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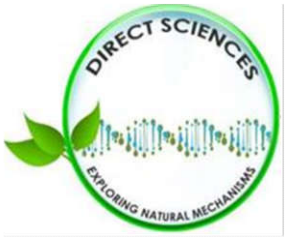

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Floristic Composition of Weed Vegetation in Citrus Orchards in Aljouf Region, Kingdom of Saudi Arabia

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Abstract: The present work aimed to study the floristic composition and species diversity of weed assemblages in citrus orchards in Aljouf region, Kingdom of Saudi Arabia. Floristic lists were prepared and species coverage values were determined in 20 stands, using ten quadrats (1 × 1 m) per stand. In total, 33 plant species belonging to 15 families and 30 genera were identified. The largest families were Asteraceae and Poaceae (5 species for each), followed by Fabaceae (4 species), Chenopodiaceae and Polygonaceae (3 species for each). Therophytes represented the dominant life form (66.7% of the total flora), followed by geophytes (12.1%), chamaephytes, hemicryptophytes (9.1% for each) and phanerophytes (3%). The application of TWINSPAN (Two Way Indicator Species Analysis) classified the weed vegetation into four groups dominated by *Plantago lagopus, Cynodon dactylon, Imperata cylindrica and Convolvulus arvensis*. The species richness for the vegetation group dominated by *Plantago lagopus* was significantly higher (15.8 species/stand) than for the other vegetation groups. Shannon index and evenness did not show significant differences among the different vegetation groups. The species richness of citrus orchards was relatively high which could be related to the environmental heterogeneity due to different light conditions in citrus orchards.

Key words: Agricultural systems, Species diversity, Life form, Plant communities

Introduction

A weed can be defined as any plant that is objectionable or interferes with the activities or welfare of man (Weed Science Society of America, 1994). As indicated by Zimmerman (1976), the term weed should be used to describe plants that able to colonize disturbed ecosystems (Grime, 1979), not members of the original plant community, locally abundant and economically of little value. All the weed definitions showed that weeds have some common biological characters and a level of relative undesirability (Radosevich et al., 1997).

Weeds cause great losses to agricultural systems as they compete with

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crop for light, water and nutrients. Moreover, they increase the costs of different field management practices and reduce the germination of crop seeds due to the phytotoxins (Gomaa et al., 2014). Losses in crop yield caused by weeds were well documented in many studies. The average annual losses caused by weeds in all crops in USA approximate $ eight billion (Aldrich, 1984). Akobundu (1987) estimated that weeds cause a yield loss of about 10% in the less developed countries and 25% in the least developed countries. Swanton et al. (1993) estimated the losses in crop production during 1991 due to weeds as $ 5984 million in Canada. In Egypt, Khedr and Hegazy (1998) reported that the presence of *lotus* as a weed in rice fields significantly reduced the growth and grain yield of the crop.

Studies on the floristic composition of weed communities and distribution of weed species provide weed biologists with the quantitative information that is necessary for designing weed management programs and provide baseline data for measuring changes in the weed flora in future (Frick and Thomas, 1992). Moreover, such studies are helpful in determining how a weed population changes over time in response to selective pressures due to field management practices (Nkoa et al., 2015). Most of the research on the phytosociology of weeds in the cultivated arable land has been concentrated in Europe (Holzner and Immonen, 1982). Among the European studies are those of Gonzalez and Penas (1984), Merino et al. (1988) and Szmeja (1994).

The weed flora of Saudi Arabia was documented by Chaudhary and Akram (1987). A check list of weeds in Al-kharj area in the central region of Saudi Arabia was given by Al-Yemeny (1999). The composition and diversity of weed assemblages in date palm orchards of Al-Qassim area in central Saudi Arabia were studied by Gazer (2011). Studies on weed flora and weed vegetation in the Kingdom of Saudi Arabia are still limited (Sher and Al-Yemeni, 2011). The structure and diversity of weed communities of olive and date palm orchards in Aljouf region of Saudi Arabia was studied by Gomaa (2012). Very little is known about the composition of weed communities of citrus orchards in Aljouf region. The floristic composition and species diversity of weed communities are affected by crop type, sowing date, field history, edaphic factors and field management practices (Hegazy et al., 2004; Ahmad et al., 2016). The present work aimed to study the floristic composition and the species diversity of weed communities in citrus orchards in Aljouf region, Saudi Arabia.

Materials and Methods

Study area

Aljouf region is located in the north of Saudi Arabia between latitudes 29˚ to 32˚N and longitudes 37˚ to 42˚E. The area of the region is about 108,000 km^2. It consists of the town of Sakaka and two governorates, Dawmat Al-Jandal and Al-Qurayat. Aljouf region is one of the important agricultural regions of Saudi Arabia. The cultivated area is about 460,000 ha. The region is characterized by the cultivation of orchards, in particular, olive, citrus and date palm, in addition to other field crops such as wheat, alfalfa and barley.

The study area is characterized by dry climate with hot summer and cool winter. The mean monthly air temperature ranges between 9.8 ºC during January and 33.8 ºC in August. The rainfall in the region is irregular and the mean annual rainfall is 55 mm. Rains occur mainly during the period from October to May (data from Sakaka meteorological station, the general authority of meteorology and environmental protection, Saudi Arabia).

Weed vegetation sampling

The weed vegetation was sampled in 20 stands in citrus orchards located in two sites, Sakaka (29°58′N, 40°12′E) and Dawmat Al Jandal (29°48′N, 39°52′E), in Aljouf province. The area of the stand was 20 × 20 m. Sampling was made during March 2016. In each stand, the present species were recorded and their coverage was evaluated visually as percentage of the ground surface in ten randomly sampled quadrats (1 × 1 m each). Species identification and nomenclature followed Chaudhary and Akram (1987), Chaudhary (1999, 2000, 2001) and Al-Hassan (2006). Species were classified according to life form (Raunkiaer, 1934) into therophytes, hemicryptophytes, geophytes, chamaephytes and phanerophytes.

Data analysis

TWINSPAN, Two Way Indicator Species Analysis (Hill, 1979), was used for the classification of stands into vegetation groups based on the cover values of species. Species richness, Shannon-index and evenness were applied for measuring weed species diversity in every stand (Pielou, 1975):

Species richness: S = the number of species per stand

Shannon-index of diversity:

$$H' = -\sum_{i=1}^{S} pi \ln pi$$

Evenness index: $E = (-\sum_{i=1}^{S} pi \ln pi) / \ln S$

Where pi is the relative cover of species i.

One-way ANOVA followed by Tukey's post-hoc test was used to compare between the diversity indices of the identified vegetation (TWINSPAN) groups. The one-way ANOVA was performed using SPSS 12 for Windows.

Results

A total of 33 plant species belonging to 15 families and 30 genera were recorded. The largest families were Asteraceae and Poaceae (5 species for each), followed by Fabaceae (4 species), Chenopodiaceae and Polygonaceae (3 species for each) (Table 1, Fig. 1). The life form spectrum showed that therophytes represented the dominant life form (66.7% of the total flora), followed by geophytes (12.1%), chamaephytes, hemicryptophytes (9.1% for each), and phanerophytes (3%) (Fig. 2).

The application of TWINSPAN technique on the cover values of species in the sampled stands classified the weed vegetation of citrus orchards in Aljouf region into four vegetation groups (A-D, Fig. 3). Group A represented five stands. The dominant species of this group was *Plantago lagopus*. The common associated species included *Lactuca serriola* and *Sonchus oleraceus*, while the indicator species for this group was *Emex spinosa*. Group B included seven stands dominated by *Cynodon*. *dactylon*. The common species were *Phragmites australis* and *Euphorbia peplus*. Group C represented four stands dominated by *Imperata cylindrica*. The common species of this group were *Euphorbia peplus* and *C*. *dactylon*. Group D (four stands) was dominated by *Convolvulus arvensis*, while the indicator species was *Malva parviflora*. *S. oleraceus* and *I. cylindrica* were common species in this group.

The species richness for vegetation group A was significantly higher (15.8 species/stand) than for the other vegetation groups in which the values of species richness varied between 12.7 species/stand for vegetation group C and 13.1 species/stand for vegetation group B. Shannon index and evenness did not show significant differences among the different vegetation groups (Table 2).

Table 1: Species recorded in citrus orchards in Aljouf region with their families, life forms and mean cover values. Th, therophytes; H, hemicryptophytes; G, geophytes; Ch, chamaephytes; Ph, phanerophytes.

Species	Family	Life form	Cover (%)
***Alhagi graecorum* Boiss.**	Fabaceae	H	**0.6**
***Brassica tournefortii* Gouan.**	Brassicaceae	Th	**0.1**
***Chenopodium album* L.**	Chenopodiaceae	Th	**0.2**
***Chenopodium murale* L.**	Chenopodiaceae	Th	**0.8**
***Cichorium endivia* L.**	Asteraceae	Th	**0.3**
***Convolvulus arvensis* L.**	Convolvulaceae	G	**6.1**
***Conyza bonariensis* (L.) Cronquist.**	Asteraceae	Th	**0.3**
***Cynodon dactylon* (L.) Pers.**	Poaceae	G	**17.4**
***Cyperus rotundus* L.**	Cyperaceae	G	**0.8**
***Emex spinosa* (L.) Campd.**	Polygonaceae	Th	**1.0**
***Euphorbia helioscopia* L.**	Euphorbiaceae	Th	**1.1**
***Euphorbia peplus* L.**	Euphorbiaceae	Th	**2.2**
***Haloxylon salicornicum* (Moq.) Bunge ex Boiss.**	Chenopodiaceae	Ch	**0.1**
***Imperata cylindrica* (L.) Raeusch**	Poaceae	H	**13.5**
***Lactuca serriola* L.**	Asteraceae	Th	**2.5**
***Launaea nudicaulis* (L.) Hook. F.**	Asteraceae	H	**0.1**
***Malva parviflora* L.**	Malvaceae	Th	**2.8**
***Melilotus indicus* (L.) All.**	Fabaceae	Th	**0.8**
***Phalaris minor* Retz.**	Poaceae	Th	**0.3**
***Phragmites australis* (Cav.) Trin.ex Steud.**	Poaceae	G	**4.0**
***Plantago lagopus* L.**	Plantaginaceae	Th	**7.1**
***Polypogon monspeliensis* (L.) Desf.**	Poaceae	Th	**1.1**
***Rumex dentatus* L.**	Polygonaceae	Th	**0.5**
***Rumex vesicarius* L.**	Polygonaceae	Th	**0.1**
***Sisymbrium irio* L.**	Brassicaceae	Th	**0.4**
***Solanum nigrum* L.**	Solanaceae	Th	**0.1**
***Sonchus oleraceus* L.**	Asteraceae	Th	**2.8**
***Spergularia marina* (L.) Griseb.**	Caryophyllaceae	Th	**0.1**
***Tamarix nilotica* (Ehrenb.) Bunge**	Tamaricaceae	Ph	**0.3**
***Trigonella hamosa* L.**	Fabaceae	Th	**0.1**
***Vicia sativa* L.**	Fabaceae	Th	**0.1**
***Withania somnifera* (L.) Dunal.**	Solanaceae	Ch	**0.1**
***Zygophyllum coccineum* L.**	**Zygophyllaceae**	**Ch**	**0.1**

Table 2: Diversity indices (Means ± SD) of the different vegetation groups in citrus orchards in Aljouf region.

Diversity index	Vegetation group			
	A	B	C	D
Species richness	15.8 [a] ±1.6	13.1 [b] ±1.4	12.7 [b] ±1.1	13.0 [b] ±1.7
Shannon index	1.82 [a] ±0.19	1.71 [a] ±0.22	1.60 [a] ±0.18	1.70 [a] ±0.16
Evenness index	0.83 [a] ±0.15	0.75 [a] ±0.28	0.72 [a] ±0.22	1.80 [a] ±0.18

Values in a raw sharing the same letter are not significantly different at $P < 0.05$

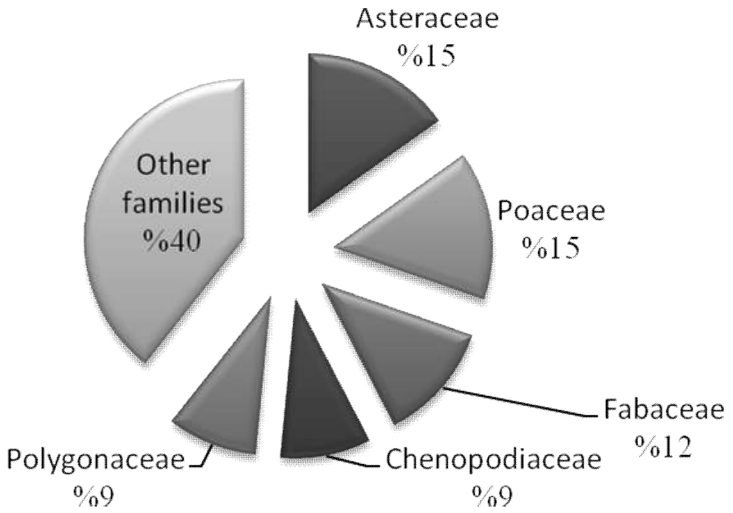

Fig. 1. Major families constituting the weed flora in citrus orchards in Aljouf region.

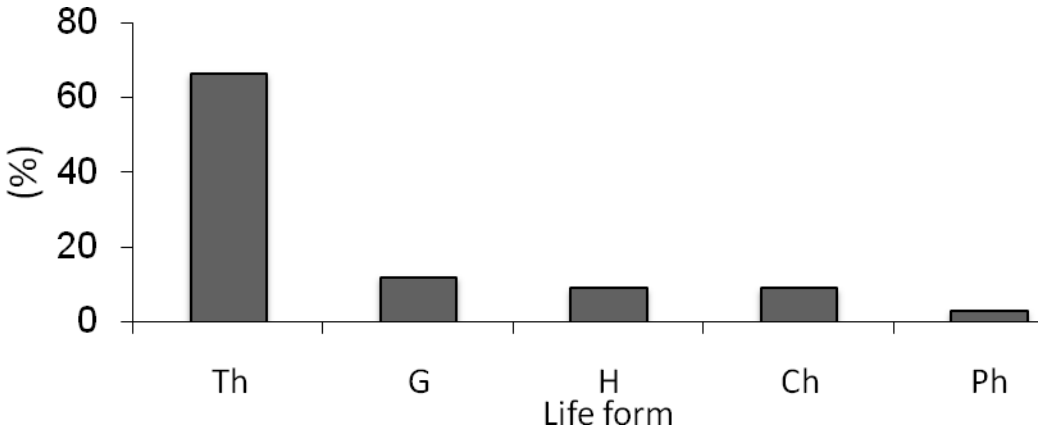

Fig. 2. Life form spectrum of weed flora in citrus orchards in Aljouf region. Th, therophytes; G, geophytes; H, hemicryptophytes; Ch, chamaephytes; Ph, phanerophytes.

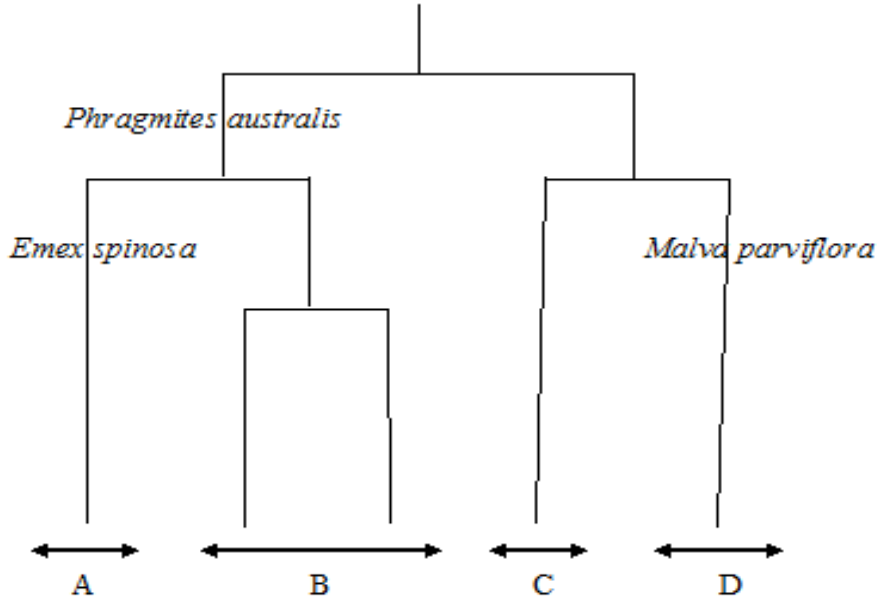

Fig. 3. Dendrogram of the vegetation groups in citrus orchards in Aljouf region resulted from the application of TWINSPAN.

Discussion

The citrus orchards in Aljouf region harbored 33 weed species. The largest families were Asteraceae, Poaceae and Fabaceae. The predominance of these families was reported for the weed flora in other regions (e.g., Hegazy et al., 2004; Sher and Al-Yemeny, 2011). The dominant life form in the present study was therophytes. The preponderance of therophytes in arable lands was documented in previous studies (Shaltout and El-Halawany, 1992; Sher and Al-Yemeny, 2011) and could be attributed to their short life cycles that enable them to cope with the instable conditions of the agricultural habitats (El-Sheikh, 2013). In addition, therophytes allocate much of their resources to the reproductive structures (Harper, 1977) and produce flowers early in their life cycle to ensure some seed production even in year when the growing season is cut short due to application of weed management techniques (Sans and Masalles, 1995). Therophytes are also able to set seeds without the need for a visiting pollinator (Baker, 1974). Geophytes were the second dominant life form in citrus orchards of the current study area. Geophytes such as *C. dactylon*, *C. arvensis*, *P. australis* and *Cyperus rotundus* are well adapted to agricultural systems because they are able to resume growth from underground perennating organs after destruction of their above ground vegetative shoots resulting from weed management methods.

The dominant species of weed communities in citrus orchards of the study area were *C. dactylon*, *I. cylindrica*, *P. lagopus* and *C. arvensis*. These species were reported by Shaltout and El-Halawany (1992) as dominant weeds in date palm plantations of Al-Hassa Oasis in eastern Saudi Arabia. The same species were recorded also as dominant plants in weed communities of olive and date palm orchards in the current study region (Gomaa, 2012). In addition, Gazer (2011) pointed out that *C. arvensis* occurred as co-dominant plant in the date palm orchards of Central Saudi Arabia. *C. dactylon* was documented as dominant or co-dominant weed in orchards and field crops in the surrounding

countries (Hegazy et al., 2004; El-Sheikh, 2013). *C. dactylon* and *C. arvensis* are perennial weeds with underground perennating organs. They are serious weeds causing very severe infestations in field crops and orchards in Saudi Arabia (Al-Yemeny, 1999). *C. arvensis* is one of the most harmful weeds of the worlds and out of 54 countries it is found in 32 different crops fields (Holm, 1997). *I. cylindrica* is a very serious weed that spreads by scaly rhizomes and can invade and over-run any disturbed ecosystem, including cultivated fields and it is very difficult to eradicate.

The weed communities in the study area included, in addition to arable weeds, some desert species that grow in the surrounding natural habitats as *Haloxylon salicornicum*, *Launaea nudicaulis* and *Zygophyllum coccineum*. Similar observations were given by Gazer (2011) for weed flora of date palm orchards in central Saudi Arabia.

The species richness of citrus orchards in the present study is relatively high. Two types of light conditions occur in orchards, the shaded places present below the crowns of trees and the relatively sunny microhabitat between trees. The relative high species richness in citrus orchards could be related to the environmental heterogeneity due to different light conditions that promotes diversity (Palmer and Maurer, 1997).

Conclusively, 33 weed species were recorded in citrus orchards in Aljouf region. The Therophytes and geophytes are the most abundant life forms. The weed vegetation in the study area was classified into four vegetation groups dominated by *Plantago lagopus, Cynodon dactylon, Imperata cylindrica and Convolvulus arvensis*. The dominant species are able to adapt with the instable conditions of the agricultural systems. The species richness was relatively high as a result of the environmental heterogeneity in citrus orchards.

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