

Associated weeds of some agroecosystems in the Northern Border region, KSA

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Abstract

The present investigation was conducted to analyze the floristic composition of agro-ecosystem in Arar Northern Border region, KSA. A total of 30 sites were surveyed and a total of 42 taxa of weeds belonging to 21 families were recorded in agro-ecosystems in Arar. Poaceae was the most common family includes ten species, while both Asteraceae and Chenopodiaceae were characterized by four species each. The most abundant life form was therophyte represented by 30 species. From a phytogeographical point of view, Mediterranean taxa were represented by 14 species. Also, 14 species were belonging to cosmopolitan phytochoria. Several soil physical and chemical parameters were analyzed in the collected soil. Studied 30 stands were classified into two groups using TWINSpan; negative group includes 16 stands characteristic with *Lamium amplexicaule* as indicator species, while the positive group includes 14 stands and the indicator species for this group are *Trianthema portulacastrum*, *Sonchus oleraceus*, *Chenopodium murale*, *Bidens pilosa* and *Ricinus communis*.

Keywords: agro-ecosystem, weeds, twinspan, arar, northern border region, KSA

1. Introduction

Agro-ecosystem is an ecosystem which made by human activities for production of food and other valued goods as fuel, timber or fiber (Augstburger *et al.*, 2018 [11]; Wood *et al.*, 2000) [43]. Agroecosystems covered about 40 % of the world's land area (Adhikari *et al.*, 2019 [6]; Foley *et al.*, 2005) [26]. The total area of KSA with 2.15 million km² and considered as one of the largest country about Arabian Peninsula (FAO, 2008). Weeds are undesired plants grow usually associated with cultivated crops. Weeds caused significant decrease in yield production as a result of their competition with cultivated crops for water and nutrient (Dangwall *et al.* 2010) [18]. Weeds considered a most important component of agro-ecosystems. Many weeds cause a significant loss of crop yield (Kraehmer, H.; Baur, 2013) [28]. According to Abouziena and Haggag (2016) [5], the annual loss of crop production was up to 10-15%. Competition among weeds and agriculture crops and among weeds and weeds, in addition to allelopathy are involved in crop decline (Zhang *et al.*, 2015 [45]; Weston and Duke, 2003) [41]. On the other hand, many weeds have economic and medicinal uses (Zimdahl, 2007) [44].

Weeds have an energetic significance as indicator for diversity and distribution of weeds for every country, also weeds have importance for recording the variation from native to introduced or invasive weeds. Weeds can grow in different soil types in association with different cultivated plants resulted in destructive impact on crop production and environment. (Ekwealor *et al.*, 2019 [19]; Waterhouse 2003) [40]. The aim of this study is to clarify the list of weeds growing in cultivated lands of Arar, KSA to be important sight in the variation and diversity of plants, in addition to types of weeds associated with important crops in order to find suitable and effective ways to discard these unwanted weeds.

Study area

Arar is sited between lat. 30° 59' 0.0024" N and long 41° 0' 59.9976" E and the altitude reaches 555 m a.s.l. Arar is of the capital of the Northern Province of KSA and is situated north of KSA with 35.000 km². Map of the studied area illustrated in Fig.1. Climatic data of Arar region was recoded through <https://www.meteoblue.com>, the average of lower air temperature differ from 2° C in January to 23°C in July and August. The average upper air temperature differ from 16°C in January to 42°C in August (Fig. 2). The highest perception (rainfall) was 9mm found during March. The direction of wind blowing of Arar through 30 years is from South-West (SW) to North-East (NE) (Fig. 3).



Fig 1: Map of KSA illustrating Northern Border region in red color.

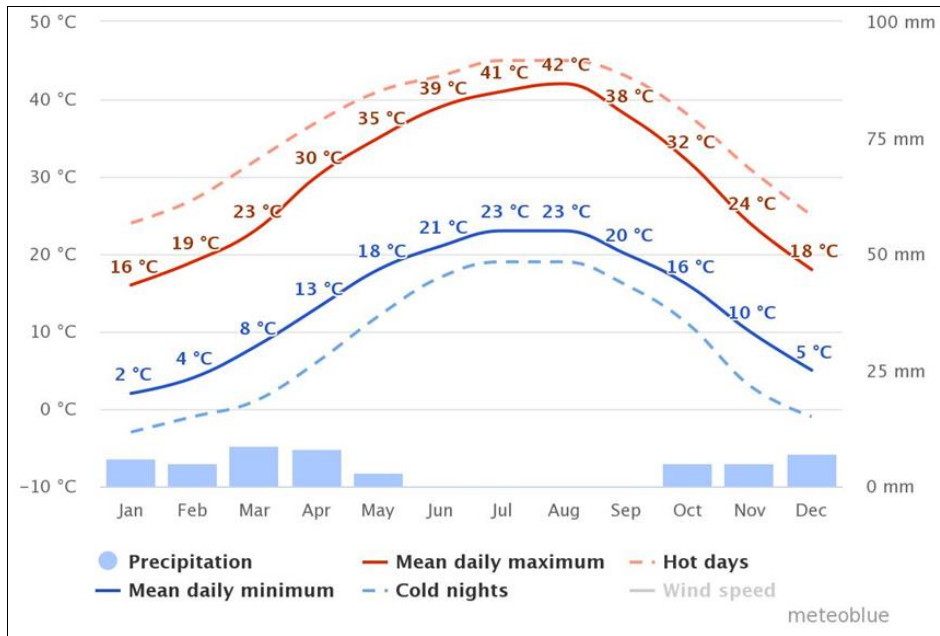


Fig 2: Average temperature and precipitation of Arar (1990-2020).

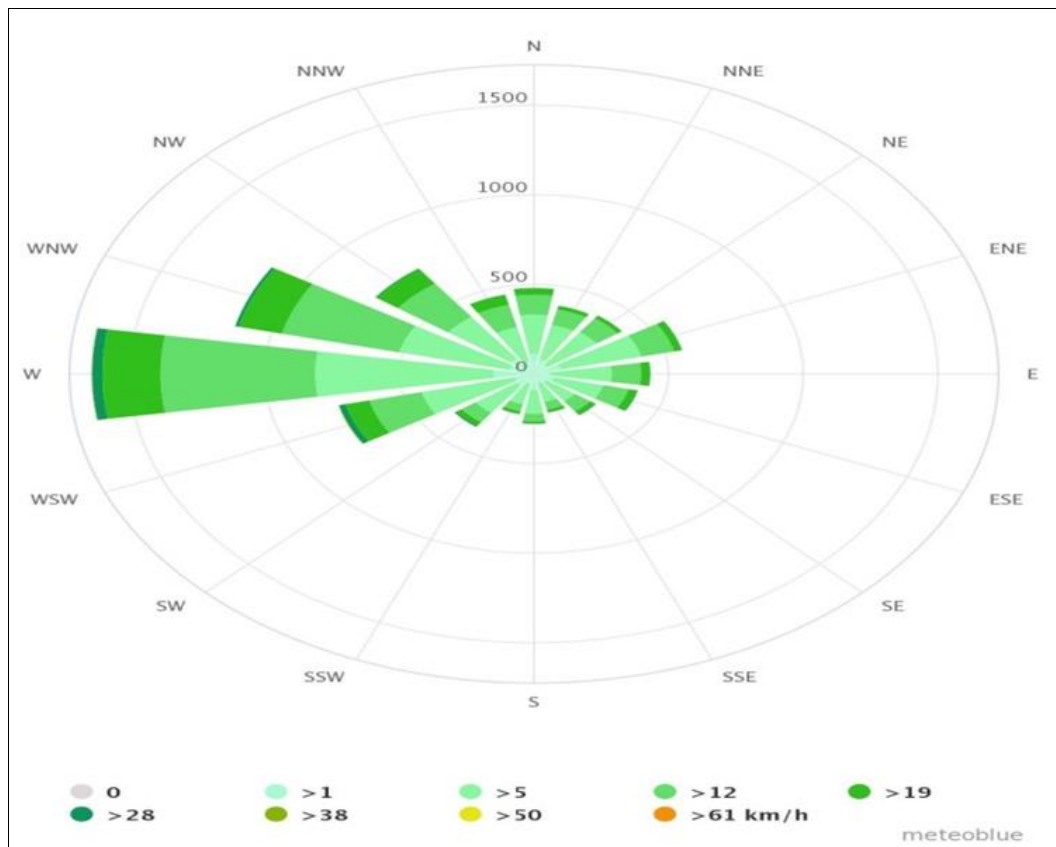


Fig 3: The wind rose for Arar (1990-2020).

Materials and methods

Vegetation analyses

Survey of some agroecosystems in Arar, Northern Border region, Saudi Arabia was conducted in February 2020. The total 30 stands under study with common crops cultivated in these locations are illustrated in Table (1). All investigated plant species present in each location were listed after identification according to Täckholm (1974) [37], and Boulos

(1999-2009) [13]. Description and life form categories were identified after Govaerts *et al.*, (2000) [27]. Phytogeographical affinities, after Tutin *et al.*, (1964-1980) [39], Townsend and Guest (1966-1985) [38], Wickens (1976) [42], and Boulos (1995, 1999, 2000, 2002, 2005) [12, 13, 14, 15, 16]. Species richness, species evenness and simpson's diversity index were calculated using PC-ORD ver. 5 program (McCune and Mefford, 1999).

Table 1: Number of studied stands and selected crops.

Crops	Number of stands
Summer squash (<i>Cucurbita pepo</i> L.)	7
Alfalfa (<i>Trifolium alexandrinum</i> L.)	5
Date Palm (<i>Phoenix dactylifera</i> L.)	2
Bean (<i>Phaseolus vulgaris</i> L.)	1
Maize (<i>Zea mays</i> L.)	9
Pear (<i>Pyrus communis</i> L.)	1
Cabbage (<i>Brassica oleracea</i> var. <i>sabellica</i>)	1
Potato (<i>Solanum tuberosum</i> L.)	4

Soil analysis

Mechanical analysis, moisture content, pH, electrical conductivity (EC), chlorides, nitrate, sodium, potassium, calcium, magnesium, organic matter and calcium carbonate were determined after Estefan *et al.* 2013.

Statistical analysis

PC-ORD program was used to perform statistical analyses and categorize of 42 taxa in 30 stands using Two Way Indicator Species Analysis (TWINSPAN) (McCune and Mefford, 1999).

Result

The study area comprises about of 42 taxa belonging to 21 families were represented in agroecosystems of Arar (Table 2). Poaceae, Asteraceae, Chenopodiaceae and Euphorbiaceae existed as the most common families with ten species, four species, four species and three species, respectively. Brassicaceae, Cyperaceae, Lamiaceae, Solanaceae were characterized by two species for each family. Only one species was characteristic for 13 families (Table 2, Fig. 4).

The majority of species were annuals (30 species), while biennial species were represented by 12 species (Table 2, Fig. 5). The most abundant life form was therophytes which constituted 71 % of total recorded species (30 species),

Geophyte (5 species = 12 %), hemicryptophytes (4 species = 9.5 %), while phanerophytes, chamaephytes and parasitic plants were represented by a single species each (Table 2, Fig. 6).

From a phytogeographical point of view, the most floristic categories were cosmopolitan species (14 species), Mediterranean–Irano–Turanian–Euro–Siberian phytochorion were represented by 8 species, Palaeotropical (8 species), Pantropical (5 species), Mediterranean–Irano–Turanian (3 species), while Mediterranean, Mediterranean–Euro–Siberian, Mediterranean–Irano–Turanian–Euro–Siberian–Saharo–Sindian and Saharo–Sindian–Sudano–Zambesian were characterized by one species each (Table 2, Fig. 7). Relations between life forms and phytogeographical affinities were showed in Fig. 8.

Species richness was calculated for each stand during spring season. Species richness with an average 5.1 species. Species evenness with an average 0.6. On the other hand, Simpson's diversity index with an average 0.5.

TWINSPAN analysis was divided into 30 stands under study two groups at the first level. The negative group includes 16 stands with indicator species *Lamium amplexicaule*. On the other hand, the second group (positive group) includes 14 stands and the indicator species for this group are *Trianthema portulacastrum*, *Sonchus oleraceus*, *Chenopodium murale*, *Bidens pilosa* and *Ricinus communis*. At the second level negative group was divided into two subgroups. The first subgroup includes five stands with indicator species *Convolvulus arvensis*, while the second group includes 11 stands and the indicator species for this group is *Chenopodium glaucum*, *Cynodon dactylon*, *Melilotus indicus* and *Digitaria sanguinalis*. The positive group was divided into two subgroups. The first subgroup includes five stands with *Chenopodium glaucum* as indicator species and the second subgroup includes nine stands and the indicator species for this group is *Cynanchum acutum* and *Melilotus indicus* (Fig. 9).

Table 2: List of associated weeds species recorded in the agroecosystems of Arar, Northern Border region, KSA.

Species	Family	Life form	Life span	Floristic categories
<i>Trianthema portulacastrum</i> L.	Aizoaceae	Th.	Ann.	PAN
<i>Amaranthus caudatus</i> L.	Amaranthaceae	Th.	Ann.	COSM
<i>Cynanchum acutum</i> L.	Asclepiadaceae	Hem.	Per.	ME+IR–TR+ER–SR
<i>Bidens pilosa</i> L.	Asteraceae	Th.	Ann.	PAN
<i>Cichorium endivia</i> L.	Asteraceae	Th.	Ann.	ME+IR–TR
<i>Pulicaria arabica</i> (L.) Cass.	Asteraceae	Cha.	Per.	SA– SI +S–Z
<i>Sonchus oleraceus</i> L.	Asteraceae	Th.	Ann.	COSM
<i>Eruca sativa</i> Mill.	Brassicaceae	Th.	Ann.	ME+IR–TR+ER–SR+SA– SI
<i>Sisymbrium irio</i> L.	Brassicaceae	Th.	Ann.	ME+IR–TR+ER–SR
<i>Beta vulgaris</i> L.	Chenopodiaceae	Th.	Ann.	ME+IR–TR+ER–SR
<i>Chenopodium album</i> L.	Chenopodiaceae	Th.	Ann.	COSM
<i>Chenopodium glaucum</i> L.	Chenopodiaceae	Th.	Ann.	ME+ER–SR
<i>Chenopodium murale</i> L.	Chenopodiaceae	Th.	Ann.	COSM
<i>Convolvulus arvensis</i> L.	Convolvulaceae	Hem.	Per.	PAL
<i>Cyperus digitatus</i> Roxb.	Cyperaceae	Geo.	Per.	ME+IR–TR+ER–SR
<i>Cyperus rotundus</i> L.	Cyperaceae	Geo.	Per.	PAN
<i>Euphorbia helioscopia</i> L.	Euphorbiaceae	Th.	Ann.	COSM
<i>Euphorbia peplus</i> L.	Euphorbiaceae	Th.	Ann.	COSM
<i>Ricinus communis</i> L.	Euphorbiaceae	Ph.	Per.	PAL
<i>Melilotus indicus</i> (L.) All.	Fabaceae	Th.	Ann.	PAL
<i>Lamium amplexicaule</i> L.	Lamiaceae	Th.	Ann.	ME+IR–TR+ER–SR
<i>Mentha longifolia</i> (L.) Huds.	Lamiaceae	Hem.	Per.	PAL
<i>Malva parviflora</i> L.	Malvaceae	Th.	Ann.	ME+IR–TR
<i>Orobancha cernua</i> Loefl.	Orobanchaceae	Par.	Per.	ME+IR–TR
<i>Oxalis corniculata</i> L.	Oxalidaceae	Th.	Ann.	COSM

<i>Avena fatua</i> L.	Poaceae	Th.	Ann.	COSM
<i>Avena sativa</i> L.	Poaceae	Th.	Ann.	COSM
<i>Cynodon dactylon</i> (L.) Pers.	Poaceae	Geo.	Per.	PAN
<i>Digitaria sanguinalis</i> (L.) Scop.	Poaceae	Th.	Ann.	PAL
<i>Dinebra retroflexa</i> (Vahl) Panz.	Poaceae	Th.	Ann.	PAL
<i>Panicum coloratum</i> L.	Poaceae	Geo.	Per.	ME
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	Poaceae	Geo.	Per.	PAL
<i>Polypogon monspeliensis</i> (L.) Desf.	Poaceae	Th.	Ann.	COSM
<i>Polypogon viridis</i> (Gouan) Breistr.	Poaceae	Th.	Ann.	ME+IR-TR+ER-SR
<i>Setaria viridis</i> (L.) P. Beauv.	Poaceae	Th.	Ann.	COSM
<i>Portulaca oleracea</i> L.	Portulacaceae	Th.	Ann.	COSM
<i>Anagallis arvensis</i> L.	Primulaceae	Th.	Ann.	COSM
<i>Solanum nigrum</i> L.	Solanaceae	Th.	Ann.	COSM
<i>Solanum villosum</i> (L.) Mill.	Solanaceae	Th.	Ann.	ME+IR-TR+ER-SR
<i>Corchorus olitorius</i> L.	Tiliaceae	Th.	Ann.	PAN
<i>Urtica urens</i> L.	Urticaceae	Th.	Ann.	ME+IR-TR+ER-SR
<i>Phyla nodiflora</i> (L.) Greene	Verbenaceae	Hem.	Per.	PAL

life span; Annual=Ann, Perennial=Per., life forms; Therophyte=Th, Hemicryptophyte=Hem, Chamaephyte=Cha, Phanerophyte=Ph, Parasite=Par, Geophyte=Geo. Phyto-geographical affinities; COSM=Cosmopolitan, ER-SR=Euro-Siberian, IR-TR= Irano-Turanian, ME=Mediterranean, PAL=Paleotropical, PAN=Pantropical, SA-SI=Saharo-Sindian, S-Z=Sudano-Zambesian.

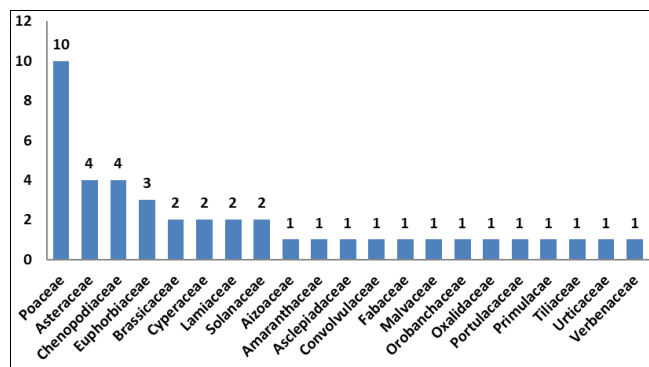


Fig 4: Graphical representation of angiosperm families according to the numbers of the species collected from agroecosystems, Arar, Northern Border region, KSA.

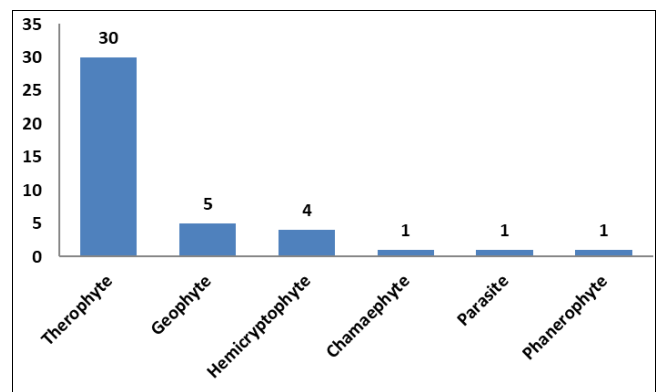


Fig 6: Life forms of plant species in agroecosystems, Arar, Northern Border region, KSA.

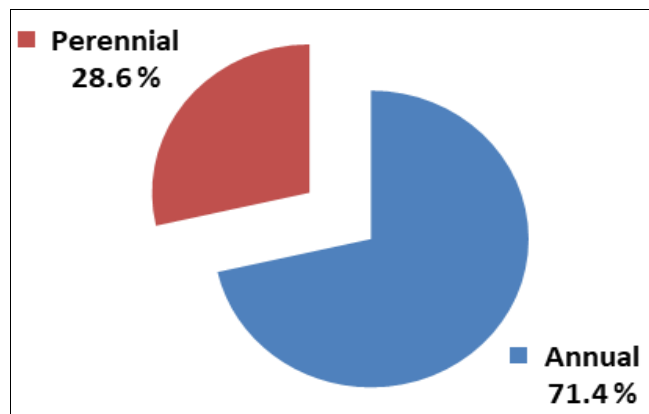


Fig 5: Life span of plant species in agroecosystems, Arar, Northern Border region, KSA.

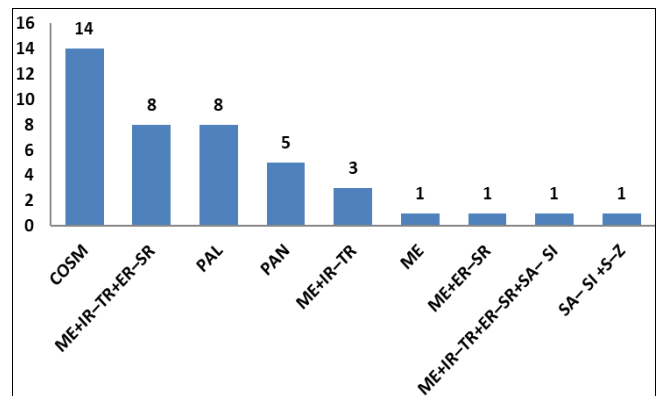


Fig 7: Floristic categories of recorded species in agroecosystems, Arar, Northern Border region, KSA.

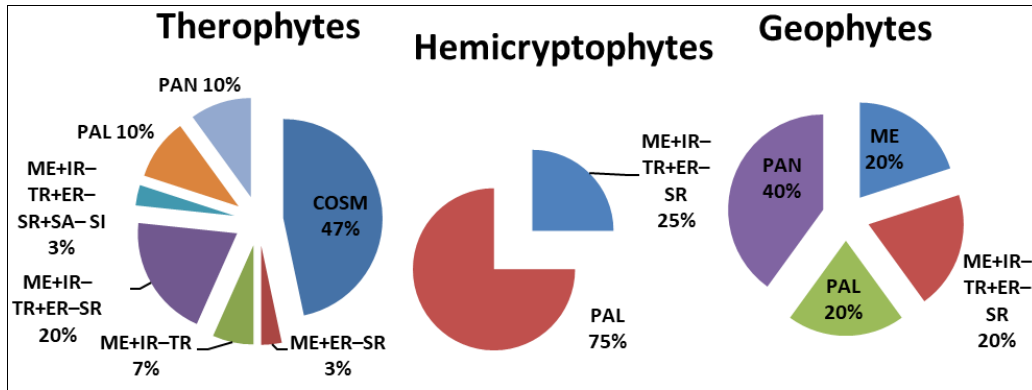


Fig 8: Distribution of chorotypes among the different life form Arar, Northern Border region, KSA.

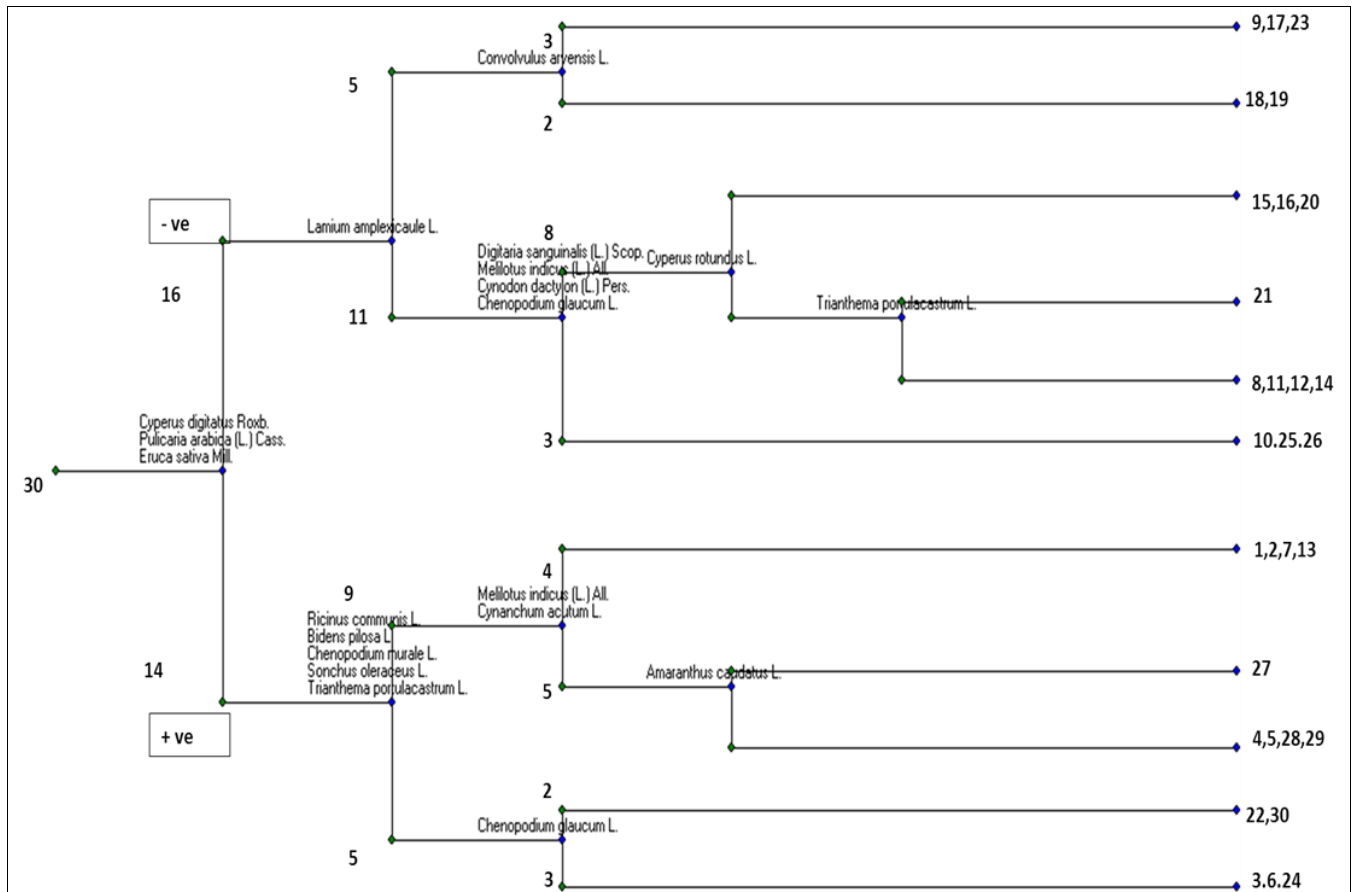


Fig 9: TWINSpan analysis for 30 stands from Arar Northern Border region, KSA.

Soil analysis

Soil analyses results showed that sand, silt, pH, nitrate, potassium, magnesium and chlorides were higher in summer

than in winter. On the other side, clay, moisture content, Organic matter, sodium, calcium and calcium carbonate were higher in winter (Table 3).

Table 3: Soil parameters during winter and summer at 30 stands, the agroecosystems of Arar, Northern Border region, KSA.

Soil parameter	Stands (n=30) Average (minimum-maximum)
Sand (%)	32.6(32-34)
Silt (%)	41.3(40.3-42)
Clay (%)	26.1(24.1-27.6)
pH	7.7(7.2-8)
Moisture content (%)	35.6(27-54.8)
Organic matter (%)	1.4(0.6-2.1)
Nitrate (ppm)	1.7(0.1-4.5)
Electrical conductivity (mS/cm)	0.4(0.9-1.1)
Sodium (mg/L)	418(207-782)
Potassium (mg/L)	37(7.8-136)
Calcium (mg/L)	51(20-100)
Magnesium (mg/L)	16(1-36)
Chlorides (mg/L)	2.4(1-4.5)
Calcium carbonate (%)	13.6(2.1-19.5)

Discussion

Annual species have the highest percentage 71.4 than perennial species 28.6 % in agreement with the result of Osman and Abdein (2019b) ^[31], and Abdein and Osman (2020) ^[3], on Northern Border region, KSA. Poaceae, Astraceae and Chenopodiaceae were the largest families in the present study with (23.8 %), (9.5 %) and (9.5 %) of species composition, respectively. Also these families are the most common families in Arar (Osman and Abdein, 2019b) ^[31], and (Abdein and Osman 2020) ^[3]. These families are also found as the most families presented in the South Asia flora (Yeung, 2018) ^[46].

Adaptation to both climate variation and environment differentiation affect on life form of plants and species (Abdel Khalik *et al.*, 2017 ^[2]; ALSherif *et al.*, 2013) ^[9]. Presence of therophytes more than other different life forms is due to the relation of this type of life forms with hot dry climate, biotic impact and in addition to topographic variation (Anaya, 1999 ^[10]; Al-Robai *et al.*, 2017 ^[8]; Ahmed *et al.*, 2015) ^[34]. The adverse climatic conditions with deficiency in humidity and moisture and variability of substrate, also short life cycles of agricultural crops in field resulted in difference of presence of therophytes life form during favorable seasons for cultivation of crops (Abd El-Ghani *et al.*, 2012 ^[1]; Shaltout *et al.*, 2015 ^[34]; El-Midany *et al.*, 2019). With 71.4 % of the recorded species, therophytes were the most dominant life form in the studied area. According to Osman *et al.* (2014) ^[32], almost 71.5 % of the associated species in Northern Border region in KSA are therophytes. In addition to Osman and Abdein (2019b) ^[31], reported that the species belong to therophytes were 118 in Wadi Arar. Abdein and Osman (2020) ^[3], studied the plant diversity assessment of Wadi Al-Hilali. Recently, Osman and Abdein (2019a) ^[30] and Abdein *et al.* (2020) ^[3] studied some species of *Plantago* and Genus *Tephrosia*, Northern Border region, KSA.

Mediterranean taxa (mono-regional, bi-regional, or pluri-regional) were characterized by 14 species forming 33.3 % of listed species. According to El-Sheikh *et al.* (2013) ^[23], Mediterranean species attained their highest values in Saudi Arabia (46 %).

Results of soil analyses showed a significant correlation among the present study and many previous studies as El-Fouly *et al.* (2012) ^[20], El-Shayeb (1984) ^[20], and Slima (2006) ^[36].

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