eISSN: 2357-044X *Taeckholmia 36 (2016): 58-76*

Weed flora of common crops in desert reclaimed arable lands of southern Egypt

Fawzy M. Salama[1*], Monier M. Abd El-Ghani[2], Noha A. El-Tayeh[3], Ahmad M. Amro[1] and Heba S. Abdrabbu[3]

[1]Department of Botany and Microbiology, Faculty of Science, Assiut University
[2]Department of Botany and Microbiology, Faculty of Science, Cairo University, Giza
[3] Botany Department, Faculty of Science, Qena, South Valley University
*corresponding author email: fawzysalama2020@yahoo.com

Abstract

The weed flora of common crops of the desert reclaimed arable lands in southern Egypt was studied. Field data were collected from three major crops: wheat as a winter crop, millet as summer crop and alfa-alfa as a perennial crop. 146 stands (fields) from 8 sites in Qena Governorate were permanently visited during 2013 and 2014. A total of 169 species (105 annuals, 64 perennials) of the vascular plants belonged to 121 genera in 39 families constituted the flora of the study area. The most species-rich families were Poaceae, Asteraceae, Fabaceae, Brassicaceae, Chenopodiaceae, and Euphorbiaceae. Annual herbs were the best represented life form, followed by annual grasses, trees and perennial shrubs. Ballochore and pogonochore were the most represented dispersal types of seeds, while cyclochore and auxochore were the least represented. 26 species were categorized as dominants (highest Q-values), where they have a wide ecological range of distribution. Classification of the associated vegetation in 146 stands by cluster analysis yielded 5 vegetation groups (A-E); the vegetation groups A and E were mainly represented by weeds in wheat and alfa-alfa (winter season), while most the stands of groups B, C and D were represented by species in millet and alfa-alfa (summer season). These groups were separated along the first two axes of Bray-Curtis ordination.

Keywords**:** Agroecology, life-form spectrum, summer crop, winter crop, segetal flora, diversity, weed vegetation, crop type.

Introduction

The history of plant cultivation is the history of confrontation with weeds. Weeds are defined as plants adapted to man-made habitats and interfering there with human impacts (Holzner, 1978). They differ from other plants in being more aggressive, having peculiar characteristics that make them more competitive. Weeds decrease the crop yield by competing for water, nutrients, space and light (Qasem and Hill, 1995). The arable weeds (segetal flora) adapted to all methods of crop production. Some weeds are also allelopathic and adversely affect crops (Shah and Khan, 2006; Jabeen and Ahmed, 2009). Weeds are important components of agroecosystems (Marshall *et al.,* 2003), as they constitute the base of food chains for herbivores and their natural enemies.

Weed vegetation has been subjected to radical changes over the last decades due to very high anthropogenic pressure and the subject of interest of numerous publications in recent years. Many arable weed studies have demonstrated the importance of local site characteristics and management practices for the occurrence of single species, community composition and species richness (Lososova *et al.*, 2004). In the last decades, the

Received on 26/06/2016 and accepted on 20/07/2016

intensification in agricultural practices has caused major changes in the composition and species richness of weed communities in arable fields (e.g. Albrecht, 1995; Sutcliffe and Kay, 2000). Marshall *et al.* (2003) showed that a variety of factors operate on different temporal and spatial scales to affect the survival of weed populations, species and communities.

Man-made habitats, as in reclaimed desert lands, represent species-rich environments (Wittig, 2002) due to habitat heterogeneity, frequent and diverse disturbances creating mosaics of different successional stages and immigration of alien species (Pyšek *et al.*, 2002). This human interference causes the weedy species to replace the wild plant species in these reclaimed areas (Baessler and Klotz, 2006), which are considered as transitional habitats between the old cultivated land and desert.

Land reclamation in the Egyptian context means converting desert areas to agricultural land and rural settlements through extending the water canals from existing agricultural land into the desert. Since the early 1960s, vast areas in the Egyptian deserts (western, eastern and Sinai) were subjected to land reclamation; private and government schemes (Soliman, 1989). Land reclamation of desert plains took place along the Nile region, around Kom Ombo near Aswan (New Nubia Project), and on both sides of the Nile Delta (Tahrir and Nubariya Projects to the west and Salhiya Project to the east). About 61% of the priority reclaimable land through the Nile waters is located on the fringes of the Delta region. In parts of these areas, where soil is loamy in nature, wheat can be cultivated relatively successfully (Biswas, 1993).

In Egypt, usually a crop rotation is applied in the farmlands. Two cropping rotation system of dense crops and row crops (for economic reason) is now usual for most Egyptian croplands. Planting time for the winter crops is September-November, February-March for cotton, and April-May for maize and rice (summer crops). The crop longevity is 5-6 months for all crops, except cotton (7-8 months). The crop rotation influences the composition of arable weeds and their seed banks, and represents a possible method for weed control (Shaltout and El Fahar, 1991). The positive influence of crop rotation can be supplemented by herbicide application. However, the chemical control with herbicide is not cheap and has negative influence on environment (resistance, residue, depressive influence on culture, etc.). For that reason, it is seldom practiced for field cultivation.

Weeds of Egyptian croplands differ from season to season because of their ecological requirements. El Hadidi and Kosinová (1971) distinguished two types of field weeds: (1) winter weeds that abound in the cooler months and are associated with winter crops (e.g., broad beans, wheat, Egyptian clover, barley) and (2) summer weeds that abound in the warmer months of the year and are associated with summer crops (e.g., cotton, maize, rice). The pioneer study of the weed flora in Egypt was that of Tadros and Atta (1958) who gave an account of the plant communities associated with the rain-fed barley fields of the western sector of the Mediterranean coastal land. A documentary study has been published by Boulos (1966) of the flora of the Nubian sector of the Nile land with special reference to the weeds associated with farmlands in the area south of Aswan to the Sudanese borders before the establishment of the Aswan High Dam. Another parallel study has been undertaken by El Hadidi and Ghabbour (1968) on the weed flora of Aswan area along the Nile and irrigation canals, in field plots of farmlands, in private gardens, flower beds and parks.

The main objective of this study wereo carry out thorough floristic surveys of weeds in the agroecosystem of the desert reclaimed lands in southern Egypt, and to assess their current distribution in major crops to provide an accurate data set for comparison by future surveys.

The Study Area

The area is located within the territories of two governorates; Sohag at the north and Luxur at the south. It comprises the reclaimed desert lands extending on both sides (eastern and western) of the Nile Valley between 25° 85' and 26° 30'N and 32° 00' and 32° 90'E (Fig. 1). The eastern part of the study area represents a part of eastern desert roads crossing the Eastern Desert parallel to the Nile Valley. This part will be referred to in this study as the 'Eastern Part'. The western part of the study area represents a part western desert road crossing the western desert parallel to the Nile valley. This part will be referred to in this study as the 'Western Part'.

The Nile Valley broadens and the flat strips of cultivable land, extending between the river and the cliffs that bound its valley on either side, gradually increase in width northward. The study area is located on the alluvial plains which slope generally to the north and west and represented by the cultivated younger plain occupying the central part of the Nile Valley and older reclaimed plain at the valley fringes. At Qena, about 120 km north of Esna, the river makes a great bend bounded by limestone cliffs rising to heights of more than 300 m on either side. Past the Qena bend, the Nile swerve in the Red Sea direction and its valley is much wider; the cliffs of the western side of the valley become much lower than those on the eastern sides.

The Egyptian desert is a part of the African Sahara. Climatic aridity prevails throughout the area: low and irregular rainfall, sharp diurnal changes of temperature and atmospheric humidity. Ayyad and Ghabbour (1986) perceived the Egyptian desert as hyper-arid bioclimatic province with mild winter and hot summer. The climate of the study area at Qena Governorate is subtropical without a rainy season, but torrents may occur between October and March coming westward from the Red Sea Mountains. The mean annual temperature ranges between 15 and 40ºC, and relative humidity between 30 and 60% (Anonymous, 1980).

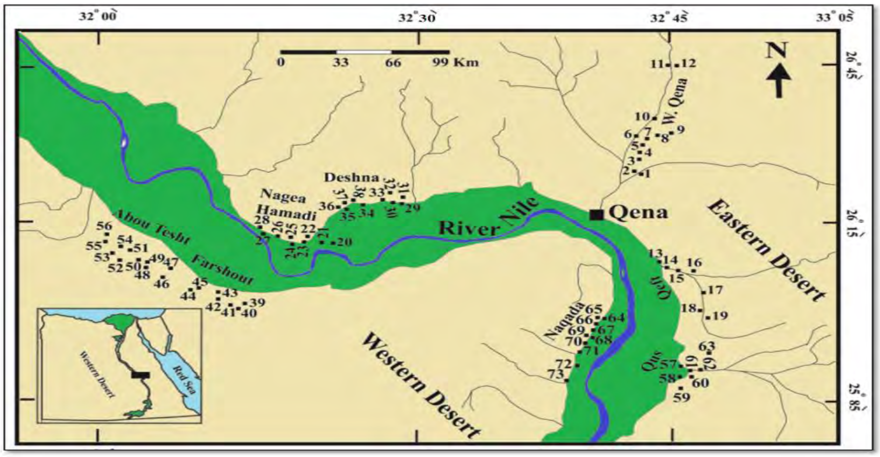

Fig. 1. Location map of the study area

Methods

Field sampling design and data collection

Field data on the floristic composition was gathered throughout intensive field tripsbetween 2013 and 2014 along the eastern and western parts of the study area. A total of 8 permanently visited sites were surveyed, using a stratified sampling method (Müller-Dombois and Ellenberg, 1974). These sites included 5 in the eastern part and 3 in the western (Fig. 1). The number of sites in each transect varied according to its agricultural potentialities. One-hundred and forty six sampling stands (fields) were selected to represent the agro-ecosystem in the croplands. Three major crops were studied: wheat (*Triticum aestivum* L.) as a winter crop, millet (*Sorghum bicolor* (L.) Moench as a summer crop, and alfa-alfa *(Medicago sativa* L.) as a perennial crop (winter and summer seasons).

In each of the 8 studied sites, presence or absence of plant species was recorded using a number of permanent stands (fields) randomly positioned and representing as much as possible the variation in the floristic composition of the agro-ecosystems. To get a reasonable estimate of the occurrence of weed species in a crop, more fields (stands) should be included, rather than investigate more plots within a field (Andreasen and Skovgaard, 2009). Frequency (F%) of species in each stand was estimated as an average. Performance percentages (P%) was calculated as the total number of fields where species recorded divided by the total number of monitored fields. The size of the stand (field) varied from one site to another, depending on the total cultivated area, variability in both croplands and habitats. The area of each stand (field) was around 20m x 100m which approximates the minimal area of weed associations in the study area. Such size of sampled fields has applied in other related studies (Saavedra *et al.,* 1989). The sampled fields may be regarded as fairly representative within each crop type. Specimens of each species were collected, and then identified at the Herbarium of Cairo University (CAI), and duplicates were deposited at Assiut University Herbarium (AST). Taxonomic nomenclature was according to Täckholm (1974) and updated by Boulos (1999-2005, 2009).

Biological spectrum, growth forms, and seed dispersal

The recorded species were classified according to El-Sheikh (2005) into nine life forms (trees, perennial shrubs, perennial herbs, annual herbs, annual forbs, annual grass, perennial grass, sedges and parasites). To express variations in growth form of species (species duration) traits, an arbitrary 7-categories system was adopted. These categories were: winter weeds (w), summer weeds (s), all-the-year weeds (a), desert annuals (da), desert perennials (dp), trees (t) and margin species (ms). The latter are those recorded at the transition zones separating different agricultural fields from each other or from other landscape elements. Seed and fruit dispersal types were evaluated according to the scheme of Dansereau and Lems (1957), which distinguishes dispersal types, primarily according to the morphology of the diaspora (dispersal units). On the other hand, the dispersal types of some species were identified according to El-Sheikh (1996 and 2005) and Shaltout *et al.* (2010).

Rarity forms and local abundance

The framework that proposed by Rabinowitz (1981) for the different types of rarity depending on range, habitat specificity and local abundance was applied. Several literatures were consulted for checking the national geographical distribution of many species in the study area, e.g. Hassib (1951), Täckholm (1974), Zahran and Mashaly (1991). Habitat specificity of each species was assessed based on El-Hadidi and Fayed (1994/95) and Boulos (1999-2005). The local abundance of each species was assessed using the Q-value (Danin *et al.,* 1985) as follows: Q=number of entries of a species × total number of species/total number of entries. Based on their Q-values, the local abundance of each species was categorized as follows: D = dominant (Q-value ≥ 0.2), VC = very common (Q-value 0.1 – 0.199), C = common (Q-value 0.05 – 0.099), O = occasional (Q-value 0.01 – 0.049), and S = sporadic (Q-value ≤ 0.01).

Data analysis

In order to obtain an effective analysis of the vegetation, both classification and ordination techniques were employed. To avoid distortion, species present 1-5 stands (98 species or *ca.* 58% of the total flora) were eliminated from the data set. Therefore, a floristic presence/absence data matrix consists of 146 stands and 71 species was subjected to cluster analysis using a similarity index (the Czekanowski coefficient; Ludwig and Reynolds, 1988). Second, the matrix was analyzed with Bray-Curtis variance regression ordination, using the Sørensen coefficient as the distance measure, to check the magnitude of change in species composition along the ecological gradients (McCune and Mefford, 1999). The Bray-Curtis variance regression ordination was used because it is considered an effective technique for community analyses and for revealing ecological gradients (McCune and Grace, 2002). Both classification and ordination techniques were performed by PC-ORD for windows version 5.0 (McCune and Mefford, 1999).

Species diversity

The species richness (α-diversity) of each vegetation cluster was calculated as the average number of species per stand. Species turnover (β-diversity) was calculated as the ratio between the total number of species recorded in a certain vegetation group and its species richness. The Shannon–Wiener index (H') for the relative species evenness and the Simpson index (C) for the concentration of species dominance were calculated for each vegetation cluster (Whittaker, 1972; Pielou, 1975).

Results

Floristic features

A total of 169 species (105 annuals, 64 perennials) of the vascular plants belonged to 121 genera in 39 families constituted the flora of the study area (Table 1). The most species-rich families were Poaceae (34 species), Asteraceae (18 species), followed by Fabaceae (14 species), Brassicaceae, Chenopodiaceae (13 species for each), Euphorbiaceae (10 species), Solanaceae, Polygonaceae (6 species for each) and Apiaceae (5 species). Mono-specific families (19 families) constituted more than 48% of the total families. Generally, the family size is small: 33 families have less than 10 species, and only 6 families have 10 or more than 10 species. Thirty-nine families were represented by one species, while *Euphorbia* included the highest number of species (8 species).

Table (1). Chorotypes (CT), life forms (LF), dispersal type (DT), and rarity forms (RF) of the recorded species within their local abundance categories (species arranged in descending order of their Q-values). Chorotypes abbreviations: Am=American, COSM=cosmopolitan, Cult. = cultivated, M= Mediterranean, IT=Irano–Turanian, SA= Saharo–Arabian, ES=Euro–Siberian, SZ=Sudano–Zambezian, PAN=Pantropical, PAL=Palaeotropical, Su=Sudanian. Rarity forms abbreviations: LWA=large geographic-wide habitat-abundant gradients, LWN= large geographic-wide habitat non-abundant gradients, LNA=large geographic-narrow habitat-abundant gradients, LNN= large geographic-narrow habitat-non-abundant gradients, SWN=small geographic-wide habitat-non-abundant gradients and SNN=small geographic-narrow habitat-non-abundant gradients. Life forms abbreviations: AH=annual herb; AG= annual grass; AF=annual forb; PAR= parasite; PH= perennial herb; PG= perennial grass; PF= perennial forb; PS=perennial shrub; TR=tree; SD=sedge and rush. Dispersal types abbreviations: AU=auxochore; CY=cyclochore; PT=pterochore; PO=pogonochore; PY= pyrenochore; DE=desmochore; SAR=sarcochore; SP=sporochore; MI=microsclerochore; BA=ballochore; BAR=barochore.

Species	CT	LF	DT	RF
Dominant species (Q-values: 1-0.22)				
Cynodon dactylon (L.) Pers.	COSM	PG	AU	LWA
Sonchus oleraceus L.	COSM	AH	PO	LWA
Phoenix dactylifera L.	SA+SZ	TR	SAR	LNA
Malva parviflora L.	M+IT+ES	AH	PT	LWA
Chenopodium murale L.	COSM	AH	SP	LWA
Chenopodium album L.	COSM	AH	SP	LWA
Echinochloa colona (L.) Link	PAN	AG	DE	LNA
Tamarix nilotica (Ehrenb.) Bunge.	SA+IT	TR	PO	LNA
Salsola imbricata Forssk.	SA	PS	PT	LWA

Species	CT	LF	DT	RF
Melilotus indicus (L.) All.	PAL	AF	MI	LWA
Portulaca oleracea L.	COSM	AH	MI	LWA
Convolvulus arvensis L.	PAL	PH	BA	LWA
Alhagi graecorum Boiss.	SA+IT	PS	BA	LNA
Lolium perenne L.	M+IT+ES	PG	MI	LWA
Phragmites australis (Cav.) Trin. ex Steud.	PAN	PG	SP	LWA
Cyperus rotundus L.	PAN	SD	SP	LNA
Corchorus olitorius L.	PAN	AH	BA	LNA
Polypogon monspeliensis (L.) Desf.	COSM	AG	PO	LWA
Dactyloctenium aegyptium (L.) Willd.	PAL	AG	DE	LNA
Pluchea dioscoridis (L.) DC.	SA+SZ	PS	PO	LWA
Beta vulgaris L.	M+IT+ES	AH	DE	LWA
Eruca sativa Miller	M+IT	AH	BA	LWA
Polygonum equisetiforme Sm.	M+IT	PH	BA	LWA
Senecio glaucus L.	M+SA+IT	AH	PO	LWA
Zizphus spina-christi (L.) Desf.	SA	TR	SAR	LWA
Solanum nigrum L.	COSM	AH	SAR	LWA
Very common species (Q-values: 0.19-0.11)				
Calotropis procera (Aiton) W.T. Aiton	SA+SZ	TR	PO	LWA
Digitaria sanguinalis (L.) Scop.	PAL	AG	MI	LNA
Zygophyllum coccineum L.	SA	PS	SAR	LWA
Dichanthium annulatum (Forssk.) Stapf	PAL	PG	AU	LNA
Aster squamatus (Spreng.) Hieron.	PAN	AH	PO	LWA
Brachiaria eruciformis (Sm.) Griseb.	PAN	AG	DE	LNA
Sesbania sesban (L.) Merr.	SZ	TR	BA	LWA
Setaria viridis (L.) P. Beauv.	COSM	AG	DE	LNA
Cichorium endivia L. subsp. *pumilum* (Jacq.) Cout.	M+IT	AH	PO	LWA
Conyza bonariensis (L.) Cronquist.	Am	PH	PO	LWA
Zea mays L.	Cult.	AG	BAR	SNN
Amaranthus hybridus L.	COSM	AH	MI	LNA
Amaranthus lividus L.	M+IT	AH	MI	LNA
Avena barbata Pott ex Link	M	AG	DE	LWA
Casuarina equisetifolia L.	Cult.	TR	PT	LNA

Species	**CT**	**LF**	**DT**	**RF**
Desmostachya bipinnata (L.) Stapf	SA	PG	SP	LNA
Emex spinosa (L.) Campd.	M+SA	AH	DE	LNA
Euphorbia peplus L.	COSM	AH	SAR	LWA
Suaeda aegyptiaca (Hasselq.) Zohary	SA+IT	AH	SAR	LNA
Lactuca serriola L.	M+IT	AH	PO	LNA
Raphanus sativus L.	Cult.	AH	BA	LNA
Common species (Q-values: 0.10-0.05)				
Amaranthus graecizans L.	PAL	AH	MI	LNA
Brassica nigra (L.) Koch	COSM	AH	CY	LNA
Chenopodium ambrosioides L.	COSM	PH	SP	LWA
Launaea nudicaulis (L.) Hook.f.	SA+IT	PH	PO	LNA
Medicago sativa L.	Cult.	AF	AU	SNN
Polygonum bellardii All.	M+IT	AH	BA	LWA
Salsola villosa Schult.	SA+IT	PS	PT	LWA
Setaria verticillata (L.) P. Beauv.	M	AG	DE	LNA
Sisymbrium irio L.	COSM	AH	BA	LWA
Trifolium resupinatum L.	M+IT	AF	PT	LWA
Urospermum picroides (L.) F.W. Schmidt	M+IT	AH	PO	LWA
Avena fatua L.	COSM	AG	DE	LWN
Diplotaxis acris (Forssk.) Boiss.	SA	AH	BA	SNN
Phalaris minor Retz.	M+SA+IT	AG	MI	LNA
Schouwia purpurea (Forssk.) Schweinf.	SA	AH	CY	LWN
Sorghum virgatum (Hack.) Stapf	SZ	AG	BA	SNN
Trianthema portulacastrum L.	Am	AH	MI	LNA
Withania somnifera (L.) Dunal	M+IT	PS	SAR	LNA
Allium cepa L.	Cult.	AH	MI	SNN
Atriplex halimus L.	M+SA+IT	PS	MI	LWN
Avena sativa L.	Cult.	AG	DE	SNN
Medicago ciliaris (L.) Heyn	M	AF	DE	LNN
Opunta ficus-indica (L.) Mill.	Cult.	PS	PY	LWN
Phalaris paradoxa L.	M+IT	AG	PY	SNN
Rumex dentatus L.	M+IT+ES	AH	DE	LWN
Sorghum bicolor (L) Moench.	Cult.	AG	BAR	SNN
Anagallis arvensis L.	COSM	AH	BA	LWN
Bassia muricata (L.) Asch.	SA+IT	AH	CY	LNN
Brassica tournefortii Gouan	M+SA	AH	CY	LNA

Species	**CT**	**LF**	**DT**	**RF**
Eucalyptus camaldulensis Dehnh.	Cult.	TR	BA	LNN
Euphorbia helioscopia L.	M+IT+ES	AH	SAR	SNN
Euphorbia heterophylla L.	PAN	AH	SAR	SNN
Fagonia arabica L.	SA	PS	DE	SNN
Hyoscyamus muticus L.	SA+SZ	PS	PY	LNA
Imperata cylindrica (L.) Raeusch.	M+SA+IT	PG	PO	LWA
Oxalis corniculata L.	COSM	AH	BA	LWA
Sinapis arvensis L.	COSM	AH	CY	SNN
Occasional species (Q-values: 0.04-0.01)				
Acacia tortilis (Forssk.) Hayne subsp. *raddiana* (Savi) Brenan	SA	TR	BAR	LNN
Ammi majus L.	M	AH	BA	SNN
Anethum graveolens L.	Cult.	AH	MI	SNN
Brachiaria reptans (L.) C.A. Gardner & C.E. Hubb.	PAN	AG	DE	SNN
Cenchrus biflorus Roxb.	SA+SZ	AG	DE	SNN
Dinebra retroflexa (Vahl) Panz.	PAL	AG	DE	SWN
Launaea mucronata (Forssk.) Muschl.	SA	AH	PO	LNN
Leptadenia pyrotechnica (Forssk.) Decne.	SA+SZ	TR	PO	LNN
Lupinus albus L.	Cult.	AF	BAR	SNN
Olea europaea L.	Cult.	PS	SAR	SNN
Psidium guajava L.	Cult.	TR	PY	SNN
Salsola sp.	SA	PS	PT	LNN
Sorghum halepense (L.) Pers.	PAN	PG	BA	SNN
Tetraena simplex (L.) Beier & Thulin	SA+SZ	AH	SAR	LNN
Amaranthus viridis L.	COSM	AH	MI	SWN
Ammi visnaga (L.) Lam.	M+IT	AH	BA	SWN
Anchusa humilis (Desf.) I. M. Johnst.	M+SA	AH	SAR	LNN
Astragalus vogelii (Webb) Bornm.	SA	AF	BA	SNN
Atiplex leucoclada Boiss.	SA+IT	PS	MI	LNN
Bassia indica (Wight) A.J. Scott.	SA+IT	AH	CY	SWN
Bromus diandrus Roth	M	AG	BA	LWN
Citrullus lanatus (Thunb.) Matsum. & Nakai	Cult.	AH	BAR	SNN
Citrus aurantifolia (Christm.) Swingle	Cult.	TR	PY	SNN

Species	CT	LF	DT	RF
Cuscuta pedicellata Ledeb.	M+IT	PAR	SP	LNN
Datura innoxia Mill.	PAN	AH	BA	SNN
Euphorbia forsskaolii G. Jay	SZ	AH	SAR	LNN
Foeniculum vulgare (L.) Mill.	Cult.	PH	MI	SNN
Lantana camara L.	Cult.	PS	SAR	SNN
Leptochloa fusca (L.) Kunth	PAL	PG	DE	LNN
Lycopersicon esculentum Mill	Cult.	AH	PY	LNN
Morettia philaeana (Delile) DC.	SA	PH	BA	LNN
Orobanche crenata Forssk.	M+SA+IT	PAR	SP	LNN
Orobanche ramosa L.	M	PAR	SP	LNN
Pennisetum divisum (Forssk. ex J.F. Gmel.) Henrard	SA	PG	DE	SNN
Polygonum plebeium R.Br.	M+IT+ES	AH	BA	SNN
Pulicaria undulata (L.) C.A. Mey.	SA	PS	PO	LNN
Ricinus communis L.	PAN	TR	DE	LWN
Rumex vesicarius L.	SA	AH	CY	LNN
Salix mucronata Thunb.	SA+SZ	TR	PO	SNN
Spergularia marina (L) Griseb.	COSM	AH	PT	SWN
Triticum aestivum L.	Cult.	AG	BAR	LNN
Sporadic species (Q-values ≤ 0.01)				
Acacia nilotica (L.) Delile	SA	TR	BAR	LNN
Aeluropus lagopoides (L.) Trin. ex Thwaites	M+SA	PG	DE	LNN
Anthemis pseudocotula Boiss.	M+SA	AH	BA	LNN
Bidens pilosa L.	M+IT+ES	AH	PO	SNN
Carthamus tinctorius L.	Cult.	AH	PO	SNN
Cenchrus ciliaris L.	SA+SZ	PG	DE	SNN
Cenchrus echinatus L.	Am	AG	DE	SNN
Chrozophora plicata (Vahl) Spreng.	M+SA	PH	SAR	SNN
Citrus limon (L.) Burm.f.	Cult.	TR	PY	SNN
Citrus reticulata Blanco	Cult.	TR	PY	SNN
Citrus sinensis (L.) Osbeck	Cult.	TR	PY	SNN
Coriandrum sativum L.	Cult.	AH	MI	SNN
Coronopus niloticus (Delile) Spreng.	SZ	AH	PT	LNN
Cotula cinerea Delile	SA	AH	PO	LNN
Cressa cretica L.	PAL	PH	BA	LWN
Cynanchum acutum L.	SA	PH	PO	LWN
Datura stramonium L.	PAN	AH	BA	SNN

Species	CT	LF	DT	RF
Diplotaxis harra (Forssk.) Boiss.	SA	PH	BA	SNN
Eclipta prostrata (L.) L.	PAN	AH	PO	SNN
Erucastrum arabicum Fisch.& C.A. Mey	PAN	AH	BA	LNN
Euphorbia granulata Forssk.	SA	AH	SAR	SNN
Euphorbia hirta L.	PAN	AH	SAR	SNN
Euphorbia indica Lam.	SA	AH	SAR	SNN
Euphorbia prostrata Aiton	M+SA+IT	AH	SAR	SNN
Fagonia indica Burm.f.	SA	PS	DE	SNN
Ficus carica L.	Cult.	TR	MI	SNN
Helianthus annuus L.	Cult.	AH	BAR	SNN
Hibiscus sabdariffa L.	Cult.	AH	BA	SNN
Hyphaene thebaica (L.) Mart.	SA+SZ	TR	SAR	LNN
Lathyrus hirsutus L.	M+IT	AF	BA	LNN
Lathyrus sativus L.	Cult.	AF	BA	SNN
Medicago polymorpha L.	COSM	AF	DE	LNN
Ochradenus baccatus Delile	SA	PS	SAR	LNN
Panicum coloratum L.	SU	PG	AU	LNN
Plantago lagopus L.	M+IT	AH	PT	LNN
Polypogon viridis (Gouan) Breistr.	M+IT	PG	PO	LNN
Reichardia tingitana (L.) Roth	M+SA+IT	AH	PO	LWN
Salsola vermiculata L.	SA	PS	PT	LNN
Sida alba L.	PAN	AH	BA	SWN
Tamarix aphylla (L.) H. Karst.	SA+IT	TR	PO	LNN
Trifolium alexandrinum L.	Cult.	AF	PT	LNN
Trigonella foenum-graecum L.	Cult.	AF	BA	SNN
Zilla spinosa (L.) Prantl	SA	PS	SAR	SNN

Chorological affinities

The chorological spectrum of the recorded species showed that cosmopolitan, palaeotropical and pantropical species constituted 45 species (26.6% of the total flora; Table 2**).** Thirty-nine mono-regional species (23.1% of the flora) belonged to five main phytochoria were recognized and distributed as follows: 25 in the Saharo-Arabian (SA), 6 in the Mediterranean (M), 4 in the Sudano-Zambezian (SZ), 3 in American?? (Am) and one Sudanian (SU). Forty species (23.7% of the total flora) were recorded as bi-regional elements, mainly with affinities in four chorotypes: Mediterranean+Irano-Turanian (M+IT), Mediterranean+Saharo-Arabian (M+SA), Saharo-Arabian+Irano-Turanian (SA+IT) and Saharo-Arabian+ Sudano-Zambezian (SA+SZ). The pluri-regional chorotypes were represented by 15 species belonged to 2 different phytochoria, formed of combinations of the six mono-regional phytochoria: M, SA, IT and ES. The combination of M+IT+ES and M+SA+IT showed apparent importance as it comprised 7 and 8 species, respectively.

Biological spectrum and seed dispersal

The determination of the dispersal types of the recorded species indicated that the ballochore (33 specie; 19.5% of the total number of recorded species) and pogonochore (25 species; 14.8%) were the most represented dispersal types. On the other hand, cyclochore (7 species; 4.1%) and auxochore (4 species; 2.4%) were the less represented dispersal types (Table 1). Annual herbs (69 species; 40.8%) were the best represented, followed by annual grasses, trees and perennial shrubs (21, 20 and 19 species, respectively). Parasites were represented by 3 species (*Cuscuta pedicellata, Orobanche crenata* and *O. ramosa*), while sedges by *Cyperus rotundus* (Table 1).

Rarity forms and local abundance

In general, species which have large ranges but associated with particular habitats are quite predictable in their occurrence (Table 1). None of the recorded species belong to SWA cell (small range-wide habitat-abundant species). Small range-narrow habitat-non abundant (SNN) species were the most represented (52 species). Large range-narrow habitat-abundant species (LNA), and large range-narrow habitat-non abundant species (LNN) constituted 38.5% of the recorded flora. Whereas 35 species were represented large geographic range-wide habitat-non abundant (LWN) and 11 species were beloned tolarge geographic range-wide habitat-abundant (LWA).

Table (2). Summarized chorological analysis of the recorded flora. For the abbreviations, see Table 1.

Chorotypes	Number of species	%
Mono-regional		
SA	25	14.8
M	6	3.6
SZ	4	2.4
Am	3	1.8
SU	1	0.6
Sub Total	**39**	**23.1**
Bi-regional		
M+IT	15	8.9
M+SA	6	3.6
SA+SZ	10	5.9
SA+IT	9	5.3
Sub Total	**40**	**23.7**
Pluri-regional		
M+IT+ES	7	4.1
M+SA+IT	8	4.7
Sub Total	**15**	**8.9**
COSM	20	11.8
PAN	16	9.5
PAL	9	5.3
Sub Total	**45**	**26.6**
Cultivated	30	17.8
Total	**169**	**100**

Twenty-six species were categorized as dominants (highest Q-values), where they have a wide ecological range of distribution (Table 1). They included the most common weeds of arable lands in Egypt (El Hadidi and Kosinová, 1971), such as *Sonchus oleraceus, Chenopodium murale, Convolvulus arvensis, Melilotus indicus, Cynodon dactylon,* and *Portulaca oleracea.* The numbers of species with the lowest degrees of occurrence (occasional) were the highest (85; 50.3% of the total flora). Some trees were recorded in this category e.g., *Leptadenia pyrotechnica, Acacia tortilis,* and *Hyphaene thebaica*.

Classification and ordination

Using cluster analysis, the 146 stands were classified into 5 vegetation groups (A-E, Fig. 2); each comprises a set of stands which are similar in their floristic composition and named after the dominants with the highest frequency percentages (F%). Inspection to Figure (2) indicated that stands of the vegetation groups A and E were mainly represented by weeds in wheat and alfa-alfa (winter season), while most the stands of groups B, C and D were represented by weed flora in millet and alfa-alfa (summer season). *Cynodon dactylon* was the dominant species (F=100%) in all the vegetation groups (Table 3). Sixteen species were recorded with variable frequency values in the five groups. These species included two desert perennials (*Alhagi graecorum* and *Salsola imbricata*), four trees (*Calotropis procera, Tamarix nilotica, Phoenix dactylifera* and *Casuarina equisetifolia*), two margin species (*Phragmites australis* and *Pluchea dioscoridis*) and five all-the-year weeds (*Cynodon dactylon, Sonchus oleraceus, Dichanthium annulatum, Conyza bonariensis* and *Malva parviflora*).

Group A had the highest number of species (63 species) from 56 stands, and dominated by *Cynodon dactylon, Sonchus oleraceus* and *Chenopodium murale*. This group exhibited a relatively high species richness (10.6 4.0 spp. stand $^{-1}$), species turnover (5.9), Shannon-Wiener index (2.3 ± 0.04) and concentration of dominance (0.8 ± 0.04).

Group B included the lowest number of species (37) from 27 stands, and codominated by *Cynodon dactylon* and *Phoenix dactylifera.* This group had the lowest values of species richness (5.5±2.7 spp stand $^{-1}$), the lowest Shannon-Wiener index (1.6±0.5) and the highest species turnover (6.7).

Group C comprised of 49 species from 22 stands, and codominated by *Cynodon dactylon*, *Echinochloa colona* and *Portulaca oleracea*. It showed the highest values of species richness (13.1±4.3 spp stand $^{-1}$), the Shannon-Wiener index (2.5±0.3), the highest concentration of dominance (0.9±0.03), and the lowest values of species turnover (3.7).

Group D included 50 species from 27 stands, and codominated by *Cynodon dactylon*, *Phoenix dactylifera* and *Tamarix nilotica.*

Group E (35 species from 14 stands) was dominated by *Cynodon dactylon* and *Suaeda aegyptiaca*, and attained a lower value of species turnover (4.2) and Shannon-Wiener index (2.0±0.5).

Application of the Bray-Curtis ordination indicated reasonable segregation between vegetation groups assigned for winter and summer seasons with slightly superimposed between 2 seasons (Fig. 3). Stands of vegetation groups A and E were mainly found in wheat and alfa-alfa (winter season) occupied the negative end of Axis 1, while stands of groups B, C and D were mainly found in millet and alfa-alfa (summer season) and occupied the positive end of Axis 1.

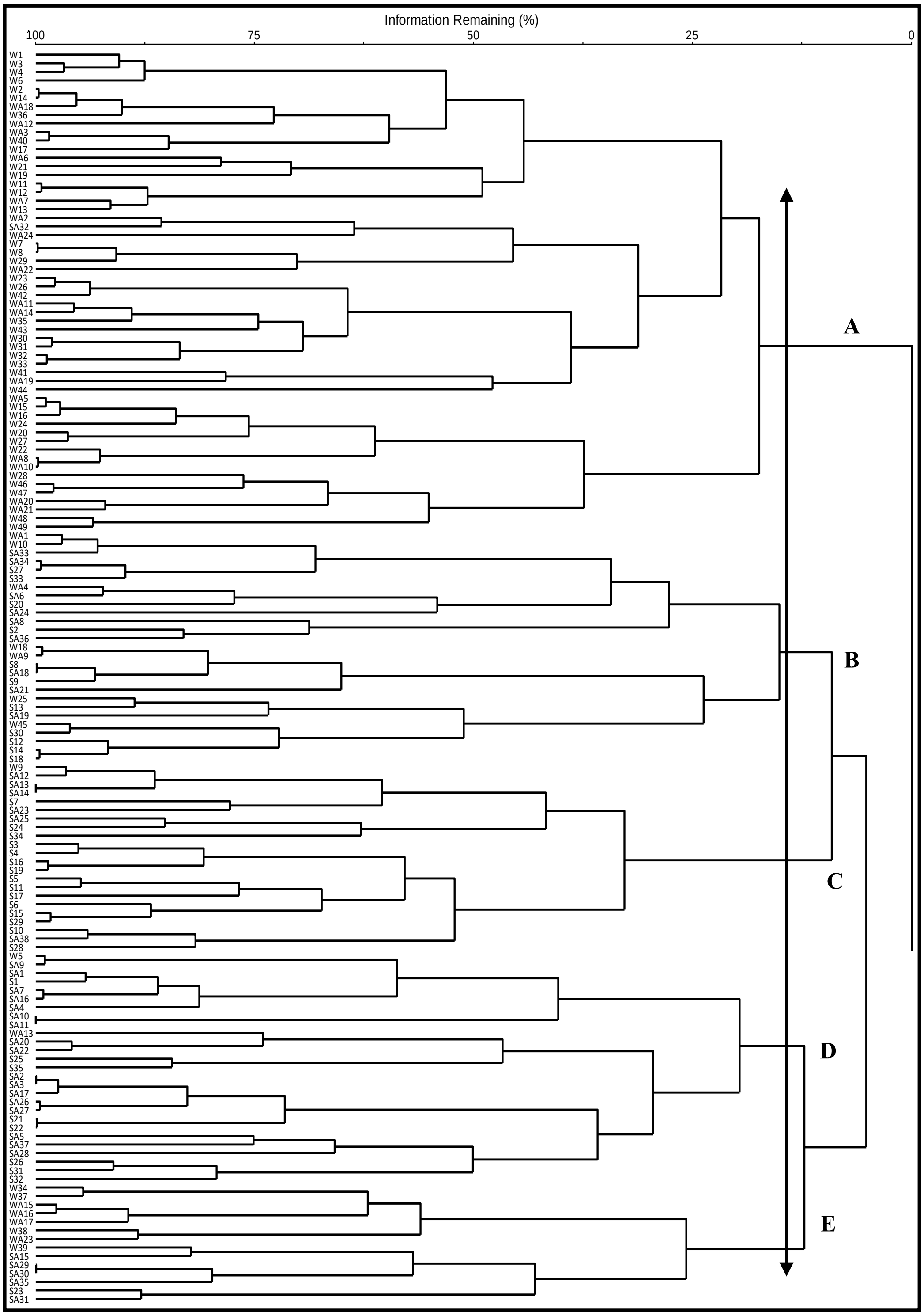

Fig. 2. Cluster analysis of the 146 stands, showing the separation of 5 vegetation groups (A-E). W=Wheat, WA=Alfa-alfa (winter season), S=*Sorghum*, SA=Alfa-alfa (summer season).

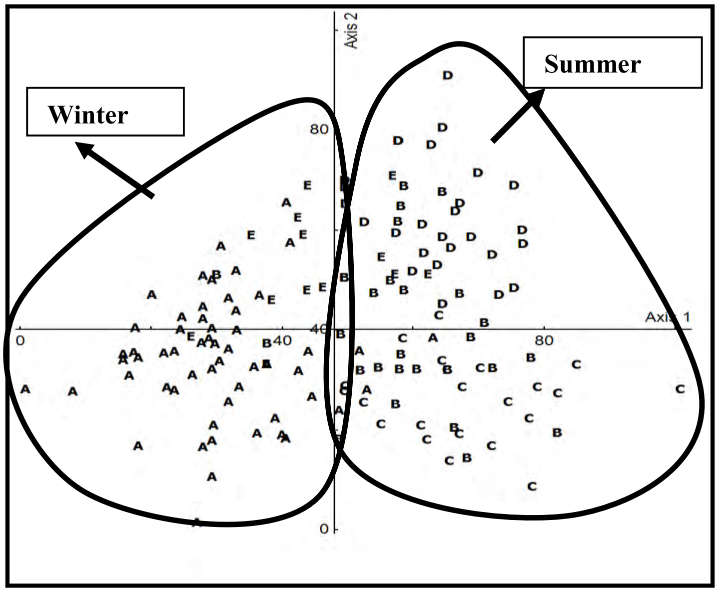

Fig. 3. Bray-Curtis ordination of 146 stands indicating the separation of the five vegetation groups (A-E) along the first two axes. For abbreviations, see Fig. 2.

Discussion

The 169 recorded species were distributed within 39 families. The six major families based on the number of species were: Poaceae (34 species), Asteraceae (18 species), Fabaceae (14 species), Brassicacea, Chenopodiaceae (13 species for each) and Euphorbiaceae (10 species); they accounted for 60.4%. These families represent the most common in the Mediterranean North African flora (Quézel, 1978), and also the most important in small-scale farming in highland Peru, central Mexico and northern Zambia (Vibrans, 1998).

Annuals (grasses, herbs and forbs) constituted the main bulk of the total flora, where 102 species (c. 60% of the total) were recorded. The dominance of annuals could be related to their high reproductive capacity, ecological, morphological and genetic plasticity under high level of disturbance (Grime, 1979). The short life cycle of annuals as well as the prevailing climatic conditions and water availability lead to their frequent occurrence (Shaltout and El- Fahar, 1991). The short life cycles of field crops, in addition to the adverse climatic conditions, moisture deficiency and substrate instability probably lead to the frequent occurrence of annuals during the favourable seasons. Da Costa *et al.* (2007) reported that annuals were the most dominant life form in arid and semi-arid areas. On the contrary, the low number (63 species; 37% of the total) of perennials (trees, shrubs, grasses and herbs) might be related to the intensive management used in the plantations, such as ploughing, sub-soiling, harrowing, levelling, and furrowing operations, which could affect vegetative growth structures, as well as the life cycles of the perennial weeds. The wide distribution of some weeds may be attributed to their being ubiquitous species with wide amplitude (e.g., *Cynodon dactylon, Sonchus oleraceus* and *Chenopodium murale*) often caused by phenotypic plasticity and heterogeneity (Shaltout and Sharaf El-Din, 1988). Restricted distribution of some weeds can be attributed to the habitat preference phenomenon. The type of crop, seasonal preferences and ecological factors may explain the differences in number clearly observed among different crop farmlands. Meanwhile, desert species showed notable variation. The higher number of desert species (25 species) in alfa-

alfa fields compared to other crops may be attributed to the ploughing scarcity of this crop. Such invasion of the desert plant species can be also attributed to anthropogenic factors, livestock grazing or other household purposes in addition to fragmentation by road network and urban sprawl in the area. These findings were in concord with Abd El-Ghani *et al.* (2015) in Wadi El-Natrun (Western Desert of Egypt) and Abd El-Ghani *et al.* (2013) in the Nile Valley. The decline of desert perennials in other crops in the reclaimed lands may confirms decreasing of xerophytic species which are replaced by mesophytic and canal bank species. Similar conclusion was reported by Soliman (1996 in the list) and Abd El-Ghani *et al.* (2013).

Phytogeographically, Egypt is the meeting point of floristic elements belonging to at least 4 different regions: The African Sudano-Zambezian, the Asiatic Irano-Turanian, the Afro-Asiatic Saharo-Arabian, and the Euro-Afro-Asiatic Mediterranean (El Hadidi, 1993). The chorological analysis of the recorded species revealed that the widely distributed species belonging to cosmopolitan, palaeotropical and pantropical chorotypes constituted 45 species, indicating that the floristic structure of the study area is relatively simple as compared with other areas of Egypt, being more affected by human disturbances (Shaltout and El-Fahar, 1991; Abd El-Ghani *et al.,* 2011). Pure Mediterranean species were very poorly represented; while bi- and tri-regional Mediterranean chorotypes were fairly represented. The Saharo-Arabian chorotype either pure or penetrated into other regions (mono-, bi- and tri-regional) dominated the recorded flora. The Saharo-Arabian plants are known as good indicators for hot arid climate as they can tolerate the extreme harsh environmental conditions in these areas**,** while Mediterranean species stand for more mesic environs. Similar results were reported in other reclaimed areas all over the country; e.g., El-Amry (1981) in Minya Province; Soliman (1989) in Tahrir area; Mustafa (2002) and Shaheen (2002) in Upper Egypt; Abd El-Ghani and Fawzy (2006) in the Egyptian Oases.

Ballochores (33 species), followed by pogonochores (25 species) and desmochores (24 species) were the most represented dispersal types that characterized the flora of the present study. As the three aforementioned seed dispersal types dominate the annual (herbs, grasses and forbs) weedy species, sarchochores (6 species) and pyrenochores (5 species) dominate the woody perennial species (herbs, grasses, trees and shrubs). On the other hand, cyclochores (7 species) and auxochore (4 species) were the least represented (Fig. 4). The prevalence of pogonochores (diasporas have long hairs) and desmochores (diasporas with short, stiff, spiny, glandular or hooked appendages) over the barochores (very heavy diaspores) and cyclochores (voluminous diaspores) reflect the suitability for wind dispersal in the study area. The dispersal spectrum of the present study is similar to that reported by El-Sheikh (1996). The annual weedy species with anemochore small seeds are very rapidly regenerated. This regeneration is due to the fact that these species produce larger numbers of light small seeds which are more capable of expansion over large areas, and of penetrating the soil, and tend to survive longer in a seed bank. In addition, the large seeds of woody perennial species have a lower dispersal and colonization ability solely on the basis of low seed number (Grime, 1979; Azcárate *et al.*, 2002).

In terms of classification, the associated vegetation can be divided into 5 vegetation groups: Group A codominated by *Cynodon dactylon, Sonchus oleraceus* and *Chenopodium murale*, Group B codominated by *Cynodon dactylon* and *Phoenix dactylifera,* Group C codominated by *Cynodon dactylon*, *Echinochloa colona* and *Portulaca oleracea*, Group D codominated by *Cynodon dactylon*, *Phoenix dactylifera* and *Tamarix nilotica,* and Group E codominated by *Cynodon dactylon* and *Suaeda aegyptiaca*. The vegetation groups B, C and D were represented by species in the stands of millet and alfa-alfa (summer season), whereas groups A and E were mainly represented by weedy species in the stands of wheat and alfa-alfa (winter season). Some of the identified vegetation groups were also recorded in similar studies (Abd El-Ghani, 1994; Gomaa, 2012; Abd El-Ghani *et al.,*2012 and 2015). Such classification indicates the significant effects of both crop and season on the weed community composition and structure. The identified vegetation groups from classification in the present study were separated along the first two Bray-Curtis ordination axes. Thus, the ordination analysis also strengthens the importance of crop and season for the formation of weed community. These results are coinciding with those of Andersson and Milberg (1998), who pointed out that season and crop type, contribute to the composition of weed community. Fertilization regimes, soil management practices, application of herbicides and weed management may vary depending on the crop type, and these factors influence weed community composition may be also of equal effect (Légere and Samson, 1999; Leeson *et al.,* 2000).

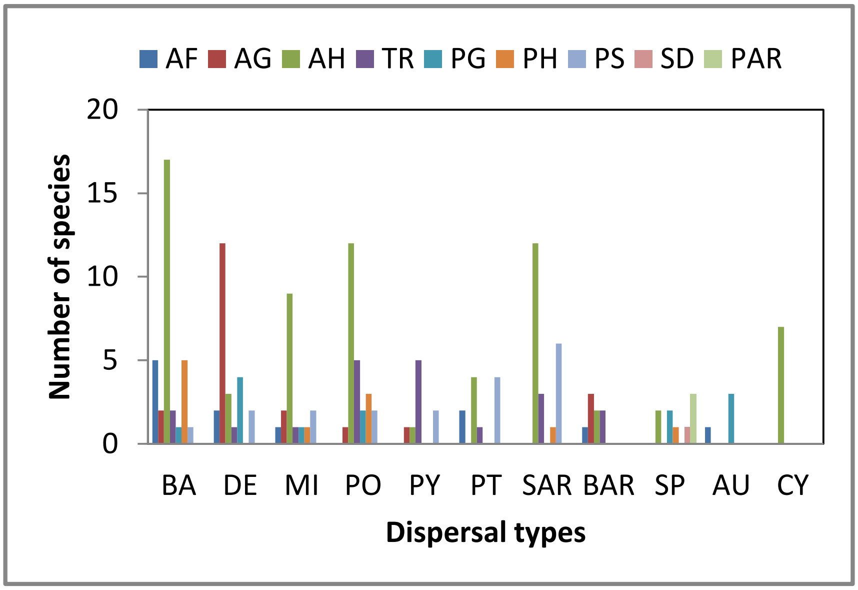

Fig. 4. Distribution of seed dispersal types in life form categories. For abbreviations, see Table (1).

References

Abd El-Ghani, M.M. 1994. Weed plant communities of orchards in Siwa Oasis. *Feddes Repertorium* **105:** 387–398.

Abd El-Ghani, M.M. & Fawzy, A.M. 2006. Plant diversity around springs and wells in five oases of the Western Desert, Egypt. *International Journal of Agriculture and Biology* **8:** 249–255.

Abd El-Ghani, M.M., Abo El-Kheir, M., Abdel-Dayem, M. & Abd El-Hamid, M. 2011. Vegetation analysis and soil characteristics of five common desert climbing plants in Egypt. *Turkish Journal of Botany* **35:** 561-580.

Abd El-Ghani, M.M., Hamdy, R.S. & Hamed A.B. 2015. Habitat diversity and floristic analysis of Wadi El-Natrun Depression, Western Desert, Egypt. *Phytologia Balcanica* **21(3):** 351–366.

Abd El-Ghani, M.M., Shehata, M.N. Mobarak, A. & Bakr, R. 2012. Factors affecting the diversity and distribution of synanthropic vegetation in urban habitats of the Nile Delta, Egypt. *Rendiconti Lincei* **23:** 327–337.

Abd El-Ghani, M.M., Soliman, A., Hamdy, R. & Bennoba. E. 2013. Weed flora in the reclaimed lands along the northern sector of the Nile Valley in Egypt. *Turkish Journal of Botany* **37:** 464-488.

Åfors, M. 1994. Weeds and weed management in small-scale cropping systems in northern Zambia. Valsätra-Ultuna, Sweden: Crop Production

Science, Swedish University of Agricultural Science.

Albrecht, H. 1995. Changes in the arable weed flora of Germany during the last five decades. In: *Ninth EWRS (European Weed Research Society) Symposium on 'Challenges for Weed Science in Changing Europe'*, Budapest, 41–48.

Andersson, T.N. & Milberg, P. 1998. Weed flora and the relative importance of site, crop, crop rotation and nitrogen. *Weed Science* **46:** 30-38.

Andreasen, C. & Skovgaard, I.M. 2009. Crop and soil factors of importance for the distribution of plant species on arable fields in Denmark. *Agriculture, Ecosystem and Environment*, 133: 61-67.

Anonymous 1980. Climatological normals for the Arab Republic of Egypt up to 1975. Ministry of Civil Aviation, Meteorological Authority, Cairo. pp. 443.

Ayyad, M.A. & Ghabbour, S.I. 1986. Hot deserts of Egypt and the Sudan. In: Evenari, M. Noy-Meir, I. & Goodall, D. W. (eds.). *Ecosystems of the World 12B, Hot Deserts and Arid Shrublands*. Amsterdam, Elsevier, 149-202.

Azcárate, F.M., Sánches, A.M., Arqueros, L. & Peco, B. 2002. Abundance and habitat segregation in Mediterranean grassland species: the importance of seed weight. *Journal of Vegetation Science* **13:** 159-166.

Baessler, C. & Klotz, S. 2006. Effects of changes in agricultural landuse on landscape structure and arable weed vegetation over the last 50 years. *Agriculture, Ecosystem and Environment* **115:** 43-50.

Becker, B., Terrones, F. & Horchler, P. 1998. Weed communities in Andean cropping systems of northern Peru. *Angewandte Botanik* **72:** 113–130.

Biswas, A.K. 1993. Land resources for sustainable agricultural development in Egypt. *Ambio* **22:** 556-560.

Boulos, L. 1966. Flora of the Nile region in the Egyptian Nubia. *Feddes Repertorium* **73:** 184-215.

Boulos, L. 1999-2005. *Flora of Egypt*. Vols. 1-4. Al Hadara Publishing, Cairo, Egypt.

Boulos, L. 2009. *Flora of Egypt. Checklist.* Revised Annotated Edition. Al Hadara Publishing, Cairo, Egypt.

Da Costa, R.C., de Araújo, F.S. & Lima-Verde, L.W. 2007. Flora and life-form spectrum in an area of deciduous thorn woodland (Caatinga) in northeastern, Brazil. *Journal of Arid Environments* **68:** 237-247.

Danin, A., Shmida, A. & Liston, A. 1985. Contributions to the flora of Sinai, III. Checklist of the species collected and recorded by the Jerusalem team 1967-1982. *Willdenowia* **15:** 255-322.

Dansereau, P. & Lems, K. 1957. The grading of dispersal types in plant communities and their ecological significance. *Botanique Institute Botany, University Montreal* **71:** 1-52.

El-Amry, M.I. 1981. Plant life in Minya Province, Egypt. M. Sc. Thesis, Cairo University, Cairo.

El Hadidi, M.N. 1993. Natural vegetation. In Craig, G.M. (eds.). *The Agriculture of Egypt*. Oxford University Press, Oxford, 39-62.

El Hadidi, M.N. & Fayed, A. 1994/95. Material for excursion flora of Egypt (EFE). *Taeckholmia* **15:** 1-233.

El Hadidi, M.N. & Ghabbour, S.I. 1968. Floristic study of the Nile Valley at Aswan. *Revue Zoologique et Botanique Africaine* **78:** 394-407.

El Hadidi, M.N. & Kosinová, J. 1971. Studies on the weed flora of cultivated lands of Egypt. I. Preliminary survey. *Bot. Staatssamml. München* **10:** 354-367.

El-Sheikh, M.A. 1996. Ruderal plant communities of the Nile Delta region. Ph. D. Thesis, Tanta University, Tanta.

El-Sheikh, M.A. 2005. Plant succession on abandoned fields after 25 years of shifting cultivation in Assuit, Egypt. *Journal of Arid Environments* **61:** 461-481.

Gomaa, N.H. 2012. Soil seed bank in different habitats of the Eastern Desert of Egypt. *Saudi Journal of Biological Sciences* **19:** 211-220.

Grime, J.P. 1979. *Plant Strategies and Vegetation Processes*. John Wiley and Sons, New York.

Hassannejad, S., Pirouie, M.S. & Abbasvand, E. 2014. Weed species distributed in wheat fields at Uremia (Northwest Of Iran). *International Journal of Scientific Research* **2:** 1-8.

Hassib, M. 1951. Distribution of plant communities in Egypt. *Bulletin of Faculty of Science, Fouad I University* **29:** 59-261.

Holzner, M. 1978. Weed species and weed communities. *Vegetatio* **38:** 13-20.

Jabeen, N. & Ahmed, M. 2009. Possible allelopathic effects of three different weeds on germination and growth of maize (*Zea mays*) cultivars. Pakistan Journal of Botany **41(4):** 1677-1683.

Leeson, J.Y., Sheard, J.W. & Thomas, A.G. 2000. Weed communities associated with arable Saskatchewan farm management systems. *Canadian Journal of Plant Science* **80:** 177-185.

Légere, A. & Samson, N. 1999. Relative influence of crop rotation, tillage, and weed management on weed associations in spring barley cropping systems. *Weed Science* **47:** 112-122.

Lososova, Z., Chytry, M., Cimalova, S., Kropac, Z., Otypkova, Z., Pysek, P. & Tichy, L. 2004. Weed vegetation of arable land in Central Europe: gradients of diversity and species composition. Journal of Vegetation Science **15:** 415-422.

Ludwig, J.A. & Reynolds, J.F. 1988. *Statistical Ecology.* John Wiley and Sons, New York.

Marshall, E.J.P., Brown, V.K., Boatman, N.D., Lutman, P.J.W., Squire, G.R., & Ward, L.K. 2003. The role of weeds in supporting biological diversity within crop fields. *Weed Research* **43:** 77-89.

Mashaly, I.A., El-Halawany, E.F. & Abd El-Gawad, A.M. 2011. Ecology of weeds and invasive plant species in newly reclaimed areas in Nile Delta, Egypt. *Journal of Environmental Sciences* **40(1):** 69-90.

McCune, B. & Grace, J.B. 2002. Analysis of Ecological Communities. MJM Software Design, Gleneden Beach, Oregon pcord.

McCune, B. & Mefford, M.L. 1999. PC-ORD. Multivariate Analysis of Ecological Data, Version 4. MJM Software Design, Gleneden Beach.

Mustafa, G. 2002. Some aspects of the biodiversity of the weed flora of the farmlands in Upper Egypt. M. Sc. Thesis, Cairo University, Cairo, Egypt.

Müller-Dombois, D. & Ellenberg, H. 1974. *Aims and Methods of Vegetation Ecology*. Wiley, New York.

Pielou, E.C. 1975. *Ecological Diversity*. Wiley, Interscience, New York.

Pyšek, P., Jarošik, V. & Kučera, T. 2002. Patterns of invasion in temperate nature reserves. *Biological Conservation* **104:** 13-24.

Qasem, J.R. & Hill, T.A. 1995. Growth, development and nutrient accumulation in *Senecio vulgaris* L and *Chenopodium album* L. *Weed Research* **35:** 187-196.

Quézel, P. 1978. Analysis of the flora of Mediterranean and Saharan Africa. *Annals of the Missouri Botanical Garden* **65:** 479-534.

Rabinowitz, D. 1981. Seven formals of rarity. In Synge, H. (eds.). *The Biological Aspects of Rare Plant Conservation*, John Wiley and Sons Ltd, London, 205-217.

Saavedra, M., Garcia-Torres, L., Hernandez-Bermjo, E. & Hidalgo, B. 1989. Weed flora of the Middle Valley of the Guadalquivir, Spain. *Weed Research* **29:** 167-179.

Shah, G.M., Khan, M.A. 2006. Checklist of noxious weeds of district Mansehra, Pakistan. *Pakistan Journal of Weed Science Research* **12(3):** 213–219.

Shaheen, A.M. 2002. Weed diversity of newly farmed land on the southern border (Eastern and Western shores of Lake Nasser). *Pakistan Journal of Biological Sciences* **5(7):** 802-806.

Shaltout, K.H. & El-Fahar, R. 1991. Diversity and phenology of weed communities in the Nile Delta region.

Journal of Vegetation Science **2:** 385-390.

Shaltout, K.H. & Sharaf El-Din, A. 1988. Habitat types and plant communities along transect in the Nile Delta region. *Feddes Repertorium* **99:** 153-162.

Shaltout, K.H., Sharaf El-Din, A. & Ahmed, D.A. 2010. *Plant life in the Nile delta*, Tanta University Press, Tanta, Egypt.

Shehata, M.N. & El-Fahar, R.A. 2000. The vegetation of reclaimed areas in Salhiya region. In: *Proceedings of the 1st International Conference on Biological Science (ICBS)*, Faculty of Science, Tanta University **1:** 315-332.

Soliman, A.T. 1989. Studies on plant life in the area of South Tahrir. M. Sc. Thesis, Cairo University, Cairo.

Soliman, A.T. 1996. Studies on plant life in newly reclaimed areas west of the Delta. Unpublished Ph.D. Thesis, Cairo University, Cairo.

Sutcliffe, O.L. & Kay, Q.O. N. 2000. Changes in the arable flora of central southern England since the 1960s. *Biological Conservation* **93:**1-8.

Täckholm, V. 1974. *Students' Flora of Egypt.* (2nd Edn.). Cairo University Press, Cairo.

Tadros, T.M. & Atta, A. 1958. The plant communities of barley fields and uncultivated desert areas of Mareotis (Egypt). *Vegetatio* **8:** 161-175.

Tamado, T. & Milberg, P. 2000. Weed flora in arable fields of eastern Ethiopia with emphasis on the occurrence of *Parthenium hysterophorus*. *Weed Research* **40:** 507-521.

Vibrans, H. 1998. Native maize field weed communities in southcentral Mexico. *Weed Research* **38:** 153-166.

Whittaker, R.H. 1972. Evolution and measurement of species diversity. *Taxon* **21:** 213-251.

Wittig, R. 2002. *Siedlungsvegetation*. Stuttgart: Eugen Ulmer (in German).

Zahran, M.A. & Mashaly, I.A. 1991. Ecological notes on the flora of the Red Sea coastal land of Egypt. *Bulletin of the Faculty of Science, Mansoura University* **18(2):** 251-292.