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Variations in floristic composition of wild and cultivated species associated with *Moringa oleifera* Lam. in Egypt

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Abstract

The aim of this work is to study the cultivated and wild species associated with *Moringa oleifera* in different sites in Egypt. The cultivated species were 174 related to 145 genera and 67 families, while the wild species were 45 related to 39 genera and 21 families. Fabaceae was the most represented cultivated family (15 species), while Poaceae was the most represented wild family (8 species). *Phoenix dactylifera* and *Portulaca oleracea* were the most common cultivated and wild species, respectively. Phanerophytes were the most represented life form, regarding the cultivated species (79.5%), whereas therophytes were the most represented life form (62.2%). The application of Two Way Indicator Species Analysis (TWINSPAN) on the floristic composition of the sampled stands led to classify them into 7 vegetation groups at level 5 for the cultivated species, and 5 groups at level 3 for the wild species. The cultivated groups were named according to their dominant species as follows: *Ficus elastica, Abutilon hirtum, Cordia myxa, Carya illinoensis, Azadirachta indica, Ficus benjamina* and *Ceiba speciosa*. In addition, the wild groups were: *Pancratium maritimum, Digitaria ciliaris, Cyperus rotundus, Lantana camara* and *Bidens pilosa*.

***Key words*:** Cultivated species, Wild species, Life form, TWINSPAN, DECORANA.

Introduction

Moringa oleifera (family: Moringaceae) is native to India and many countries in Africa, Arabia, Southeast Asia and South America (Iqbal & Bhanger, 2006). This tree is known as "drumstick tree" because its pods are used by drummers, and the "horseradish tree" due to the flavor of its roots (Palada & Chang, 2003). *M. oleifera* is a multipurpose that has nutritional (Anwar *et al.*, 2005), medicinal (Kajihara *et al*., 2008), antifungal (Akinbode & Ikotun, 2008), antibacterial (Mohan *et al.*, 2006), antiviral (Virmani & Garg, 2005) and nematicidal properties (Pandey *et al.*, 2001).

In Egypt, Diwan *et al.* (2004) and Hamdy *et al.* (2007) listed it as a cultivated species in Orman Botanic Garden. Moreover, Khalifa and Loutfy (2006) recorded it in Faculty of Science and Faculty of Education Botanic Gardens (Ain Shams University), Zoo Garden plant collection and Aswan Botanic Garden. It was also recorded by Heneidy (2010) in Botanic Garden of Faculty of Science (Alexandria University). Recently, Ammar (2015) listed this tree among the garden flora characterizing the Nile Delta. The aim of this paper was to survey the cultivated and wild species associated with the distribution of *M. oleifera* in many sites in Egypt, and to estimate the main characteristics of these associated species (e.g., life forms, presence and cover percentage).

Material and methods

Thirteen stands were sampled during September and October 2009 in 8 studied sites in Egypt (Table 1). The coordinates of each stand were determined using GPS. The area of each stand was about 20 × 20 m, but that of Qanatir Horticulture Research

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Table 1 - Features of the 8 studied botanic sites in Egypt.

Site	Governorate	Latitude (N)	Longitude (E)	Area (ha)	Construction date
1-Sheikh Zuweid Station	North Sinai	31° 14' 10"	34° 06' 53"	6.9	1995
2- Faculty of Science, Alexandria University	Alexandria	31° 11' 23.9"	29° 54' 27.9"	1.4	1942
3- Antoniadis Garden	Alexandria	31° 12' 15.0"	29° 56' 56.1"	18.9	1860
4- Qanatir Horticulture Research Institute	Qalubeiya	30° 10' 56.0"	31° 07' 50.7"	7.6	-
5- Faculty of Science } Ain Shams	Cairo	30° 04' 38.7"	31° 16' 56.3"	1.3	1953
6- Faculty of Education } University	Cairo	30° 05' 29.6"	31° 18' 35.5"	0.07	1994
7- Orman Botanic Garden	Giza	30° 01' 49.1"	31° 12' 47.1"	11.3	1873
8- Aswan Botanic Garden	Aswan	24° 05' 33.8"	32° 53' 07.4"	7.5	1928

Institute was approximately 250 × 6 m; as the distribution of *M. oleifera* extends along the field edges.

Floristic identification of *M. oleifera* was according to Bailey (1960), while the associated cultivated species in different studied sites were identified according to RHS (1992) and Botanica (2004). The associated wild species were identified according to Täckholm (1974) and Boulos (1999; 2000; 2002; 2005). Moreover, Latin names of species were updated following The Plant List (2013) and APG II System.

In each stand, the presence of cultivated and wild species associated with *M. oleifera* was recorded (during September and October 2009). Also, the following characters were determined for each species: life form and percent of plant cover. Life forms were identified according to the well-known system of Raunkiaer (1934). The percentage of cover occupied by each associated species was determined visually following Braun-Blanquet cover-abundance scale (Muller-Dombois & Ellenberg, 1974).

Two trends of multivariate analysis were applied to the vegetation data in the present study: classification and ordination. Both trends have their merits in assisting to understand the vegetation and environmental phenomena. The two-way indicator species analysis, as a classification technique (Hill, 1979 a) and deterended correspondence analysis, as an ordination one (Hill, 1979 b). (TWINSPAN) and (DECORANA) were applied to the matrix of the presence-absence of 219 species (174 cultivated and 45 wild) the designed stands.

Results

1. Cultivated species

1. 1. Taxonomic diversity

The cultivated species associated with *M. oleifera* were 174, related to 145 genera and 67 families (Table 2, Fig. 1). Dicotyledonous families were 49 represented by 111 genera and 134 species; the highly represented of them were Fabacea (15 species), Moraceae (9 species), Rutaceae (8 species) and Malvaceae (7 species). Each of Apocynaceae, Araliaceae and Solanaceae were represented by 6 species. In addition, 24 dicotyledonous families were represented only by one species. Monocotyledonous families were 12; the highly represented of them were Arecaceae (9 species), Asparagaceae (8 species) and Araceae (5 species). Gymnosperms were represented by 6 families, 8 genera and 8 species.

Each of Cupressaceae and Zamiaceae were represented by 2 species; while each of Araucariaceae, Cycadaceae, Ginkgoaceae and Pinaceae were represented by one species only. *Phoenix dactylifera* was the most common associated cultivated species (presence > 35%), followed by *Ailanthus altissima*, *Duranta erecta*, *Ficus elastica*, *Leucaena leucocephala*, *Olea europaea*, *Schinus terebinthifolia* and *Washingtonia robusta*.

Taxonomic diversity of the 8 studied sites indicated that the maximum number of species, genera and families was recorded in Faculty of Science - Ain Shams University, while Sheikh Zuweid had the minimum number of species and genera. The maximum number of dicotyledons and monocotyledons was recorded in Botanic Garden of Faculty of Science - Ain Shams University, whereas the minimum number of dicotyledons was recorded in Sheikh Zuweid and that of monocotyledons was recorded in Sheikh Zuweid and Orman Botanic Garden. The

maximum number of gymnospermic families was in Faculties of Science and Education - Ain Shams University (Table 3).

Table 2 - Cultivated species associated with *Moringa oleifera* in the 13 studied stands in Egypt. P: presence and C: cover. Life forms are coded as follows: Ph: phanerophytes, Ch: chamaephytes, Hc: hemicryptophytes, Ge: geophytes, Th: therophytes.

Species	Family	Life form	P	C
			(%)	
Abutilon hirtum (Lam.) Sweet.	Malvaceae	Ch	28.6	15
Acacia farnesiana (L.) Willd.	Fabaceae	Ph	7.1	1
Acalypha wilkesiana Müell. Arg.	Euphorbiaceae	Ph	14.3	2
Acer negundo L.	Sapindaceae	Ph	7.1	4
Acokanthera oblongifolia (Hochst.) Benth. & Hook.f. ex B. D. Jacks.	Apocynaceae	Ph	14.3	4
Agave americana L.	Asparagaceae	Hc	14.3	3
Ailanthus altissima (Mill.) Swingle	Simaroubaceae	Ph	35.7	11
Alcea rosea L.	Malvaceae	Ch	14.3	3
Alocasia macrorrhizos (L.) G. Don	Araceae	Ch	14.3	2
Aloe ciliaris Haw.	Xanthorrhoeaceae	Hc	7.1	1
A. vera (L.) Brum. f.	Xanthorrhoeaceae	Hc	7.1	1
Alpinia officinarum Hance	Zingiberaceae	Ge	7.1	1
Annona muricata L.	Annonaceae	Ph	7.1	1
A. squamosa L.	Annonaceae	Ph	7.1	1
Araucaria heterophylla (Salisb.) Franco	Araucariaceae	Ph	14.3	4
Aristolochia littoralis Parodi	Aristolochiaceae	Hc	7.1	1
Asparagus densiflorus (Kunth) Jessop	Asparagaceae	Hc	7.1	1
A. setaceus (Kunth) Jessop	Asparagaceae	Hc	7.1	1
Azadirachta indica A Juss.	Meliaceae	Ph	14.3	11
Bauhinia variegata L.	Fabaceae	Ph	7.1	4
Beaumontia grandiflora Wall.	Apocynaceae	Ph	14.3	3
Bougainvillea spectabilis Willd.	Nyctaginaceae	Ph	7.1	1
Brachychiton acerifolius (A. Cunn. ex G. Don) F. Muell.	Malvaceae	Ph	7.1	1
Breynia disticha J. R. Forst. & G. Forst.	Phyllanthaceae	Ph	7.1	1
Brunfelsia australis Benth.	Solanaceae	Ph	7.1	1
Caesalpinia palmeri S. Watson	Fabaceae	Ph	7.1	2
Canna indica L.	Cannaceae	Ge	7.1	1
Cardiospermum halicacabum L.	Sapindaceae	Ph	7.1	2
Carya illinoensis (Wangenh.) K. Koch	Juglandaceae	Ph	21.4	19
Caryota mitis Lour.	Arecaceae	Ph	7.1	1
Cascabela thevetia (L.) Lippold	Apocynaceae	Ph	21.4	6
Casimiroa edulis La Llave	Rutaceae	Ph	14.3	2
Cassia fistula L.	Fabaceae	Ph	7.1	1
Ceiba speciosa (A. St. - Hil.) Ravenna	Malvacea	Ph	21.4	17
Cereus uruguayanus R. Kiesling	Cactaceae	Ph	7.1	1
Cestrum nocturnum L.	Solanaceae	Ph	14.3	4
C. parqui (Lam.) L´Hér.	Solanaceae	Ph	7.1	1
Cinnamomum verum J. Presl	Lauraceae	Ph	14.3	2
Citharexylum spinosum L.	Verbenaceae	Ph	7.1	2
Citrus aurantium L.	Rutaceae	Ph	14.3	2
C. aurantifolia (Christm.) Swingle	Rutaceae	Ph	7.1	1

Table 2 - cont. 1

Species	Family	Life form	P	C
			(%)	
C. maxima (Brum.) Merr.	Rutaceae	Ph	7.1	2
C. reticulata Blanco	Rutaceae	Ph	7.1	1
C. sinensis (L.) Osbeck.	Rutaceae	Ph	14.3	2
Clematis flammula L.	Ranunculaceae	Ph	7.1	2
Clivia miniata (Lindl.) Boose	Amaryllidaceae	Hc	7.1	2
Codiaeum variegatum (L.) Rumph. ex A. Juss.	Euphorbiaceae	Ph	28.6	4
Coffea arabica L.	Rubiaceae	Ph	7.1	1
Cordia myxa L.	Boraginaceae	Ph	7.1	7
Cupressus sempervirens L.	Cupressaceae	Ph	14.3	3
Cycas revoluta Thunb.	Cycadaceae	Ph	21.4	3
Cyperus alternifolius L.	Cyperaceae	Hc	14.3	3
Dendrocalamus giganteus Munro	Poaceae	Ph	14.3	11
Dichrostachys cinerea (L.) Wight & Arn.	Fabaceae	Ph	7.1	1
Dioon edule Lind.	Zamiaceae	Ph	7.1	2
Dodonaea viscosa (L.) Jacq.	Sapindaceae	Ph	21.4	2
Dombeya burgessiae Gerr. ex Harv.	Malvaceae	Ph	14.3	4
Dracaena marginata hort.	Asparagaceae	Hc	28.6	11
Duranta erecta L.	Verbenaceae	Ph	35.7	7
Enterolobium cyclocarpum (Jacq.) Griseb.	Fabaceae	Ph	7.1	3
Eriobotrya japonica (Thunb.) Lindl.	Rosaceae	Ph	21.4	3
Erythrina caffra Thunb.	Fabaceae	Ph	7.1	2
E.corallodendrum L.	Fabaceae	Ph	7.1	2
Eugenia uniflora L.	Myrtaceae	Ph	7.1	1
Euonymus japonicus Thunb.	Celasteraceae	Ph	7.1	1
Ficus benjamina L.	Moraceae	Ph	21.4	9
F. carica L.	Moraceae	Ph	7.1	2
F. deltoidea Jack	Moraceae	Ph	7.1	3
F. elastica Roxb. ex Hornem.	Moraceae	Ph	35.7	14
F. lyrata Warb.	Moraceae	Ph	14.3	5
F. microcarpa L. f.	Moraceae	Ph	21.4	6
F. sycomorus L.	Moraceae	Ph	7.1	6
F. virens Aiton	Moraceae	Ph	7.1	3
Firmiana simplex (L.) W. Wight	Malvaceae	Ph	7.1	1
Galium sp.	Rubiaceae	Ch	7.1	1
Gerbera jamesonii Bolus ex Hook. f.	Asteraceae	Hc	7.1	1
Ginkgo biloba L.	Ginkgoaceae	Ph	14.3	2
Haematoxylum campechianum L.	Fabaceae	Ph	14.3	2
Harpullia pendula Planch. ex F. Muell.	Sapindaceae	Ph	7.1	3
Hedera helix L.	Araliaceae	Ph	7.1	2
Hemerocallis fulva (L.) L.	Xanthorrhoeaceae	Ge	7.1	1
Hibiscus rosa-sinensis L.	Malvaceae	Ph	14.3	3
Hiptage sp.	Malpighiaceae	Ph	7.1	1
Hyphaene thebaica (L.) Mart.	Arecaceae	Ph	7.1	1
Ipomoea cairica (L.) Sweet	Convolvulaceae	Hc	7.1	2

Table 2 - cont. 2

Species	Family	Life form	P (%)	C
I. carnea Jacq.	Convolvulaceae	Ch	14.3	3
Jacaranda mimosifolia D. Don	Bignoniaceae	Ph	7.1	2
Jasminum officinale L.	Oleaceae	Ph	7.1	1
Jatropha curcas L.	Euphorbiaceae	Ph	7.1	2
Justicia adhatoda L.	Acanthaceae	Ph	14.3	4
Kigelia africana (Lam.) Benth.	Bignoniaceae	Ph	7.1	2
Koelreuteria paniculata Laxm.	Sapindaceae	Ph	14.3	2
Lagerstroemia indica L.	Lythraceae	Ph	7.1	1
Laurus nobilis L.	Lauraceae	Ph	28.6	8
Lawsonia inermis L.	Lythraceae	Ph	7.1	1
Leucaena leucocephala (Lam.) De Wit.	Fabaceae	Ph	35.7	14
Livistona chinensis (Jacq.) R. Br. ex Mart.	Arecaceae	Ph	7.1	2
Lonicera japonica Thunb.	Caprifoliaceae	Ch	7.1	2
Lycianthes rantonnei (Carrière) Bitter	Solanaceae	Ph	14.3	2
Magnolia grandiflora L.	Magnoliaceae	Ph	7.1	2
Mangifera indica L.	Anacardiaceae	Ph	7.1	2
Markhamia lutea (Benth.) K. Schum.	Bignoniaceae	Ph	7.1	2
Melaleuca ericifolia Sm.	Myrtaceae	Ph	7.1	2
Mesembryanthemum cordifolium L. f.	Aizoaceae	Ch	7.1	1
Monstera deliciosa Liebm.	Araceae	Ph	14.3	3
Morus alba L.	Moraceae	Ph	14.3	2
Murraea paniculata (L.) Jack	Rutaceae	Ph	14.3	2
Musa paradisiaca L.	Musaceae	Ph	14.3	2
Nandina domestica Thunb.	Berberidaceae	Ph	7.1	1
Nephthytis afzelii Schott.	Araceae	Hc	21.4	3
Nerium oleander L.	Apocynaceae	Ph	21.4	4
Ocimum basilicum L.	Lamiaceae	Ch	7.1	1
Olea europaea L.	Oleaceae	Ph	35.7	10
Oreopanax reticulatum Willd	Araliaceae	Ph	7.1	1
Passiflora caerulea L.	Passifloraceae	Ph	14.3	2
Pelarogonium zonale (L.) L'Hér. ex Aiton	Geraniaceae	Ph	7.1	1
Persea Americana Mill.	Lauraceae	Ph	7.1	1
Phoenix canariensis Hort. ex Chabaud.	Arecaceae	Ph	7.1	2
Ph. dactylifera L.	Arecaceae	Ph	50	25
Phytolacca dioica L.	Phytolaccaceae	Ph	14.3	5
Pinus sp.	Pinaceae	Ph	7.1	1
Pleiogynium timoriense (DC.) leenth.	Anacardiacea	Ph	7.1	1
Plinia edulis (Vell.) Sobral	Myrtaceae	Ph	7.1	1
Plumeria alba H. B. & K.	Apocynaceae	Ph	7.1	1
Polyscias guilfoylei (W. Bull) L. H. Bail.	Araliaceae	Ph	7.1	2
Pongamia pinnata (L.) Merr.	Fabaceae	Ph	7.1	2
Poplus nigra L.	Salicaceae	Ph	7.1	2
Prunus persica L.	Rosaceae	Ph	7.1	1
Punica granatum L.	Punicaceae	Ph	7.1	1

Table 2 - cont. 3

Species	Family	Life form	P (%)	C
Quercus robur L.	Fagaceae	Ph	7.1	6
Rosa sp.	Rosaceae	Ph	28.6	5
Rosmarinus officinalis L.	Lamiaceae	Ph	7.1	1
Roystonea regia (Kunth) O. F. Cook	Arecaceae	Ph	14.3	4
Ruscus aculeatus L.	Asparagaceae	Ge	28.6	4
Ruta graveolens L.	Rutaceae	Ph	14.3	2
Sabal Palmetto (Walt.) Lodd. ex Schult. & Schult. f.	Arecaceae	Ph	14.3	2
Salix mucronata Thunb.	Salicaceae	Ph	7.1	1
Salvia splendes Sellow ex Schult.	Lamiaceae	Ch	7.1	1
Sambucus nigra L.	Adoxaceae	Ph	14.3	2
Sansevieria trifasciata Prain	Asparagaceae	Ge	7.1	1
Schefflera actinophylla (Endl.) Harms	Araliaceae	Ph	7.1	2
S. elegantissima (Veitch ex Mast.) Lowry & Frodin	Araliaceae	Ph	7.1	3
S. umbellifera (Sond.) Baill.	Araliaceae	Ph	14.3	4
Schinus terebinthifolia Raddi	Anacardiaceae	Ph	35.7	6
Schotia brachypetala Sond.	Fabaceae	Ph	7.1	1
Senna didymobotrya (Fres.) H. S. Irwin & Barneby	Fabaceae	Ph	7.1	1
S. occidentalis (L.) Link	Fabaceae	Th	7.1	1
Simmondsia chinensis (Link) C. K. Schneid.	Simmondsiaceae	Ph	7.1	1
Solandra grandiflora Sw.	Solanaceae	Ph	7.1	2
Solanum diphyllum L.	Solanaceae	Ph	21.4	3
Sophora secundiflora (Ortega) DC.	Fabaceae	Ph	14.3	2
Spiraea thunbergii Siebold ex Blume	Rosaceae	Ph	7.1	1
Strelitzia nicoli Regel. & K. Koch	Strelitziaceae	Ph	14.3	2
S. reginae Banks	Strelitziaceae	Hc	7.1	1
Symphyotrichum novi-belgii (L.) G. L. Nesom	Asteraceae	Hc	7.1	1
Syngonium podophyllum Schott	Araceae	Hc	14.3	2
Tabebuia rosea (Betrol.) Bertero ex A. DC.	Bignoniaceae	Ph	7.1	1
Tabernaemontana divaricata (L.) R. Br. ex Roem. & Schult.	Apocynaceae	Ph	14.3	2
Taxodium distichum (L.) Rich.	Cupressaceae	Ph	14.3	5
Terminalia catappa L.	Combretaceae	Ph	7.1	2
T. arjuna (Roxb. ex DC.) Wight & Arn.	Combretaceae	Ph	7.1	4
T. mulleri Benth.	Combretaceae	Ph	7.1	1
Tradescantia pallida (Rose) D. R. Hunt	Commelinaceae	Ch	7.1	1
Vitex agnus-castus L.	Lamiaceae	Ch	14.3	2
Vitis vinifera L.	Vitaceae	Ph	14.3	2
Volkameria inermis L.	Lamiaceae	Ph	7.1	1
Washingtonia filifera (Linden ex André) H.Wendl. ex de Bary	Arecaceae	Ph	7.1	2
W. robusta H. Wendl.	Arecaceae	Ph	35.7	10
Yucca aloifolia L.	Asparagaceae	Ph	7.1	1

Species	Family	Life form	P (%)	C
Yucca gigantea Lem.	Asparagaceae	Ph	14.3	2
Zamia furfurasea L. f. ex Aiton	Zamiaceae	Hc	7.1	1
Zantedeschia aethiopica (L.) Spreng.	Araceae	Ge	7.1	1
Ziziphus jujuba Mill.	Rhamnaceae	Ph	7.1	1
Z. spina-christi (L.) Desf.	Rhamnaceae	Ph	14.3	2

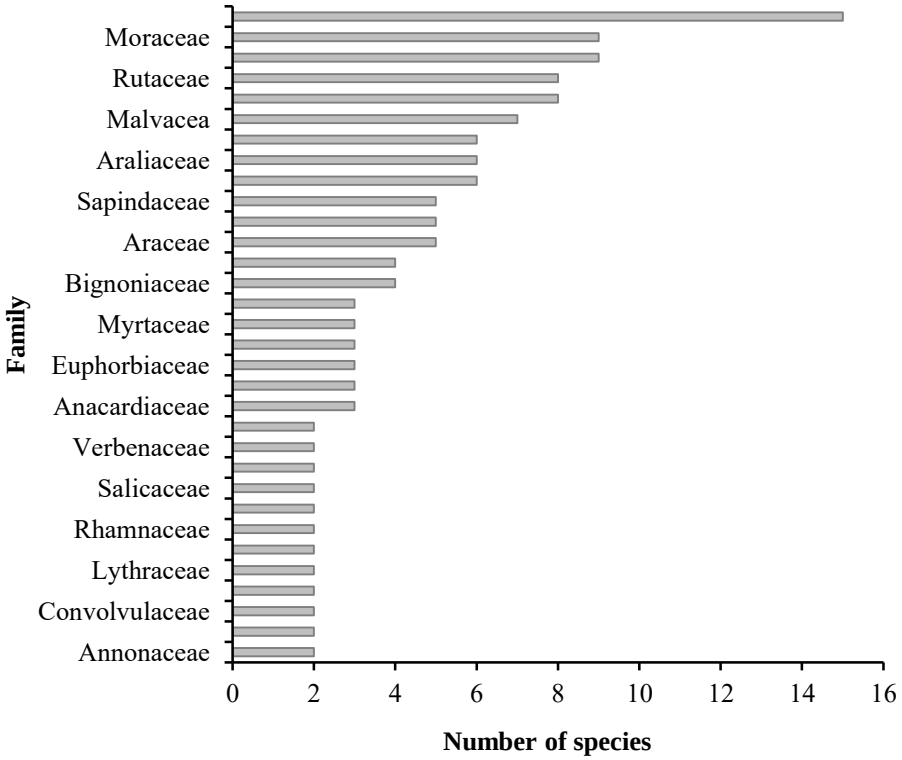


Fig. 1- Number of cultivated species associated with *Moringa oleifera* in relation to their families (families of < 2 species were not represented).

1. 2. Life forms

Determination of the life forms of the cultivated species associated with *M. oleifera* indicated that the most represented life form was the phanerophytes (140 species = 79.5% of the total species) followed by the hemicryptophytes (16 species = 9.1% of the total species), then chamaephytes (11 species = 6.3% of the total species) and geophytes (6 species = 3.4% of the total species). On the other hand, therophytes were the least represented (Fig. 2). Regarding the flora of the 8 studied sites, phanerophytes had the maximum representation in Faculty of Science - Ain Shams University, and the minimum in Sheikh Zuweid and Aswan Botanic Garden. Chamaephytes had the highest representation in Faculty of Science - Ain Shams University, while thus absent in Sheikh Zuweid and Orman Botanic Garden. Moreover, hemicryptophytes and geophytes were recorded in 3 studied sites only and their maximum representation was in Faculty of Science - Ain Shams University and Faculty of Science - Alexandria University. Therophytes were restricted to Faculty of Science - Ain Shams University (Table 4).

Table 3 - Taxonomic diversity of the cultivated species associated with *Moringa oleifera* in 8 studied sites in Egypt. Sheikh Zuweid Station (SZ), Botanic Garden of Faculty of Science - Alexandria University (XS), Antoniadis Botanic Garden (XA), Qanatir Horticulture Research Institute (QA), Botanic Garden of Faculty of Science - Ain Shams University (SA), Botanic Garden of Faculty of Education - Ain Shams University (ED), Orman Botanic Garden (OR) and Aswan Botanic Garden (AS).

Taxic variable	Study site								Total
	SZ	XS	XA	QA	SA	ED	OR	AS	
Dicotyledons									
Species	3	23	14	6	80	49	10	4	134
Genus	3	23	14	5	66	47	10	4	111
Family	3	15	14	5	38	26	7	4	49
Monocotyledons									
Species	1	11	3	3	19	8	1	2	32
Genus	1	10	3	3	16	8	1	2	26
Family	1	4	1	2	8	5	1	1	12
Gymnosperms									
Species	1	2	1	-	4	5	-	-	8
Genus	1	2	1	-	4	5	-	-	8
Family	1	2	1	-	4	4	-	-	6
Total									
Species	5	36	18	9	103	62	11	6	174
Genus	5	35	18	8	86	60	11	6	145
Family	5	21	16	7	50	35	8	5	67

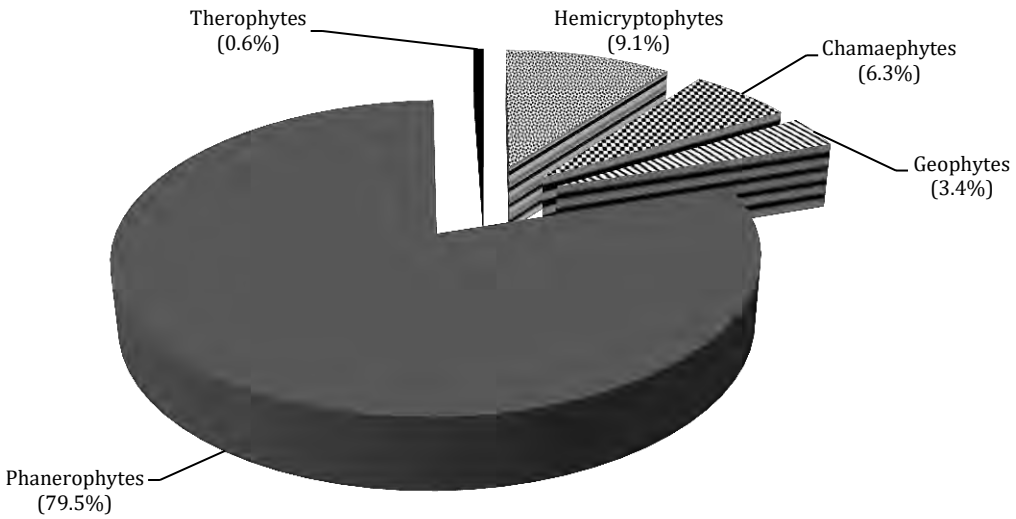


Fig. 2 - Life form spectrum of the cultivated species associated with *Moringa oleifera* in 8 studied sites in Egypt.

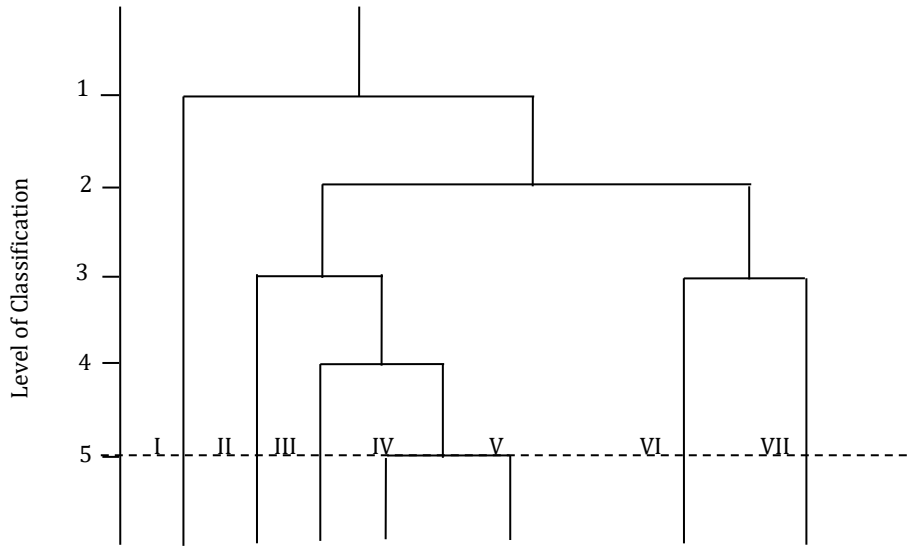
Table 4 - Life form spectrum of the cultivated species associated with *Moringa oleifera* in 8 studied sites in Egypt: Sheikh Zuweid Station (SZ), Botanic Garden of Faculty of Science - Alexandria University (XS), Antoniadis Botanic Garden (XA), Qanatir Horticulture Research Institute (QA), Botanic Garden of Faculty of Science - Ain Shams University (SA), Botanic Garden of Faculty of Education - Ain Shams University (ED), Orman Botanic Garden (OR) and Aswan Botanic Garden (AS).

Life form	Study site								Total
	SZ	XS	XA	QA	SA	ED	OR	AS	
Phanerophytes	5	23	17	8	85	57	11	5	140
Chamaephytes	-	4	1	1	6	1	-	1	11
Hemicryptophytes	-	4	-	-	10	3	-	-	16
Geophytes	-	5	-	-	1	1	-	-	6
Therophytes	-	-	-	-	1	-	-	-	1
Total	5	36	18	9	103	62	11	6	174

1. 3. Vegetation analysis

The application of Two Way Indicator Species Analysis (TWINSPAN) on the floristic composition of the 13 sampled stands led to classify them into 7 vegetation groups at level 5 (Fig. 3 A). The application of DECORANA on the same set of data indicates a reasonable segregation between these groups along the ordination axes 1 and 2 (Fig. 3 B). Four groups contained only one stand: **Group I** (Orman Botanic Garden) and dominated by *Ficus elastica*. **Group II** (Faculty of Science - Ain Shams University) and dominated by *Abutilon hirtum*, **group III** (Faculty of Science - Ain Shams University) and dominated by *Cordia myxa* and **group VI** (Antoniadis Garden) and dominated by *Ficus benjamina*. **Group IV** consisted of 2 stands (Sheikh Zuweid and Faculty of Science - Ain Shams University) and dominated by *Carya illinoensis*, while **group V** included 4 stands (2 stands in Sheikh Zuweid, and one stand in each of Qanatir Horticulture Research Institute and Aswan Botanic Garden) and dominated by *Azadirachta indica* and **group VII**

A- TWINSPAN classification



B- DECORANA ordination

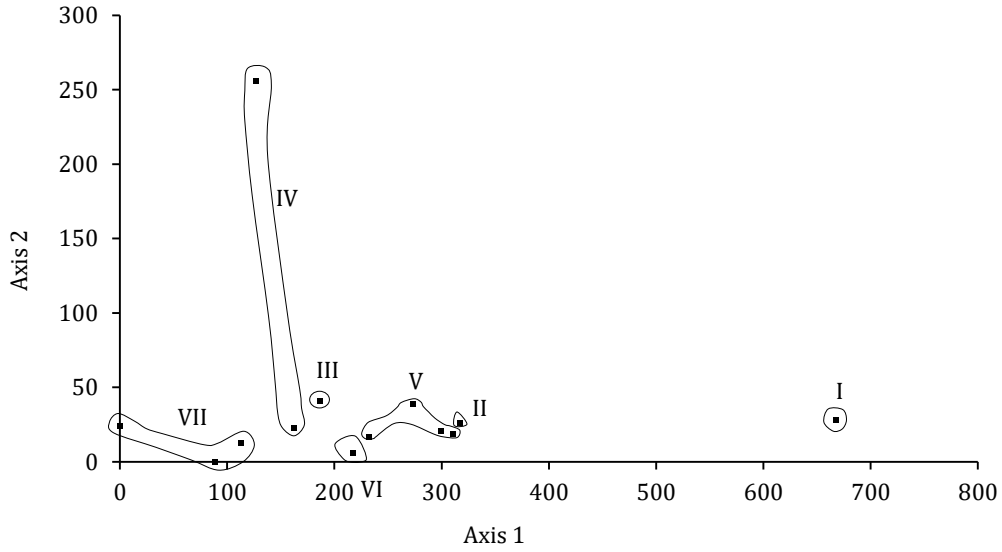


Fig. 3 - TWINSPAN classification (A) and DECORANA ordination (B) of the vegetation groups of the cultivated species associated with *Moringa oleifera* in 8 studied sites in Egypt based on their floristic composition. The 7 vegetation groups of the 13 sampled stands are encircled together (I - VII).

consisted of 3 stands (Sheikh Zuweid, Faculty of Science - Alexandria University and Faculty of Education - Ain Shams University) and dominated by *Ceiba speciosa*. It was clear that **group VII** had the highest number of species (89 species = 51.1% of the total number of cultivated species), followed by **groups II** and **III** (each contained 45 species = 25.9%), whereas **group I** contained the lowest number of species (11 species = 6.3%) (Table 5).

Table 5 - Characteristics of the 7 vegetation groups (I-VII) at level 5 after the application of TWINSPAN on the 13 sampled stands of cultivated species associated with *Moringa oleifera* in 8 studied sites in Egypt. P: Presence, C: Cover, VG: Vegetation group, NS: No. of stands, TS: total species.

VG	NS	TS	First dominant species	C %	P %	Second dominant species	C %	P %
I	1	11	*Ficus elastica*	4	100	*Leucaena leucocephala*	3	100
II	1	63	*Abutilon hirtum*	7	100	*Quercus robur*	6	100
III	1	45	*Cordia myxa*	7	100	*Carya illinoensis*	5	100
IV	2	45	*Carya illinoensis*	8	50	*Ficus elastic*	5	50
V	4	14	*Azadirachta indica*	9	25	*Dendrocalamus giganteus*	7	25
VI	1	18	*Ficus benjamina*	5	100	*Leucaena leucocephala*	3	100
VII	3	89	*Ceiba speciosa*	10	33	*Carya illinoensis*	6	33

2. Wild Species

2. 1. Taxonomic diversity

The wild species associated with *M. oleifera* were 45, related to 39 genera and 21 families (Table 6, Fig. 4). Dicotyledonous families were 17 represented by 29 genera and 34 species; the highly represented of

them were Asteraceae and Amaranthaceae (each of 7 species), Euphorbiaceae (4 species) and Solanaceae (3 species). Thirteen dicotyledonous families were represented only by one species. Monocotyledonous families were 3; the most represented was Poaceae (8 species), while each of Amaryllidaceae and Cyperaceae were represented by only one species. Pteridophytes were represented only by one species related to Pteridaceae. *Portulaca oleracea* was the most common associated wild species (presence > 40%), followed by *Bidens pilosa*, *Digitaria ciliaris, Oxalis corniculata*, *Cyperus rotundus*, *Lantana camara* and *Setaria viridis*.

Table 6 - Wild species associated with *Moringa oleifera* in the 12 studied stands in Egypt. P: presence and C: cover. Life forms are coded as follows: Ph: phanerophytes; Ch: chamaephytes; Hc: hemicryptophytes; Ge: geophytes; Th: therophytes.

Species	Family	Life form	P	C
			(%)	
Adiantum capillus-veneris L.	Pteridaceae	Hc	8.3	0.5
Amaranthus viridis L.	Amaranthaceae	Th	8.3	1.0
A.blitum L.	Amaranthaceae	Th	25.0	2.1
A.hybridus L.	Amaranthaceae	Th	8.3	1.0
A.retroflexus L.	Amaranthaceae	Th	8.3	1.0
Bidens pilosa L.	Asteraceae	Th	50.0	20.0
Cenchrus echinatus L.	Poaceae	Th	8.3	0.5
Centaurea pallescens Delile	Asteraceae	Hc	8.3	0.1
Chenopodium album L.	Chenopodiceae	Th	8.3	0.1
C.murale L.	Chenopodiceae	Th	16.7	2.0
Chichorium intybus L.	Asteraceae	Th	8.3	1.0
Convolvulus arvensis L.	Convolvulaceae	Ge	25.0	1.2
Crepis micrantha Czerep.	Asteraceae	Th	8.3	1.0
Cynanchum acutum L.	Apocynaceae	Ph	8.3	1.0
Cynodon dactylon (L.) Pres.	Poaceae	Ge	25.0	2.2
Cyperus rotundus L.	Cyperaceae	Ge	41.1	7.5
Dactyloctenium aegptium (L.) Willd.	Poaceae	Th	33.3	2.6
Datura innoxia Mill.	Solanaceae	Th	16.7	2.0
Digitaria ciliaris (Retz.) Koeler	Poaceae	Th	50.0	7.5
Dysphania ambrosioides (L.) Mosyakin & Clemants	Amaranthaceae	Th	25.0	2.2
Echinochloa colona (L.) Link	Poaceae	Th	8.3	1.0
Erigeron bonariensis L.	Asteraceae	Th	33.3	4.0
Euphorbia heterophylla L.	Euphorbiaceae	Th	8.3	1.0
E.hirta L.	Euphorbiaceae	Th	25.0	2.1
E.prostrata Aiton	Euphorbiaceae	Th	16.7	4.0
Foeniculum vulgare Mill.	Apiaceae	Hc	8.3	1.0
Heliotropium supinum L.	Boraginaceae	Ch	8.3	0.1
Lantana camara L.	Verbenaceae	Ph	41.1	16.0
Malva parviflora L.	Malvaceae	Th	16.7	1.1
Oxalis corniculata L.	Oxalidaceae	Ge	50.0	7.1
Pancratium maritimum L.	Amaryllidaceae	Ge	16.7	4.0
Phytolacca americana L.	Phytolaccaceae	Hc	8.3	1.0
Plantago major L.	Plantaginaceae	Hc	16.7	3.0
Portulaca oleracea L.	Portulacaceae	Th	66.7	7.4

Table 6 - cont. 1

Species	Family	Life form	P	C
			(%)	
Ricinus communis L.	Euphorbiaceae	Ph	33.3	4.1
Salsola kali L.	Chenopodiceae	Th	8.3	0.1
Setaria verticillata (L.) P. Beauv.	Poaceae	Th	33.3	4.6
S.viridis (L.) P.Beauv.	Poaceae	Th	41.1	7.0
Solanum americanum Mill.	Solanaceae	Ch	25.0	3.0
Sonchus oleraceus (L.) L.	Compositae	Th	16.7	2.0
Sorghum virgatum (Hack.) Stapf	Poaceae	Th	8.3	1.0
Trianthema portulacastrum L.	Aizoaceae	Th	16.7	2.0
Tribulus pentandrus Forssk.	Zygophyllaceae	Hc	16.7	0.6
Verbesina encelioides (Cav.) Benth. & Hook. f. ex A. Gray	Compositae	Th	8.3	1.0
Withania somnifera (L.) Dunal	Solanaceae	Ch	8.3	1.0

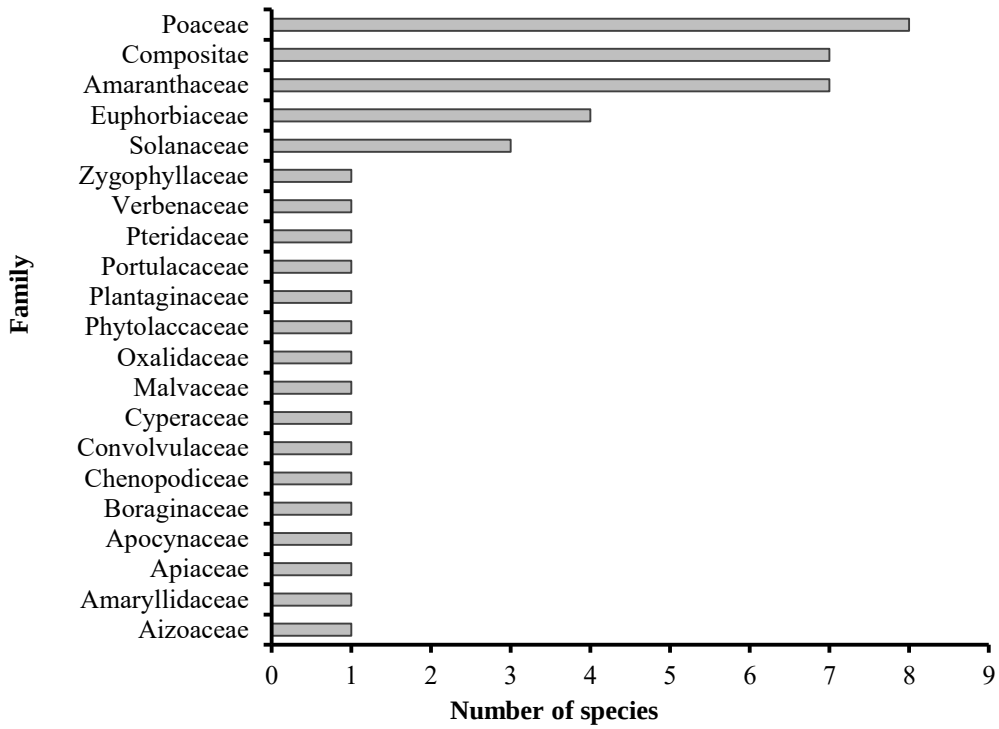


Fig. 4 - Number of the wild species associated with *Moringa oleifera* in relation to their families.

The taxonomic diversity of the 8 studied sites indicated that Qanatir Horticulture Research Institute had the maximum total number of species, genera and families. On the other hand, Antoniadis Garden had the minimum number of families, genera and species. Pteridophytes were represented only in Faculty of Science - Alexandria University. The maximum number of dicotyledonous families, genera and species was recorded in Qanatir Horticulture Research Institute; while the maximum number of monocotyledonous families and species was recorded in Sheikh Zuweid (Table 7).

Table 7 - Taxonomic diversity of the wild species associated with *Moringa oleifera* in 7 studied sites in Egypt: Sheikh Zuweid Station (SZ), Botanic Garden of Faculty of Science - Alexandria University (XS), Antoniadis Botanic Garden (XA), Qanatir Horticulture Research Institute (QA), Botanic Garden of Faculty of Science - Ain Shams University (SA), Botanic Garden of Faculty of Education - Ain Shams University (ED) and Orman Botanic Garden (OR).

Taxic variable	Study site							Total
	SZ	XS	XA	QA	SA	ED	OR	
Dicotyledons								
Species	7	7	4	24	12	7	7	34
Genus	7	7	4	21	12	6	7	29
Family	6	6	3	13	8	5	5	17
Monocotyledons								
Species	6	2	3	4	5	2	4	10
Genus	2	2	3	4	5	2	4	9
Family	3	2	1	1	2	2	2	3
Pteridophytes								
Species	-	1	-	-	-	-	-	1
Genus	-	1	-	-	-	-	-	1
Family	-	1	-	-	-	-	-	1
Total								
Species	13	10	7	28	17	9	11	45
Genera	13	10	7	25	17	8	11	39
Families	9	9	4	14	10	7	7	21

2. 2. Life forms

Determination of the life forms of the wild species associated with *M. oleifera* indicated that the therophytes was the most represented life form (28 species = 62.2% of the total species), followed by hemicryptophytes (6 species = 13.3% of the total species) and geophytes (5 species = 11.1% of the total species). Phanerophytes and chamaephytes were the least recorded life forms (each comprised 3 species = 6.7% of the total species) (Fig. 5). Regarding the flora of the 8 studied sites, the maximum representation of the chamaephytes, hemicryptophytes and therophytes was observed in Qanatir Horticulture Research Institute. On the other hand, the maximum representation of the phanerophytes was in Faculty of Science - Ain Shams University, while that of the geophytes was in Sheikh Zuweid (Table 8).

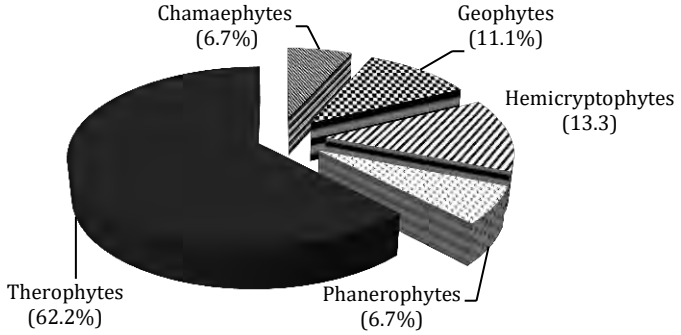


Fig. 5 - Life form spectrum of the wild species associated with *Moringa oleifera* in 7 studied sites in Egypt.

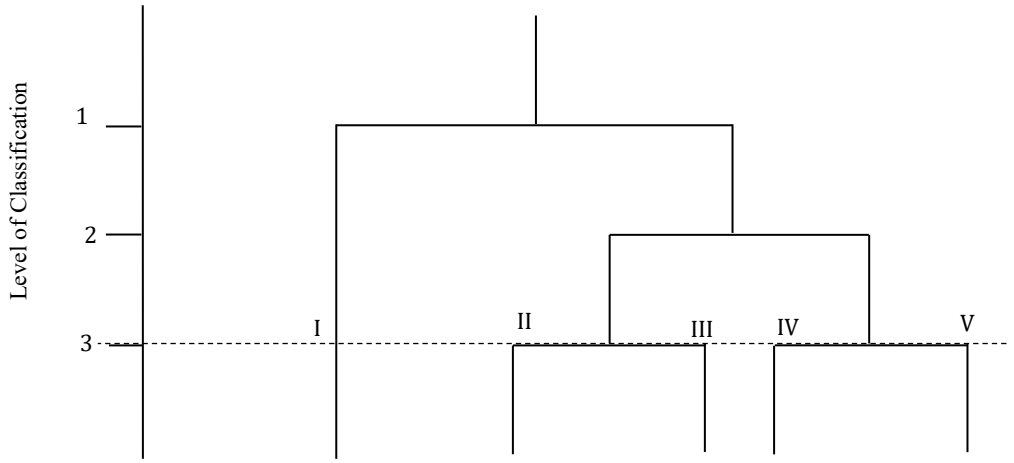
Table 8 - Life form spectrum of the wild species associated with *Moringa oleifera* in 7 studied sites in Egypt: Sheikh Zuweid Station (SZ), Botanic Garden of Faculty of Science - Alexandria University (XS), Antoniadis Botanic Garden (XA), Qanatir Horticulture Research Institute (QA), Botanic Garden of Faculty of Science - Ain Shams University (SA), Botanic Garden of Faculty of Education - Ain Shams University (ED) and Orman Botanic Garden (OR).

Life form	Study site							Total
	SZ	XS	XA	QA	SA	ED	OR	
Phanerophytes	-	-	1	2	3	1	-	3
Chamaephytes	-	-	1	2	1	-	-	3
Hemicryptophytes	2	1	-	3	1	-	-	6
Geophytes	4	3	-	2	3	2	2	5
Therophytes	7	6	5	19	9	6	9	28
Total	13	10	7	28	17	9	11	45

2. 3. Vegetation analysis

The application of TWINSPAN classification on the floristic composition of the 13 sampled stands led to classify them into 5 vegetation groups at level 3 (Fig. 6 A). The application of DECORANA on the same set of data indicates a reasonable segregation among these groups along the ordination axes 1 and 2 (Fig. 6 B). **Group III** included 1 stand (Faculty of Science - Alexandria University) and dominated by *Cyperus rotundus*, **group I** included 2 stands (Sheikh Zuweid) and dominated by *Pancratium maritimum*, **group V** represented by 2 stands (Qanatir Horticulture Research Institute and Faculty of Education - Ain Shams University) and dominated by *Bidens pilosa*, **group IV** included 3 stands (Faculty of Science - Ain Shams University) and dominated by *Lantana camara* and **group II** comprised 4 stands (tow in Sheikh Zuweid, Antoniadis Garden and Orman Botanic Garden) and dominated by *Digitaria ciliaris*. It was clear that **group V** had the highest number of species (31 species = 68.9% of the total number of wild species), followed by **group II** (19 species = 42.2%), whereas **group I** contained the lowest number (7 species = 15.6%) (Table 9).

A- TWINSPAN classification



B- DECORANA ordination

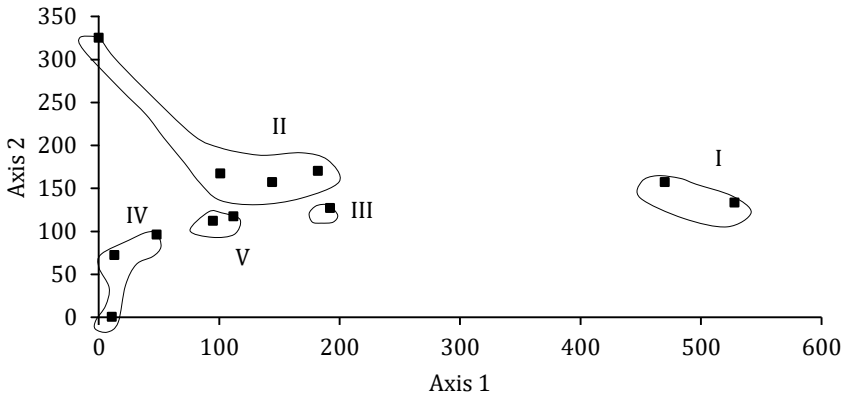


Fig. 6 - TWINSPAN classification (A) and DECORANA ordination (B) of the vegetation groups of the wild species associated with *Moringa oleifera* in 7 studied sites in Egypt based on their floristic composition. The 5 vegetation groups of the 12 sampled stands are encircled together (I - V).

Table 9 - Characteristics of the 5 vegetation groups (1-v) at level 3 after the application of TWINSPAN on the 12 sampled stands of wild species associated with *Moringa oleifera* in Egypt. P: Presence, C: Cover, VG: Vegetation group, NS: No. of stands, TS: Total species.

VG	NS	TS	First dominant species	C %	P %	Second dominant species	C %	P %
I	2	8	*Pancratium maritimum*	4	100	*Verbesina encelioides*	1	50
II	4	28	*Digitaria ciliaris*	3	50	*Setaria verticillata*	2	75
III	1	10	*Cyperus rotundus*	2	100	*Euphorbia prostrata*	1	100
IV	3	29	*Lantana camara*	10	100	*Bidens pilosa*	8	100
V	2	37	*Bidens pilosa*	9	50	*Lantana camara*	6	100

Discussion

The most represented family of the cultivated species associated with *M. oleifera* was Fabaceae, which is the third-largest terrestrial plant family in terms of number of species, after Orchidaceae and Asteraceae. It has 630 genera and over 18,860 species (Judd *et al.,* 2002; Stevens, 2006). This family have a universal distribution, being found everywhere except Antarctica and the high arctic (Stevens, 2006). The cosmopolitan distribution of this family may be related to its wide variation of growth forms which includes trees, shrubs and herbaceous plants (annuals, biennials or perennials). They also could be upright plants, epiphytes or even vines. Also, they could be helophytes, mesophytes or xerophytes (Watson & Dallwitz, 1992; Judd *et al.*, 2002). In addition, many legumes are able to survive and compete effectively in nitrogen poor conditions (ildis.org) through a symbiotic relationship with some species of Rhizobium bacteria that present in root nodules. Many leguminous species, recorded in the present study, have medicinal importance as *Cassia fistula* (Danish *et al.*, 2011) and *Dichrostachys cinerea* (Banso & Adeyemo, 2007). Other species have been used as ornamentals throughout the world. The vast diversity of heights, shapes, foliage and flower colors caused this family to be commonly used in the design and planting of small gardens and even large parks (Burkart, 1987). Examples of these ornamentals which were recorded in the present study are *Bauhinia variegata*, *Caesalpinia palmeri*, *Erythrina caffra*, *Erythrina corallodendrum*

and *Sophora secundiflora.* On the other hand, *Acacia farnesiana* flowers contain an essential oil which was widely used in European perfumery (Duke, 1983). The valuable *Leucaena leucocephala* produces a large volume of medium-light hardwood for fuel (specific gravity of 0.50 - 0.75) with low moisture and high heating value, and makes an excellent charcoal that yields little ash and smoke. It also can be used for flooring, small furniture as well as for paper pulp production (Shelton & Brewbaker, 1998).

The most represented life form was the phanerophytes, which had a superior representation in botanic gardens of Faculties of Science and Education (Ain Shams University), then Botanic Garden of Faculty of Science - Alexandria University. Phanerophytes are dominant in tropical regions of the world, even that, as recorded in this study, they can be recorded in sites other than the tropics. This may be attributed to their adaptability to life in less favorable localities by the protection of the growing point against the effects of the unfavorable season through many efficient ways (Raunkiaer, 1934). Some deciduous phanerophytes became adapted through leaf fall. Examples of this in the present study are *Cordia myxa, Ginkgo biloba, Morus alba, Taxodium distichum, Vitex agnus-castus and Vitis vinifera*. Other evergreen phanerophytes, like *Ficus* sp. had their buds being protected by unexpanded adherent stipules. Whereas other evergreens like *Melaleuca* sp., their new leaves become full grown and still folded for a long time, thus helping the enclosed younger leaves to achieve a considerable development before being subjected to direct air desiccation. Furthermore, depending on Raunkiaer classification of life forms (Raunkiaer, 1934), we can assume that, *Pelarogonium zonale* and *Musa paradisiaca* are examples of herbaceous phanerophytes, while *Monstera deliciosa* is an epiphytic phanerophyte and *Cereus uruguayanus* is a stem-succulent phanerophyte.

Phoenix dactylifera was the most common associated species with *M. oleifera*. Together with the olive, grape and fig, *P. dactylifera* were amongst the oldest cultivated plants of human kind and used as food for 6000 years (Zohary & Speigel-Roy, 1975; Sulieman *et al.*, 2012). *P. dactylifera* is well-suited to vegetative propagation because it produces offshoots at the trunk base which can be used in simple clonal reproduction of chosen palms (palmweb.org). This Plant can grow in very hot and dry climates, and can tolerate salty and alkaline soils. It requires a long, intensely hot summer with little precipitation and very low humidity during the stage from pollination to harvest, but with abundant underground water near the surface or irrigation. Such conditions are found in the oases and valleys in the arid sub-tropical deserts of the Middle East and North Africa countries (Jaradat, undated).In Egypt, It was recorded to be mainly distributed in the following habitats: along rail and high ways, abandoned fields and drains (Shaltout *et al.*, 2010 b).

The wide distribution of *P. dactylifera* may be related to its commercial importance. It is the main crop in Egypt, Saudi Arabia, and Middle East countries (Chao & Krueger, 2007).The primary use of date palms is, of course, their nourishing fruit which is eaten fresh, dried or processed as one of a wide-range of date products. Date fruits can be stored and transported easily and hence become an important component of the Middle East diets. In addition, its vegetative parts are used as building materials (leaves, trunks), fencing (leaves, midribs), thatch (leaves), rope (fibres of leaf sheath, leaflet and midrib), fuel (all vegetative parts, but especially leaf bases); packaging, padding and protection (leaf sheath fibre) (Barrow, 1998).

Numerous popular plants (e.g., *P. dactylifera*) as well as other rare species (e.g., *Ginkgo biloba*) were recorded in many botanic gardens. This confirms the important role of these gardens in conservation of threatened species. Amaglo (2006) stated that, to cultivate *M. oleifera* with other crops, it is important to choose species that are adapted to alley cropping, such as shade-tolerant leafy vegetables, legumes and herbs. Many studies tried to determine the appropriate species which can be associated with *M. oleifera* and their suitable intercropping models (e.g., Swaminathan *et*

al., 1999; Palada *et al.*, 2003; Shanmughavel *et al*., 2003; Immanuel & Ganapathy, 2010).

The maximum number of species, genera and families was recorded in the Botanic Gardens, especially that of Faculty of Science - Ain Shams University. Most of these species were introduced from different countries and cultivated in the form of mixture of human-made microhabitats (e.g., shrub beds, rockeries, hedges, walls, flower beds and compost heaps), and being receiving large amounts of materials including nutrients (Gilbert, 1991). The most crowded botanic garden was that of Faculty of Education - Ain Shams University (Khalifa, 2006); where 300 species related to 70 families were housed in only 700 m^2. Not only, had the valuable plants in this garden subjected to damage by crowdedness, but also to unwise practices like laborer shortage (author observation).According to the authors opinion, the best served and cared botanic garden was the Botanic Garden of Faculty of Science (Alexandria University) followed by Aswan Botanic Garden.

Classification and ordination of the sample stands of the cultivated species in the present study indicated a clear distinction of seven groups which were recognized on the basis of their characteristic species as follows: *Ficus elastica* - *Leucaena leucocephala*, *Abutilon hirtum* - *Quercus robur*, *Cordia myxa* - *Carya illinoensis*, *Carya illinoensis* - *Ficus elastica*, *Azadirachta indica- Dendrocalamus giganteus*, *Ficus benjamina* - *Leucaena leucocephala* and *Ceiba speciosa* - *Carya illinoensis*. It was observed that *Ficus elastica* was the 1st dominant species in **group I** and the 2nd in **group III**. Both groups were related to botanic gardens which were characterized by presence of shade tolerant species like *F. elastica* (cabi.org). *F. elastica* thrives in moister, warmer, tropical climates and in vegetation zones of tropical rain forest, wood and shrub lands and light tropical forest, but apparently can tolerate temperature range of 0 - 10 °C in winter and 10 - 30 °C in summer, with an annual precipitation up to 200 mm (Starr *et al.*, 2003). This species tolerates drought, and can be grown in the well-drained soil (Gilman & Watson, 2014).

It can reproduce by both cuttings and seeds (Starr *et al.*, 2003; Gilman & Watson, 2014). Its root system is shallow and dense, making mixed plantation or intercropping systems unfeasible (proseanet.org). In the 19th and 20th centuries, it was heavily cultivated to produce commercial rubber, but fell into disuse with the rise of production of the higher-quality rubber from *Hevea brasiliensis* (Tawan, 2000; Whistler, 2000).

Carya illinoensis was the 1st dominant species in **group IV** and the 2nd in **groups III** and **VII**. These groups characterized the Botanic Gardens of Faculties of Science and Education of Ain Shams University. It is a long-lived, medium to large, deciduous tree ranging from 30 to 45 m in height and 1.8 to 2.1 m in diameter (Duncan & Duncan, 1988). It is widely planted as an ornamental, and for its sweet edible nuts which are used widely in candies and cookies (Stephens, 1973). This tree prefers well-drained loamy soils not subjected to prolonged flooding (Peterson, 1990), and rarely grows on low and poorly drained clay flats (Allen & Kennedy, 1989). It is shade intolerant (Peterson, 1990) with its deep lateral roots providing excellent watershed protection (Wasser, 1982).

Leucaena leucocephala was the 2nd dominant species in **groups I** and **VI**. It is characterized by plentiful, precocious and year-round seed production (building up a substantial seed bank), lack of pollinator specificity, ability to renew after cutting or burning, drought tolerance, ability to produce thickets, and self-compatibility meaning that it can spread from an isolated tree (Hughes & Jones, 1998). Once established, this species is difficult to eradicate, as the soil seed bank is able to remain viable for at least 10 years after removal of seeding trees (Walton, 2003). Despite preceding points, Parrotta (1993) mentioned that *M. oleifera* was found to grow in association with this species in the secondary forests (south coastal plain of Puerto Rico).

Regarding the wild flora associated with *M. oleifera*, the most represented family was Poaceae. It has grains of intermediate weight capable of immediate germination and rapid growth; and many of their species have ability for extensive lateral spread providing flexible regeneration strategies. These

characters equipped this family well to exploit man-made habitats (Hodgson, 1986; Gilbert, 1991). The absence of associated species in Aswan Botanic Garden may be due to the paved ground around *M. oleifera* trees; hence the weakly rooted species cannot penetrate it. In addition, the most recorded life form was the therophytes which had highest representation in Qanatir Horticulture Research Institute. Comparing with the perennial species, therophytes have higher reproductive capability and morphological, ecological and genetic plasticity under high levels of disturbances (Harper, 1977; Grime, 1979).

In the present study, *Portulaca oleracea* was the most common wild species associated with *M. oleifera*. Shaltout *et al.* (2010 b) had recorded this species to be distributed in numerous habitats in Nile Delta (e.g., high ways, waste lands, abandoned fields, fields of orchards, fields of summer and winter crops, canals and drains). In addition, Matthews *et al.* (1993) reported that *P. oleracea* is a weed of open, disturbed habitats and almost of global adaptability and distribution. The self-compatible breeding system, seed dormancy, and ability of seeds to resist animal digestive processes; facilitated to ensure its survival and distribution.

Classification and ordination of sampled stands of the wild species in the present study indicated a clear distinction of five groups which were recognized on the basis of their characteristic species as follows: *Pancratium maritimum* -*Verbesina encelioides*, *Digitaria ciliaris- Setaria verticillata*, *Cyperus rotundus* -*Euphorbia prostrata*, *Lantana camara* - *Bidens pilosa* and *Bidens pilosa* - *Lantana camara.* *Pancratium maritimum* was the 1st dominant species in **group I**. It is an Amaryllidaceous endangered species (Grassi *et al.*, 2005). In Egypt, it is distributed along the Mediterranean coastal region including Deltaic and Sinai coast (Shaltout *et al.*, 2010 b; El-Hadidy *et al.*, 2011). It can colonize sandy shores of different geologies and in some cases, rocky cliffs (Giovino *et al.*, 2015). The salt stress tolerance of *P. maritimum* in maritime habitats is caused by proline production activity (Khedr *et al.*, 2003). In recent years, the level of attention given to this species has increased due to its importance as a bio-indicator, the potential industrial value of its chemical compounds, and its use as an ornamental plant (Abbassy *et al.*, 1998; Sanaa *et al.*, 2013).

Lantana camara was the 1st dominant species in **group IV** and the 2nd in **group V**. It is a beautiful plant, often planted in gardens, and had been introduced from Central and South America to many countries like Egypt to be used as an ornamental plant (Day, 2003). Shaltout *et al.* (2016) recorded it as one of the naturalized species in many habitats in Nile region including waste places, fields, fence lines and pasture. The wide geographic distribution of *lantana* indicates its wide ecological tolerance. It occurs in diverse habitats and on different soil types. In general, it grows best in open un-shaded situations such as rainforest edges, beachfronts, wastelands, and forests recuperating from fire or logging. This species also favors disturbed sites such as road and railway sides and canal banks (Winder & Harley, 1983; Thakur *et al*., 1992; Munir, 1996). *L. camara* is a major problem in agricultural areas in most countries in which it occurs (Holm *et al.*,1991), because it reduces the productivity in pasture by the formation of compact thickets which reduce growth of crops as well as make harvesting more difficult (Okoth, 1987).

Bidens pilosa was the 1st dominant species in **group V** and the 2nd in **group IV**. It is a cosmopolitan, annual therophyte which originates from tropical and Central America (issg.org).High seed production and ability to grow in many habitats are the most important survival strategies (Souza *et al.*, 2009). This species is capable of invading numerous habitats ranging from moist soil, sand, lime-rock, or dry, infertile soil and low to high elevations of up to 3600 m. It grows well in disturbed areas, high sunlight, and moderately dry soils. It is known to invade grassland, forest clearings, wetlands, plantations, streamlines, canals, roadsides, rail ways, pasture, coastal areas and agriculture areas(PIER, 2007; DPI, 2008; Shaltout *et al.*, 2010 b). The vast distribution of this species together with *P. oleracea*, *L. camara*, must be taken in consideration.

Protection and security plans, designed by the experts, should be applied in the sites where *M. oleifera* crop will be cultivated in Egypt to prevent the probable damage caused by these harmful weeds.

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