatial distribution, population sizes, and community composition of terrestrial and aquatic ecosystems (Staudinger *et al.*, 2012; Lenoir & Svenning, 2015; Pacifici *et al.*, 2017). While species range shifts are often seen as a primary adaptive strategy to climate change, their implications must be evaluated at the ecosystem level, as the successful adaptation of one species may negatively impact existing ecological communities (Wallingford *et al.*, 2020).

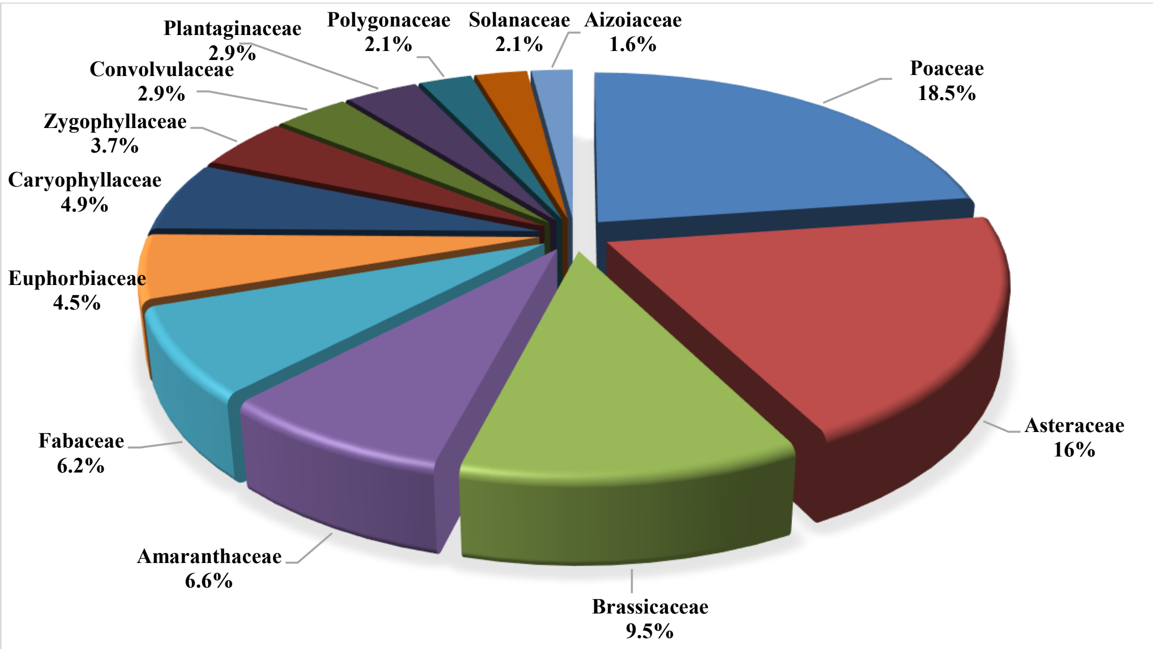

Fig. 2: The percentage of species within each of the 40 families documented in the survey area.

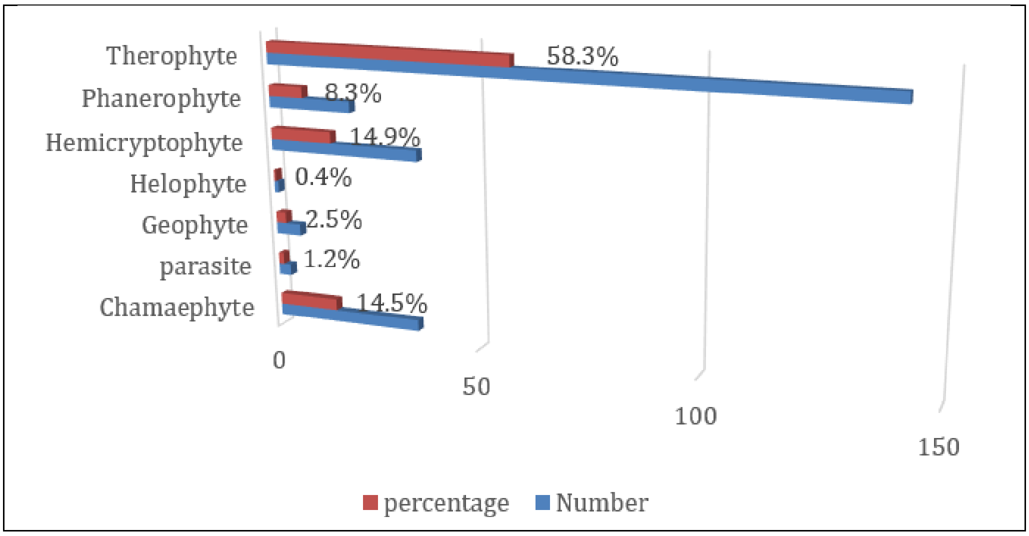

Fig. 3: Composition of life forms among recorded species in the survey area (numbers and percentages).

Table 1: List of families, species, presence habitat, life forms, and chorotypes.

No	Family	Taxa	Presence	Life form	Indigeneity	chorotype
1	**Acanthaceae**	*Blepharis ciliaris* (L.) B.L.Burtt	In Both	Chamaephyte	Native	IR-TR + SA
2	**Aizoaceae**	*Aizoanthemopsis hispanica* (L.) Klak	Roadside & Rudral	Therophyte	Native	SA-SI + S-Z
3		*Aizoon canariense* L.	In Both	Therophyte	Native	SA-SI + S-Z
4		*Sesuvium hydaspicum (Edgew.) Gonç.* Synonym *(Trianthema hydaspicum Edgew.)*	In Both	Therophyte	Native	SA-SI
5		*Zaleya pentandra* (L.) Jeffrey *	Roadside & Rudral	Hemicryptophyte	Native	SA-SI + S-Z
6	**Amaranthaceae**	*Amaranthus viridis* L.	Roadside & Rudral	Therophyte	Introduced	COSM
7		*Anabasis articulata* (Forssk.) Moq *	Roadside & Rudral	Chamaephyte	Native	SA
8		*Atriplex dimorphostegia* Kar. & Kir.	Roadside & Rudral	Therophyte	Native	IR-TR+SA
9		*Atriplex halimus* L.*	In Both	Phanerophyte	Native	ME + SA
10		*Bassia eriophora* (Schrad.) Asch.	In Both	Therophyte	Native	SA + IR-TR
11		*Bassia muricata* (L.) Asch.	In Both	Therophyte	Native	SA + IR-TR
12		*Beta vulgaris* L.	Roadside & Rudral	Therophyte	Native	ER-SI + ME + IR-TR
13		*Caroxylon vermiculatum (L.) Akhani & Roalson* * Synonym *(Salsola vermiculata L.)*	Roadside & Rudral	Chamaephyte	Introduced	IR-TR + SA
14		*Chenopodiastrum* murale (L.) S.Fuentes, Uotila & Borsch	In Both	Therophyte	Native	COSM
15		*Chenopodium album* L.	In Both	Therophyte	Native	COSM
16		*Chenopodium ficifolium* Sm. *	Roadside & Rudral	Therophyte	Native	PAL
17		*Haloxylon salicornicum* (Moq.) Bunge ex Boiss.	Roadside & Rudral	Chamaephyte	Native	S-Z
18		*Ouret lanata (L.) Kuntze* * Synonym *(Aerva lanata (L.) Juss. ex Schult.*)	In Both	chamaephyte	Native	PAL
19		*Oxybasis glauca* (L.) S.Fuentes, Uotila & Borsch Synonym (*Chenopodium glaucum* L.)	Garden	Therophyte	Introduced	IR-TR + ER-SI
20		*Salicornia fruticosa* (L.) L. *	Roadside & Rudral	Phanerophyte	Introduced	ME +IR-TR
21		*Suaeda monoica* Forssk. ex J.F.Gmel. *	Roadside & Rudral	Phanerophyte	Native	S-Z
22	**Anacardiaceae**	*Searsia tripartita* (Ucria) Moffett Synonym *(Rhus tripartita* (Ucria) Grande)	Roadside & Rudral	Phanerophyte	Native	ME + SA
23	**Apiaceae**	*Deverra tortuosa* (Desf.) DC	Roadside & Rudral	Chamaephyte	Native	SA
24		*Foeniculum vulgare* Mill	In Both	Hemicryptophyte	Native	ME + IR-TR
25		*Torilis nodosa* (L.) Gaertn. *	In Both	Therophyte	Native	ER-SI + ME + IR-TR
26	**Apocynaceae**	*Calotropis procera* (Aiton) W.T.Aiton	In Both	Phanerophyte	Native	SA-SI + S-Z
27		*Pergularia tomentosa* L.	Roadside & Rudral	Chamaephyte	Native	SA-SI + S-Z
28		*Rhazya stricta* Decne.	Roadside & Rudral	Phanerophyte	Native	SA-SI
29	**Asteraceae**	*Acanthospermum hispidum* DC. **	Garden	Therophyte	Introduced	PAN
30		*Anthemis cotula* L.	Roadside & Rudral	Therophyte	Native	SA
31		*Anvillea garcinii* (Burm.f.) DC.	Roadside & Rudral	Chamaephyte	Native	SA
32		*Asteriscus graveolens* (Forssk.) Less. Synonym *(Nauplius graveolens* (Forssk.) Wikl)	Roadside & Rudral	Chamaephyte	Native	SA
33		*Atractylis carduus* (Forssk.) C.Chr.	In Both	Chamaephyte	Native	SA
34		*Calendula arvensis* L.	In Both	Therophyte	Native	ME+ SA-SI + IR-TR
35		*Centaurea hyalolepis* Boiss. *	In Both	Therophyte	Native	ME + IR-TR
36		*Chondrilla juncea* L.**	Roadside & Rudral	Hemicryptophyte	Native	ME - IR-TR
37		*Crepis pulchra* L.***	In Both	Therophyte	Newly Introduce	ER-SI + ME + IR-TR
38		*Echinops galalensis* Schweinf. *	Roadside & Rudral	Hemicryptophyte	Native	SA
39		*Echinops spinosissimus* Turra	Roadside & Rudral	Hemicryptophyte	Native	IR-TR
40		*Erigeron abyssinicus* (Sch.Bip. ex A.Rich.) Sch.Bip. Ex Synonym *(Conyza abyssinica Sch.Bip. ex A.Rich)*	In Both	Therophyte	Native	ME+ SA-SI + IR-TR
41		*Erigeron bonariensis* L. Synonym (*Conyza linifolia* (Willd.) Täckh)	In Both	Therophyte	Introduced	COSM
42		*Filago arvensis* L.**	In Both	Therophyte	Introduced	ER-SI + ME + IR-TR
43		*Filago pyramidata* L.	Garden	Therophyte	Newly Introduce	ME
44		*Gazania rigens* (L.) Gaertn.***	In Both	Therophyte	Newly Introduce	PAN
45		*Koelpinia linearis* Pall.	In Both	Therophyte	Native	ME + SA + IR-TR
46		*Lactuca serriola* L.	In Both	Therophyte	Native	ER-SI + ME + IR-TR
47		*Launaea fragilis* (Asso) Pau	In Both	Hemicryptophyte	Native	ME+SA–SI
48		*Launaea mucronata* (Forssk.) Muschl.	In Both	Therophyte	Native	SA
49		*Launaea nudicaulis* (L.) Hook.f.	In Both	Hemicryptophyte	Native	SA–SI + IR–TR + S–Z
50		*Matricaria chamomilla* L.***	Garden	Therophyte	Newly Introduced	ER-SI + ME + IR-TR
51		*Otoglyphis factorovskyi* (Warb. & Eig) *	In Both	Therophyte	Native	SA
52		*Pluchea dioscoridis* (L.) DC.	In Both	Phanerophyte	Native	SA-SI+ S-Z
53		*Pulicaria undulata* (L.) C.A.Mey. Synonym *(Pulicaria crispa* (Forssk.) Oliv.)	In Both	Chamaephyte	Native	SA + S-Z
54		*Pulicaria vulgaris* Gaertn.	Roadside & Rudral	Therophyte	Native	ME+ SA-SI + IR-TR
55		*Senecio flavus* (Decne.) Sch.Bip.	In Both	Therophyte	Introduced	SA
56		*Senecio glaucus* L.	In Both	Therophyte	Native	SA-SI + IR-TR
57		*Senecio vulgaris* L. **	In Both	Therophyte	Introduced	ER-SI + ME + IR-TR
58		*Sonchus asper* (L.) Hill	Roadside & Rudral	Therophyte	Native	COSM
59		*Sonchus oleraceus* L.	In Both	Therophyte	Native	COSM

60		*Sonchus tenerrimus* L. *	Roadside & Rudral	Therophyte	Native	ME + IR-TR
61		*Sphagneticola trilobata* (L.) Pruski***	Roadside & Rudral	Chamaephyte	Newly Introduced	PAN
62		*Symphyotrichum squamatum* (Spreng.) G.L.Nesom ** Synonym *(Aster squamatus* (Spreng.) Hieron)	In Both	Therophyte	Introduced	PAN
63		*Tripleurospermum auriculatum* (Boiss.) Rech.f.	In Both	Therophyte	Native	IR-TR
64		*Tripleurospermum caucasicum* (Willd.) Hayek ** Synonym *(Chamaemelum oreades* (Boiss.) Boiss.)	Roadside & Rudral	Hemicryptophyte	Introduced	ME + IR-TR
65		*Urospermum picroides* (L.) Scop. ex F.W.Schmidt	In Both	Therophyte	Native	ME - IR-TR
66		*Verbesina encelioides* (Cav.) Benth. & Hook.f. ex A.Gray **	Roadside & Rudral	Therophyte	Introduced	PAN
67	**Boraginaceae**	*Heliotropium europaeum* L.***	In Both	Therophyte	Newly Introduced	ME - IR-TR
68		*Heliotropium curassavicum* L.	In Both	Chamaephyte	Introduced	Neotropics
69		*Heliotropium bacciferum* Forssk.	In Both	Chamaephyte	Native	SA-SI + S-Z
70	**Brassicaceae**	*Mutarda nigra* (L.) Bernh. Synonym *(Brassica nigra* (L.) W.D.J.Koch)	Roadside & Rudral	Therophyte	Introduced	ME
71		*Brassica rapa* L.	Roadside & Rudral	Therophyte	Native	COSM
72		*Capsella bursa-pastoris* (L.) MEik.	Garden	Therophyte	Native	COSM
73		*Coincya tournefortii* (Gouan) Alcaraz, T.E.Díaz, Rivas Mart. & Sánchez-Gómez Synonym (*Brassica tournefortii* Gouan)	In Both	Therophyte	Native	ME + SA
74		*Diplotaxis acris* (Forssk.) Boiss.	Roadside & Rudral	Therophyte	Native	SA
75		*Diplotaxis harra* (Forssk.) Boiss.	Roadside & Rudral	Chamaephyte	Native	SA
76		*Diplotaxis viminea* (L.) DC. **	Roadside & Rudral	Therophyte	Introduced	ME
77		*Eremobium aegyptiacum* (Spreng.) Asch. ex Boiss.	Roadside & Rudral	Hemicryptophyte	Native	SA
78		*Eruca sativa* Mill.	Roadside & Rudral	Therophyte	Native	ME+ IR-TR+ ER-SR
79		*Eruca vesicaria* (L.) Cav.**	Roadside & Rudral	Therophyte	Introduced	ME + ER-SI
80		*Farsetia aegyptia* Turra	Roadside & Rudral	Chamaephyte	Native	SA-SI
81		*Lepidium didymum* L.**	Garden	Therophyte	Introduced	COSM
82		*Lepidium draba* L. Synonym *(Cardaria draba* (L.) Desv.)	Roadside & Rudral	Therophyte	Native	ME + IR-TR +SA
83		*Lepidium sativum* L.**	Garden	Therophyte	Native	COSM
84		*Morettia canescens* Boiss.	In Both	Chamaephyte	Native	SA
85		*Mutarda arvensis* (L.) D.A.German Synonym *(Sinapis arvensis* L.)	Roadside & Rudral	Therophyte	Native	ME
87		*Notoceras bicorne* (Aiton) Amo	In Both	Therophyte	Native	SA-SI+ SA
88		*Raphanus raphanistrum* L.**	Roadside & Rudral	Therophyte	Introduced	ME + ER-SI
89		*Savignya parviflora* (Delile) Webb	In Both	Therophyte	Native	SA-SI + IR-TR
90		*Sinapis alba* L.*	Roadside & Rudral	Therophyte	Native	ER-SI - ME - IR-TR
91		*Sisymbrium irio* L.	In Both	Therophyte	Native	ME + SA-SI + IR-TR + ER-SI
92		*Sisymbrium orientale* L.	Roadside & Rudral	Therophyte	Native	ME + IR-TR
93		*Zilla spinosa* (L.) Prantl	Roadside & Rudral	Chamaephyte	Native	SA
94	**Capparaceae**	*Capparis spinosa* L.	Roadside & Rudral	Chamaephyte	Native	SA+ IR-TR
95	**Caryophyllaceae**	*Arenaria leptoclados* (Rchb.) Guss *	Roadside & Rudral	Therophyte	Native	ER-SI + ME + IR-TR
96		*Gymnocarpos decander* Forssk.	Roadside & Rudral	Chamaephyte	Native	SA
97		*Gymnocarpos sclerocephalus* (Decne.) Dahlgren & Thulin *	Roadside & Rudral	Therophyte	Native	ME + SA-SI + IR-TR
98		*Herniaria hirsuta* L.	Roadside & Rudral	Hemicryptophyte	Native	ER-SI + ME + IR-TR
99		*Paronychia arabica* (L.) DC.	Roadside & Rudral	Therophyte	Native	ME + SA-SI
100		*Paronychia argentea* Lam.	Roadside & Rudral	Hemicryptophyte	Introduced	ME
101		*Paronychia capitata* (L.) Lam	Roadside & Rudral	Hemicryptophyte	Newly Introduced	ME
102		*Polycarpon tetraphyllum* (L.) L.	Roadside & Rudral	Therophyte	native	ME+ ER-SI
103		Pteranthus *dichotomus* Forssk.	Roadside & Rudral	Therophyte	Native	ME + SA + IR-TR
104		*Spergula arvensis* L.	In Both	Therophyte	Introduced	ME + ER-SI
105		*Spergularia flaccida* (Madden) I.M.Turner	In Both	Therophyte	Native	SA+SA-SI
106		*Spergularia marina* (L.) Besser	In Both	Therophyte	native	ER-SI + ME + IR-TR
107	**Cistaceae**	*Helianthemum ledifolium* (L.) Mill.	Roadside & Rudral	Therophyte	Native	ME
108		*Helianthemum lippii* (L.) Dum.Cours.	Roadside & Rudral	Chamaephyte	Native	SA-SI + S-Z
109	**Convolvulaceae**	*Convolvulus arvensis* L.	In Both	Hemicryptophyte	Native	COSM
110		*Cressa cretica* L.	Roadside & Rudral	Hemicryptophyte	Native	ME + IR-TR
111		*Cuscuta campestris* Yunck. **	Garden	Parasite	Introduced	Neotropics
112		*Cuscuta pedicellata* Ledeb. **	Garden	Parasite	Native	IR-TR
113		*Cuscuta planiflora* Ten.	In Both	Parasite	Native	ME + SA
114		*Dichondra micrantha* Urb. **	garden	Chamaephyte	Introduced	Neotropics
115		*Ipomoea cairica* (L.) *	In Both	Hemicryptophyte	Native	S-Z
116	**Cucurbitaceae**	*Citrullus colocynthis* (L.) Schrad.	Roadside & Rudral	Hemicryptophyte	Native	ME+SA-SI + IR-TR+ S-Z
117	**Euphorbiaceae**	*Chrozophora oblongifolia* (Delile) A.Juss. ex Spreng. *	Roadside & Rudral	Chamaephyte	Native	SA+ SA-SI

118		*Chrozophora tinctoria* (L.) A.Juss.	Roadside & Rudral	Therophyte	Native	ME + IR-TR
119		*Euphorbia chamaesyce* L. *	Garden	Therophyte	Native	ME + IR-TR
120		*Euphorbia granulata* Forssk.	In Both	Therophyte	Native	SA+ SA-SI + IR-TR
121		*Euphorbia hirta* L.	In Both	Therophyte	Introduced	Neotropics
122		*Euphorbia hypericifolia* L.**	garden	Therophyte	Introduced	Neotropics
123		*Euphorbia nutans* Lag. **	In Both	Therophyte	Introduced	PAN
124		*Euphorbia peplus* L.	In Both	Therophyte	Native	COSM
125		*Euphorbia prostrata* Aiton	In Both	Therophyte	Introduced	Neotropics
126		*Euphorbia serpens* Kunth	In Both	Therophyte	Introduced	Neotropics
127		*Ricinus communis* L.	Roadside & Rudral	Phanerophyte	Introduced	PAL
128	**Fabaceae**	*Astragalus bombycinus* Boiss	Roadside & Rudral	Therophyte	Native	SA-SI+ IR-TR
129		*Indigofera coerulea* Roxb. *	In Both	Phanerophyte	Native	S-Z
130		*Medicago laciniata* (L.) Mill.	In Both	Therophyte	Native	SA-SI
131		*Melilotus indicus* (L.) All	In Both	Therophyte	Native	PAL
132		*Neltuma juliflora* (Sw.) Raf.	In Both	Phanerophyte	Introduced	PAN
133		*Parkinsonia aculeata* L.	In Both	Phanerophyte	Introduced	PAN
134		*Senna italica* Mill.	In Both	Chamaephyte	Native	SA-SI + S-Z
135		*Trifolium repens* L. **	In Both	Hemicryptophyte	Introduced	ER-SI+ ME - IR-TR
136		*Trigonella glabra* subsp. *glabra* Synonym (*Trigonella hamosa* L.)	In Both	Therophyte	Native	SA-SI + IR-TR
137		*Trigonella laciniata* L.	In Both	Therophyte	Native	ME + SA-SI + IR-TR
138		*Trigonella stellata* Forssk.	In Both	Therophyte	Native	SA
139		*Vachellia farnesiana* (L.) Wight & Arn. **	In Both	Phanerophyte	Introduced	PAN
140		*Vachellia gerrardi* (Benth.) P.J.H.Hurter	In Both	Phanerophyte	Native	S-Z
141		*Vachellia seyal* (Delile) P.J.H.Hurter	Roadside & Rudral	Phanerophyte	Native	SA-SI+ S-Z
142		*Vachellia tortilis* (Forssk.) Galasso & Banfi	Roadside & Rudral	Phanerophyte	Native	PAL
143	**Geraniaceae**	*Erodium cicutarium* (L.) L'Hér.	Roadside & Rudral	Therophyte	Native	ER-SI + ME + IR-TR
144		*Erodium laciniatum* (Cav.) Willd.	Roadside & Rudral	Therophyte	Native	ME
145	**Lamiaceae**	*Mentha spicata* L.	In Both	Hemicryptophyt e	Native	ER-SI + ME - IR-TR
146		*Salvia spinosa subsp. spinosa*	Roadside & Rudral	Chamaephyte	Native	SA
147	**Malvaceae**	*Malva neglecta* Wallr. *	In Both	Therophyte	Native	Eu-SI+ Me + IR-TR
148		*Malva parviflora* L.	In Both	Therophyte	Native	ME + IR-TR
149	**Nitrariaceae**	*Peganum harmala* L.	Roadside & Rudral	Hemicryptophyte	Native	IR-TR + SA
150	**Nyctaginaceae**	*Boerhavia diffusa* L.	In Both	Chamaephyte	Native	SA-SI + S-Z
151	**Oxalidaceae**	*Oxalis corniculata* L.	Garden	Therophyte	Introduced	COSM
152		*Oxalis violacea* L. **	Garden	Geophyte	Introduced	PAN
153	**Phyllanthaceae**	*Andrachne aspera* Spreng.	In Both	Chamaephyte	Native	SA-SI + S-Z
154	**Plantaginaceae**	*Plantago amplexicaulis* Cav.	In Both	Therophyte	Native	SA
155		*Plantago ciliata Desf.*	Roadside & Rudral	Therophyte	Native	SA
156		*Plantago lanceolata* L. *	Roadside & Rudral	Hemicryptophyte	Native	ER-SI + ME + IR-TR
157		*Plantago major* L. *	Garden	Therophyte	Native	COSM
158		*Plantago ovata* Forssk.	In Both	Therophyte	Native	IR-TR + SA
159		*Veronica agrestis* L. **	In Both	Chamaephyte	Introduced	ER-SI + ME
160		*Veronica polita* Fr. *	Garden	Therophyte	Native	ER-SI + ME + IR-TR
161	**Polygonaceae**	*Polygonum aviculare* L.	Roadside & Rudral	Therophyte	Native	ME+ IR-TR+ ER-SR
162		*Polygonum bellardii* All.	Roadside & Rudral	Therophyte	Introduced	ME + IR-TR
163		*Polygonum arenastrum* Boreau	Roadside & Rudral	Therophyte	Introduced	PAN
164		*Rumex dentatus* L. *	Garden	Therophyte	Native	ME+ IR-TR+ ER-SR
165		*Rumex vesicarius* L.	Garden	Therophyte	Native	SA
166	**Portulacaceae**	*Portulaca oleracea* L.	In Both	Therophyte	Native	COSM
167		*Portulaca pilosa* L. **	Garden	Therophyte	Introduced	PAN
168	**Primulaceae**	*Lysimachia arvensis (L.) U.Manns & Anderb.* Synonym *(Anagallis arvensis* L.)	In Both	Therophyte	Native	ER-SI + ME + IR-TR
169		*Lysimachia foemina* (Mill.) U.Manns & Anderb.	In Both	Therophyte	Native	ME+ ER-SI
170	**Resedaceae**	*Caylusea hexagyna* (Forssk.) M.L.Green	Roadside & Rudral	Therophyte	Native	SA-SI
171		*Ochradenus baccatus* Delile	Roadside & Rudral	Phanerophyte	Native	SA-SI
172		*Oligomeris linifolia* (Vahl ex Hornem.) J.F.Macbr.	In Both	Therophyte	Native	PAN
173	**Rhamnaceae**	*Ziziphus spina-christi* (L.) Desf.	In Both	Phanerophyte	Native	SA-SI
174	**Rubiaceae**	*Oldenlandia capensis* L.f.	Roadside & Rudral	Therophyte	Native	PAL
175	**Rutaceae**	*Haplophyllum tuberculatum* (Forssk.) A.Juss.	Roadside & Rudral	Chamaephyte	Native	SA
176		*Datura innoxia* Mill.	Roadside & Rudral	Therophyte	Introduced	PAN
177		*Hyoscyamus albus* L. *	Roadside & Rudral	Therophyte	Native	ME
178	**Solanaceae**	*Solanum nigrum* L.	In Both	Hemicryptophyte	Native	COSM
179		*Solanum villosum* Mill.	In Both	Hemicryptophyte	Native	ME+IR-TR+ ER-SR
180		*Withania somnifera* (L.) Dunal	In Both	Chamaephyte	Native	ME + IR-TR
181	**Tamaricaceae**	*Tamarix amplexicaulis* Ehrenb. **	In Both	Phanerophyte	Introduced	SA
182		*Tamarix aphylla* (L.) H.Karst.	Roadside & Rudral	Phanerophyte	Native	SA-SI + S-Z
183		Tamarix nilotica (Ehrenb.) Bunge	Roadside & Rudral	Phanerophyte	Native	SA + S-Z
184	**Typhaceae**	*Typha domingensis* Pers.	Roadside & Rudral	Helophyte	Native	ME + IR-TR+ SA
185	**Urticaceae**	*Forsskaolea tenacissima* L.	In Both	Hemicryptophyte	Native	SA-SI + S-Z
186		*Parietaria alsinefolia* Delile	Roadside & Rudral	Therophyte	Introduced	SA
187	**Verbenaceae**	*Phyla nodiflora* (L.) Greene	Garden	Hemicryptophyte	Native	PAN

188	**Zygophyllaceae**	*Tribulus pentandrus* Forssk.	Garden	Therophyte	Native	S-Z+ SA-SI
189		*Tribulus terrestris* L.	In Both	Therophyte	Native	COSM
190		*Zygophyllum album* L.f.	Roadside & Rudral	Chamaephyte	Native	SA
191		*Zygophyllum bruguieri* (DC.) Christenh. & Byng Synonym *(Fagonia bruguieri DC.)*	In Both	Chamaephyte	Native	SA
192		*Zygophyllum glutinosum* (Delile) *Christenh.* & Byng Synonym (*Fagonia glutinos*a Delile)	In Both	Chamaephyte	Native	SA
193		*Zygophyllum indicum* (Burm.f.) Christenh. & Byng Synonym (*Fagonia indica* Burm.f.)	In Both	Therophyte	Native	PAN
194		*Zygophyllum* mayanum (Schltdl.) Christenh. & Byng*** Synonym (*Fagonia isotrich*a Murb.)	In Both	Therophyte	Newly Introduced	PAL
195		*Zygophyllum olivieri* (DC.) Christenh. & Byng Synonym (*Fagonia olivieri* DC.)	In Both	Chamaephyte	Native	SA
196		*Zygophyllum simplex* L.	In Both	Therophyte	Native	SA-SI + S-Z
197	**Asphodelaceae**	*Asphodelus fistulosus* L.	Roadside & Rudral	Hemicryptophyte	Native	ME
198	**Cyperaceae**	*Cyperus rotundus* L.	Garden	Geophyte	Native	PAN
199	**Poaceae**	*Aegialina* pumila (Lam.) Quintanar & Barberá Synonym (*Rostraria pumila* (Lam.) Tzvelev)	Garden	Therophyte	Native	IR-TR + SA
200		*Aegilops kotschyi* Boiss.	Roadside & Rudral	Therophyte	Native	ME + IR-TR
201		*Andropogon distachyos* L. *	Roadside & Rudral	Hemicryptophyte	Native	COSM
202		*Aristida adscensionis* L.	Roadside & Rudral	Therophyte	Native	PAN
203		*Avena fatua* L.	Roadside & Rudral	Therophyte	Native	COSM
204		*Avena sterilis* L.	In Both	Therophyte	Native	ME + IR-TR
205		*Bromus catharticus* Vahl **	In Both	Therophyte	Introduced	ER-SI + ME + IR-TR
206		*Bromus diandrus* Roth	Roadside & Rudral	Therophyte	Native	ME
207		*Cenchrus biflorus* Roxb. *	In Both	Therophyte	Native	PAL
208		*Cenchrus ciliaris* L.	In Both	Hemicryptophyte	Native	SA
209		*Cenchrus pennisetiformis* Steud.	Roadside & Rudral	Therophyte	Native	PAL
210		*Cenchrus setaceus* (Forssk.) Morrone *	Roadside & Rudral	Hemicryptophyte	Native	SA
211		*Chloris barbata* Sw.*	Roadside & Rudral	Hemicryptophyte	Native	SA-SI + S-Z
212		*Chloris pycnothrix* Trin. **	Roadside & Rudral	Therophyte	Introduced	PAN
213		*Cynodon dactylon* (L.) Pers.	In Both	Geophyte	Native	COSM
214		*Dactyloctenium aegyptium* (L.) Willd. *	In Both	Therophyte	Native	PAL
15		*Dichanthium annulatum* (Forssk.) Stapf	In Both	Hemicryptophyte	Native	PAL
216		*Diplachne fusca* (L.) P.Beauv. ex Roem. & Schult. *	Roadside & Rudral	Hemicryptophyte	Native	PAL
217		*Echinochloa colona* (L.) Link	In Both	Therophyte	Native	PAN
218		*Echinochloa crus-galli* (L.) P.Beauv. *	Roadside & Rudral	Therophyte	Native	ME + IR-TR
219		*Eleusine indica* (L.) Gaertn.	In Both	Therophyte	Native	PAN
220		*Eragrostis cilianensis* (All.) Janch	Roadside & Rudral	Therophyte	Native	COSM
221		*Eragrostis minor* Host	Roadside & Rudral	Therophyte	Native	ER-SI + ME + IR-TR
222		*Hordeum marinum* Huds. *	Roadside & Rudral	Therophyte	Native	ME + IR-TR
223		*Hordeum murinum* L.	Roadside & Rudral	Therophyte	Native	ME + IR-TR
224		*Hyparrhenia hirta* (L.) Stapf	In Both	Geophyte	Native	ME + IR-TR + SA
225		*Lolium perenne* L.	In Both	Hemicryptophyte	Introduced	ER-SI + ME + IR-TR
226		*Lolium rigidum* Gaudin	Roadside & Rudral	Therophyte	Native	ME + IR-TR
227		*Melica persica* Kunth *	Roadside & Rudral	Hemicryptophyte	Native	ME + IR-TR
228		*Moorochloa eruciformis (Sm.) Veldkamp * Synonym (Brachiaria eruciformis (Sm.) Griseb.)*	Roadside & Rudral	Therophyte	Native	PAN
229		*Panicum repens* L.**	Roadside & Rudral	Hemicryptophyte	Introduced	COSM
230		*Panicum turgidum* Forssk.	Roadside & Rudral	Hemicryptophyte	Native	SA + S-Z
231		*Phragmites australis* (Cav.) Trin. ex Steud.	Roadside & Rudral	Geophyte	Native	COSM
232		*Poa annua* L.	In Both	Therophyte	Native	ER-SI + ME + IR-TR
233		*Poa pratensis* L.***	Roadside & Rudral	Therophyte	Newly Introduced	ER-SI + ME + IR-TR
234		*Polypogon monspeliensis* (L.) Desf.	In Both	Therophyte	Native	ME + IR-TR + SA
235		*Polypogon viridis* (Gouan) Breistr. *	Garden	Hemicryptophyte	Native	ME + IR-TR
236		*Rostraria cristata* (L.) Tzvelev	Garden	Therophyte	Native	ME+IR-TR
237		*Schismus barbatus* (L.) Thell.	Roadside & Rudral	Therophyte	Native	IR-TR + SA
238		*Setaria pumila* (Poir.) Roem. & Schult. *	In Both	Therophyte	Native	COSM
239		*Setaria verticillata* (L.) P.Beauv.	In Both	Therophyte	Native	COSM
240		*Setaria viridis* (L.) P.Beauv.	Roadside & Rudral	Therophyte	Native	ER-SI + ME + IR-TR
241		*Sorghum halepense* (L.) Pers.	Roadside & Rudral	Geophyte	Native	S-Z
242		*Stipagrostis plumosa* (L.) Munro ex T.Anderson	Roadside & Rudral	Hemicryptophyte	Native	IR-TR + SA
243		*Stipellula capensis (Thunb.) Röser & Hamasha Synonym (Stipa capensis Thunb.)*	Roadside & Rudral	Therophyte	Native	IR-TR + SA

A list of the species recorded in the study Area, floristic categories: (Saharo–Sindian = SA–SI), (Pantropical = PAN), (Sudano–Zambesian = S–Z), (Saharo-Arabian = SA), (Cosmopolitan = COSM), (Euro–Siberian = ER–SR), (Irano–Turanian = IR–TR), (Mediterranean = ME), (Paleotropical = PAL), * native newly introduced species for Ha'il, ** newly introduced species for Hail, and *** for species new to Saudi Arabia.

The study revealed that the most species-rich genera were *Euphorbia*, with eight species; *Zygophyllum*, with seven species; *Plantago*, with four species; and *Vachellia*, with four species. The genera *Sonchus*, *Senecio*, and *Trigonella* each contained three species.

Understanding the distribution of plant species is essential for biodiversity conservation and ecosystem management. These areas face increasing challenges from human activities and climate change, which affect species ranges and community compositions (Parmesan, 2006; Bellard *et al*., 2012). Thus, it is crucial to identify regions of endemism, predict species responses to environmental changes, and assist in planning protected areas and effective resource use.

Phytogeographically, Saudi Arabia's vegetation primarily lies within the Saharo-Arabian region (Zohary, 1973). However, it also shows characteristics indicative of a transition zone influenced by Saharo-Arabian, Sindian, and Mediterranean climatic regimes (El-Sheikh *et al*., 2013; AlAklabi *et al*., 2016). Previous studies in the Ḥaʾil region noted a broad transition between the Mediterranean, Saharo-Sindian, and Saharo-Arabian regions (Turki & Al-Olayan, 2003). Phytogeographical studies of the extracted species mainly categorize them into three main chorotypes: the Saharo-Arabian, the Irano-Turanian, and the Sudanian (Al-Mutairi *et al*., 2016). Supporting this trend, studies in Wadi Arar in the Northern Region of Saudi Arabia reported that this area is regarded as a central phytogeographic transition zone, influenced by the Mediterranean, Irano-Turanian, Saharo-Sindian, Saharo-Arabian, and Sudan-Zambezian floristic regions, as evidenced by its flora representation (Osman *et al*., 2014).

The current study's phytogeographic assessment revealed a clear dominance of species with Saharo-Arabian affinities (13.2%, 32 species). Subsequent representation included species with Euro-Siberian, Mediterranean, and Irano-Turanian affinities (11.5%, 28 species), followed by Cosmopolitan (10.3%, 25 species) and combined Mediterranean/Irano-Turanian elements (9.9%, 42 species). Pantropical species constituted 9.1% (22 species), while the combined Saharo-Sindian/Sudano-Zambezian affinities accounted for 7% (17 species), and Paleotropical elements represented 4.9% (12 species). Minor representation was observed for Saharo-Sindian and Neotropical elements (2.9%, seven species each), Mediterranean/Euro-Siberian, Sudano-Zambezian, and combined Mediterranean/Irano-Turanian/Saharo-Arabian affinities (2.5%, six species each), along with Mediterranean/Irano-Turanian/Saharo-Sindian affinities (2.1%, five species). Further diminishing proportions included Saharo-Sindian/Irano-Turanian and Mediterranean/ Saharo-Arabian affinities (1.7%, four species each), as well as Saharo-Arabian/Sudano-Zambezian and Irano-Turanian affinities (1.2%, three species each). Notably sparse (1.2%, three species each) were Irano-Turanian species and those with combined Saharo-Arabian/Sudano-Zambezian and Saharo-Arabian/Saharo-Sindian affinities, while Mediterranean/Saharo-Sindian (0.8%, two species). Single species (0.4% each) exhibited with complex affinities: Euro-Siberian/Mediterranean/Irano-Turanian/Saharo-Sindian, Irano-Turanian/Euro-Siberian, Saharo-Sindian/ Irano-Turanian/ Sudano-Zambezian, Mediterranean/Irano-Turanian/ Saharo-Sindian/Sudano-Zambezian, and Saharo-Arabian/Saharo-Sindian/Irano-Turanian (Fig. 4).

According to Al-Turki & Al-Olayan (2003), the northern region is an ecological contact zone with distinct phytogeographic links to Mediterranean, Irano-Turanian, Saharo-Sindian, Saharo-Arabian, and Sudano-Zambezian floristic zones. The emergence of cosmopolitan, pantropical, palaeotropical, euro-Siberian, and Sudanian elements demonstrates varied abundances in the flora of this region, reflecting their diverse colonization abilities within this transitional environment.

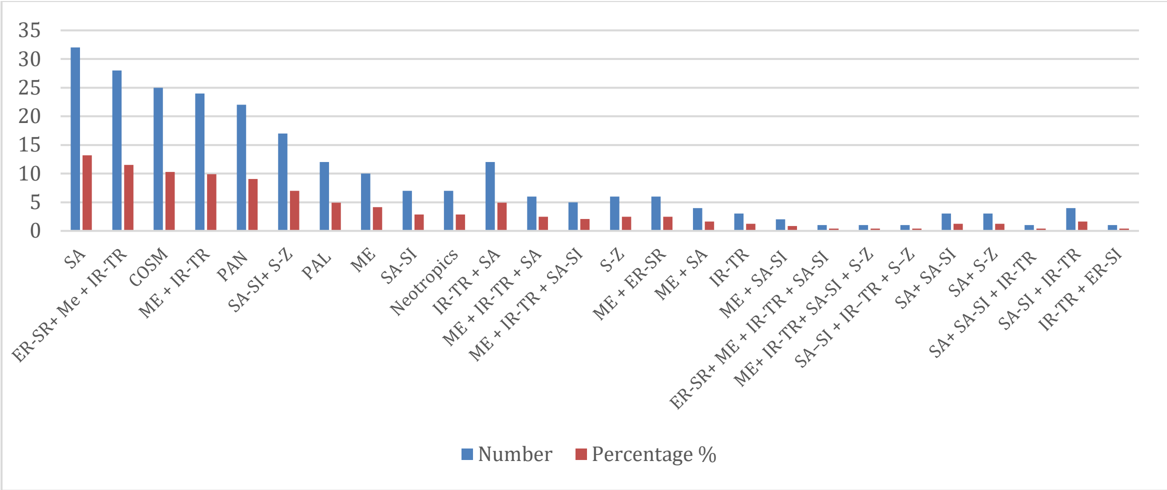

Fig. 4: Phytogeographical distribution pattern of recorded species in the survey area.

The study area is characterized by a significant richness of native plant species, representing approximately 77.8% of its total vascular flora. The floristic inventory identified 189 indigenous species and 46 known introduced species (18.9%), while noting the presence of 29 newly introduced species compared to earlier inventories of this region. Among these, eight species were newly recorded for Saudi Arabia, comprising 3.3% of the overall species pool (Fig. 5). The 189 native species included 41 newly introduced native species to the Ha'il region.

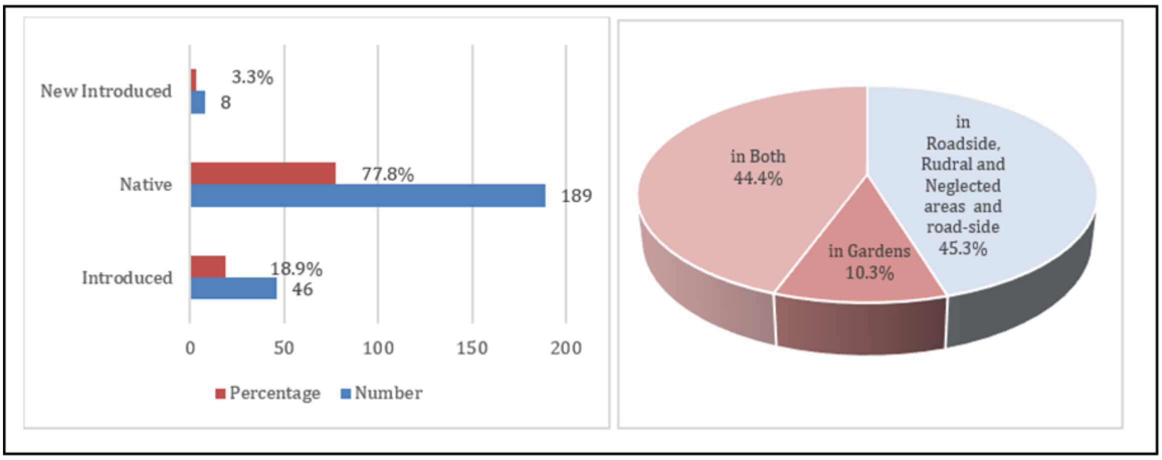

Fig. 5: Species composition by habitat and origin. (a) Distribution of native, introduced, and newly introduced species. (b) Species richness across roadside, ruderal, neglected, and garden sites.

Saudi Arabia currently harbors 55 documented alien plant species, most of which have restricted distributions (≤ 2% cover). However, modeling indicates a rapid potential expansion to 10-15% coverage in affected areas (Alfarhan *et al*., 2021). Thomas *et al*. (2016) identified 48 exotic species in the Kingdom, among which only six – *Argemone mexicana* L., *Nicotiana glauca* Graham, *Oenothera dillenii*, *Opuntia ficus-indica* (L.) Mill., *Prosopis juliflora*, and *Trianthema Portulacastrum L. demonstrates negative impacts on local habitats and native species richness.* Regional studies have further highlighted the detrimental effects of specific invasive species: *Calotropis procera* (Aiton) W.T. Aiton in Taif region negatively affects floristic composition and associated plant communities, the invasive shrub *N. glauca* reduces species richness and evenness in Taif region, western Saudi Arabia (Alharthi *et al*., 2021). Aljeddani *et al*. (2021) reported 42 alien plant species from

15 families across 11 Saudi governorates. Additionally, *Cylindropuntia rosea* (DC.) Backeb. was newly reported as a significant invasive cactus near Jebel Hizna, in the Baljurashi region of southwestern Saudi Arabia (Al-Robai *et al*., 2018).

Considering the inevitable need for more inclusive data, especially in Saudi regions that are highly vulnerable to alien invasion, this study explores the diversity of invasive alien species within a section of the north-central region of Ḥaʾil governorate. This area has served as a historical route for Iraqi and Jordanian pilgrims, possibly contributing to the introduction of exotic species. In this work, the percentage of plant species exclusive to roadside, abandoned, and rural habitats (45.3%, 110 species, mainly therophytes, 57 species) was higher than that exclusive to gardens (10.3%, 25 species, mainly therophytes, 17 species). However, species in both habitats accounted for 44.4%, comprising 108 species, predominantly therophytes (67 species). The dominance of therophytes can also be explained by the fact that native and alien therophytes consistently react positively to increasing mean annual temperatures (Hulme, 2009; 2011). The relationship with human population density was similarly positive for both groups, suggesting that annual life cycles provide an advantage in anthropogenic environments for both native and introduced taxa, possibly due to increased dispersal and more rapid resource exploitation following disturbance (McIntyre *et al*., 1995; Thompson & McCarthy, 2008). According to Aljeddani *et al.* (2021) and Thomas (2024), the following species are considered invasive: *Conyza bonariensis* (L.) Cronq., *Datura innoxia* Mill., *Euphorbia prostrata* Aiton, *Heliotropium curassavicum* L., *Lysimachia arvensis* subsp. *arvensis*, *Parkinsonia aculeata* L., *Phragmites australis* (Cav.) Steud., *Prosopis juliflora* (Sw.) DC., Verbesina encelioides (Cav.) A. Gray, in addition to *Calotropis procera* (Aiton), *Euphorbia hypericifolia* L., *Euphorbia hirta* L., and *Ricinus communis* L. (Thomas *et al*., 2021). These species have been detected in our floristic survey in the study region.

Thomas *et al*. (2016) identified several introduced species in Saudi Arabia as invasive, with a notable prevalence of American origin. These include *Heliotropium curassavicum* L. (Boraginaceae), an herbaceous species of American origin documented as invasive in the Eastern, Central, and Southwestern regions of Saudi Arabia; *Prosopis juliflora* (Sw.) DC. (Leguminosae), a South American invasive tree reported across all regions of Saudi Arabia; *Euphorbia prostrata* Aiton (Euphorbiaceae), an American herb documented as invasive in the Central region; and *Euphorbia hirta* L. (Euphorbiaceae), along with *Datura innoxia*, *Erigeron bonariensis*, and *Cenchrus setaceus* (Forssk.) Morrone, which have been identified as invasive alien species observed in the present study and have previously been documented as invasive throughout Saudi Arabia. This confirms their widespread establishment across various habitats within the region. *Prosopis juliflora* is considered one of the exotic species recorded in Saudi Arabia that has caused numerous problems (Thomas *et al*., 2016). Native plant biodiversity in Saudi Arabia faces significant challenges from various anthropogenic factors. The encroachment of invasive species, such as *Prosopis juliflora*, and the spread of introduced agricultural flora actively displaces native vegetation. These pressures, compounded by habitat loss, have contributed to the extinction of several endemic and non-endemic plant species (Collenette, 1999; Hall *et al*., 2008).

In the current study, 70 identified species are considered new floristic records for the Ḥaʾil region, including 29 newly introduced species; eight of these species constitute novel additions to the documented flora of both Ḥaʾil and Saudi Arabia and are regarded as new alien species. Conversely, of the 189 indigenous species, there are 41 native species whose occurrence is documented for the first time in Ḥaʾil province, representing several native taxa within 14 families, including one species from the family Aizoaceae (*Zaleya pentandra* (L.) Jeffrey) and seven species from the Amaranthaceae family (*Anabasis articulata* (Forssk.) Moq, *Atriplex halimus* L., *Caroxylon vermiculatum* (L.) Akhani & Roalson (*Salsola vermiculata* L.), *Chenopodium ficifolium* Sm., *Ouret lanata* (L.) Kuntze

(*Aerva lanata* (L.) Juss. ex Schult.), *Salicornia fruticosa* (L.) L., *Suaeda monoica* Forssk. ex J.F.Gmel.). The Apiaceae family includes *Torilis nodosa* (L.) Gaertn, the family Asteraceae features *Centaurea hyalolepis* Boiss., *Otoglyphis factorovskyi* (Warb. & Eig), *Sonchus tenerrimus* L., and *Echinops galalensis* Schweinf Gaertn., while the Brassicaceae family encompasses *Mutarda arvensis* L.) D.A. German (*Sinapis arvensis* L.) and *Sinapis alba* L., together with the Caryophyllaceae family (*Arenaria leptoclados* (Rchb.) Guss and *Gymnocarpos sclerocephalus* (Decne.) Dahlgren & Thulin), and the family Convolvulaceae (*Ipomoea cairica* (L.)). Additionally, the family Euphorbiaceae includes *Chrozophora oblongifolia* (Delile) A.Juss. ex Spreng. and *Euphorbia chamaesyce* L., the Fabaceae family contains *Indigofera coerulea* Roxb, the Malvaceae family consists of *Malva neglecta* Wallr, the Plantaginaceae family comprises *Plantago lanceolata* L., *Plantago major* L., and *Veronica polita* Fr., while the Polygonaceae family includes *Polygonum a*viculare L. and *Rumex dentatus* L. Among other families, the Solanaceae family includes *Hyoscyamus albus* L., and the Poaceae family features *Andropogon distachyos* L., *Bromus diandrus* Roth, *Cenchrus biflorus* Roxb., *Cenchrus setaceus* (Forssk.) Morrone (invasive, Thomas *et al*., 2016), *Chloris barbata* Sw, *Dactyloctenium aegyptium* (L.) Willd., *Diplachne fusca* (L.) P.Beauv. ex Roem. & Schult., *Echinochloa crus-galli* (L.) P.Beauv., *Hordeum marinum* Huds., *Melica persica* Kunth, *Moorochloa eruciformis* (Sm.) Veldkamp, *Polypogon viridis* (Gouan) Breistr., and *Setaria pumila* (Poir.) Roem. & Schult.

21 documented plant species in this study have been previously introduced as alien species in other parts of Saudi Arabia; the following have been detected for the first time in the study region *Acanthospermum hispidum* DC., *Chondrilla juncea* L., *Filago arvensis* L., *Senecio vulgaris* L., *Symphyotrichum squamatum* (Spreng.) G.L.Nesom, *Tripleurospermum caucasicum* (Willd.) Hayek, *Verbesina encelioides* (Cav.) A. Gray (invasive, Thomas, 2024) (Family Asteraceae), *Lepidium sativum* L., *Diplotaxis viminea* (L.) DC., *Eruca vesicaria* (L.) Cav., *Lepidium didymum* L., *Raphanus raphanistrum* L. (Family Brassicaceae), *Cuscuta campestris* Yunck. (Invasive, Thomas, 2024), *Dichondra micrantha* Urb. (Family Convolvulaceae), *Euphorbia hypericifolia* L., and *Euphorbia nutans* Lag. (Family Euphorbiaceae), *Trifolium repens* L. and *Vachellia farnesiana* (L.) Wight & Arn. (Family Fabaceae), *Oxalis violacea* L. (Family Oxalidaceae), *Tamarix amplexicaulis* Ehrenb (Family Tamaricaceae), *Chloris pycnothrix* Trin. (Family Poaceae).

The following eight species represent new records for Saudi Arabia, specifically within the Ha’il region: *Crepis pulchra* L., *Gazania rigens* (L.) Gaertn. (escaped from cultivation as an ornamental plant), *Matricaria chamomilla* L., *Sphagneticola trilobata* (L.) Pruskib (Family Asteraceae), *Heliotropium europaeum L.* (Family Boraginaceae), *Paronychia capitata* (L.) Lam. (Family Caryophyllaceae), *Zygophyllum mayanum* (Schltdl.) Christenh. & Byng (formerly *Fagonia isotricha* Murb.) (Family Zygophyllaceae), and *Poa pratensis* L. (Family Poaceae).

In the current study, a large group of the detected plant species (most flora) was restricted to roadsides, rural areas, and waste places. This observation aligns with the previously reported abundance of stress-tolerant and ruderal species in these habitats, which are characterized by poor soils, high pollution levels, and water stress (Grime, 2001; Bradshaw, 1984; Pyšek *et al*., 2004). A strong positive relationship between real estate gross state product and the number of exotic species was illustrated by Taylor & Irwin (2004). This indicates that the real estate industry (such as constructing infrastructure [i.e., roads] and landscaping with exotic ornamental plants) enables non-native species to establish and spread. Anthropogenic activities have drastically modified terrestrial and aquatic ecosystems, leading to significant consequences for species range and abundance (Vitousek *et al*., 1997; Rahel, 2000). Biological invasions—introducing and spreading non-native species in new environments are a major byproduct of these transformations, resulting in considerable economic and ecological damage and serving as a notable source of anthropogenically driven environmental change. Despite substantial floristic and vegetation research in Saudi Arabia, the extent and impact of exotic species invasions have yet to be quantified. Most existing research, primarily focused on species presence and vegetation type, lacks comprehensive information on current infestation levels and the timing of non-native species introductions. This information is vital for understanding the ecological impacts of these invasions and facilitating effective management.

The introduction and expansion of alien and invasive species pose significant threats to native ecosystems. This includes habitat degradation, alterations in food web structures, shifts in community compositions, local extinctions, reductions in native genetic diversity, and losses in ecosystem functions (Vilà *et al*., 2010; Bellard *et al*., 2016; Macˇic´ *et al*., 2018). Moreover, introducing these species can lead to substantial socio-economic costs if ecosystem services are diminished and human welfare is compromised (Vilà & Hulme, 2017). Additionally, the Convention on Biological Diversity (CBD, 2022) highlights the ecological impact of invasive alien species, considering them one of the primary factors driving global biodiversity loss. This will enhance understanding and comparison of the exotic flora in the Ḥaʾil Province by providing new information regarding the regional flora, assisting with ecological management, and mitigating the impact of the recorded invasive exotics. Biodiversity surveys are crucial for acquiring plant distribution data necessary to map and model species distributions, enabling analyses and predictions of their responses to global climatic change (Hall & Miller, 2010).

CONCLUSION

This study aimed to characterize the floristic diversity and composition across roadside, ruderal, neglected areas, and gardens as human-managed cultivated areas within Ha'il City, providing a baseline understanding of urban spontaneous vegetation. Our findings reveal a significant presence of alien and naturalized species, with a notable dominance of therophytes. The analysis identified 243 plant species belonging to 40 families, with Poaceae, Asteraceae, and Brassicaceae being the most represented families.

This study reveals 70 new species of floristic records for the Ḥaʾil region, including 29 newly introduced species. Among these, eight species are novel additions to the documented flora of both Ḥaʾil and Saudi Arabia and are considered new alien species. Additionally, 41 new native species were detected in the study area across several native taxa within 14 families.

The study highlights that urban roadside, ruderal, and neglected habitats in Ha'il City exhibit richer floristic diversity than managed areas, influenced by anthropogenic factors and climate change. It provides a new systemic perspective on regional plant diversity, including exotic flora, which should serve as a basis for controlling alien species while considering the manmade characteristics and human roles in the distribution of these plants. These lesser-known habitats are ecologically significant for urban biodiversity and ecosystem services. Although limited, our study suggests that further research must rely on extensive surveys to accurately represent ecological spectra, phenological phases, and timing patterns. Importantly, research must clarify the arrival, spread, and ecological effects of exotics on indigenous plant forms, habitat composition, soil, and ecosystem performance. Understanding the functional traits of urban plant communities is also necessary to assess their adaptive potential. For Saudi Arabian biodiversity and conservation, systematic surveys and long-term monitoring of invasion processes should be prioritized, emphasizing the development, testing, and evaluation of management strategies, including early detection, prevention, and investigation of invasion pathways. Our research is a novel and significant contribution to dryland urban ecology, highlighting the importance of spontaneous vegetation for conserving urban biodiversity and informing urban planning in Ha'il City to sustain the biodiversity of Saudi Arabia, aligning with the Global Biodiversity Framework

(GBF) and its Sustainable Development Goals (SDGs) ensures that scientific efforts directly support conservation and the sustainable use of biodiversity.

Declarations:

Ethical Approval: N.A.

Conflict of interest: The author declares no conflict of interest.

Author's Contributions: I hereby verify that the author mentioned on the title page has Contributed significantly to the idea and planning of the research, has carefully read the work, attested to the veracity and correctness of the data and its interpretation, and has given their approval for submission.

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