Salinity tolerance of the flora halophytes to coastal habitat of Jarjr-oma in Libya

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Abstract: Halophytic vegetation and flora of Jarjr-oma in Libya**.** The recorded 33 species in Sandy beach during four seasons of autumn 2010 and winter, spring and summer 2011. Importance value and density of the different association type are perennials *Cynodon dactylon* and *Tamarix tetragyna*. It appears exclusive in Sandy beach, association *Sarcopoterium spinosum*, *Limonium sibthorpianum*, *Cichorium spinosum*. The dominant species Sandy beach of this type is *Allium rumherianum* and *Sarcopoterium spinosum*. Density of Sandy beach habitat of winter and spring seasons *Cynodon dactylon*, in summer season highest annuals *Euphorbia peplis* and *Salsola kali*. As well as, total 19 species in Salt march gave highest Dominance *Suaeda vera* and *Limoniastrum monopetalum* its species salinity tolerance. Appear all seasons similar in results density of species perennial of Salt march habitat. Found 114 species in Saline lands of four associations the dominant species of this type is *Polycarpon tetraphyllum*, the indicator species is *Suaeda vera* and *Onopordum cyrenaicum*, *Rumex bucephalophorus*, *Sarcopoterium spinosum*. Association by *Mercurialis annua* and *Arisarum vulgare*, *Juniperus phoenicea*. association by *Anagallis arvensis*, *Bellevalia sessiliflora* and *Rhus tripartita*. Vegetation in Sand formation habitat recorded eight species during four seasons. The dominant species of this type is *Carex divisa*, which attained the highest density in winter and spring. The indicator species are *Pancratium maritimum*. The principal components analysis for the vegetation habitats-soil relationships distinguished that the highest affinity for sand and clay soil content. The maximum mean value for Cl^-, Na^+, $So4^{--}$ and EC. The species *Suaeda vera*, *Retama raetem*, *Cynodon dactylon* and *Juncus acutus* preferred to grow in coarse sand soil.
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Key Words: Salinity, Halophytes, Flora, Density and Important value

1. Introduction

Halophytic communities of Libya are still among the most poorly known vegetation units. Our knowledge of the list of halophytes is restricted to Flora Libya (Jafri and El-Gadi, 1977). Saline soils of various nature and degree occupy over 80 million hectares in the Mediterranean basin (Hamdy, 1995). In previous years, it has been demonstrated that revegetation of saline habitats with halophytic species is profitable and provides many additional benefits (Marcar *et al*., 1993). There are about 6000 species of terrestrial and tidal halophytes in the world and 700 species in the Mediterranean climate area (Le Houérou, 1991). In general, these species are neglected and usually considered impediments rather than opportunities for agricultural development. Many plants have adapted, genetically, morphologically and physiologically to withstand stresses, partially or completely, with variable degrees between plant species (Gad *et al*., 2012). This is mainly due to the absence of up-to-date information on the halophytes and the interest of most botanists and ecologists in the rich flora of low-salt or salt-free habitats. The distribution of halophytic species on salt-affected sites is zoned in response to minor differences in topography. The saline soil habitats are mostly covered by xerohalophytic communities with salt-tolerant xerophytes. As with other plant formations, the annual species also play an important role in the vegetation of salty habitats (Akhani and Ghorbanli, 1993). Shrubs grew faster in the sandy than in the rocky habitat in semi-arid savanna (Schleicher *et al*., 2011). The Coastal Beach Association is comprised of unconsolidated sand and gravel deposits that are subject to marine wave and tidal action. This association also include eolian, or dune deposits that form immediately landward of the coastal beach (Town of Scituate Open Space Conservation & Recreation Plan, 1998). The halophytic vegetation is briefly discussed and a proposal is made to use some of the halophytes for soil improvement. The objectives of our study were to (1) define vegetation patterns through assessing spatial distribution and density, Importance value, Dominance of plant species and plant groups, (2) evaluate the halophytes plants in salinity habitats. (3) Difference density between seasons.

The study area

Location: The study area is located in the Mediterranean Coast of Libya Jarjr-oma between latitude 32, 47′ ,49.8″ N and longitude ,26° ,″40.6 21° E. distance 28 km west Al Baida city (Figure 1). Three transect were investigated from north to south. Distance Jarjr-oma 300 m of the sea with altitude 1 m.

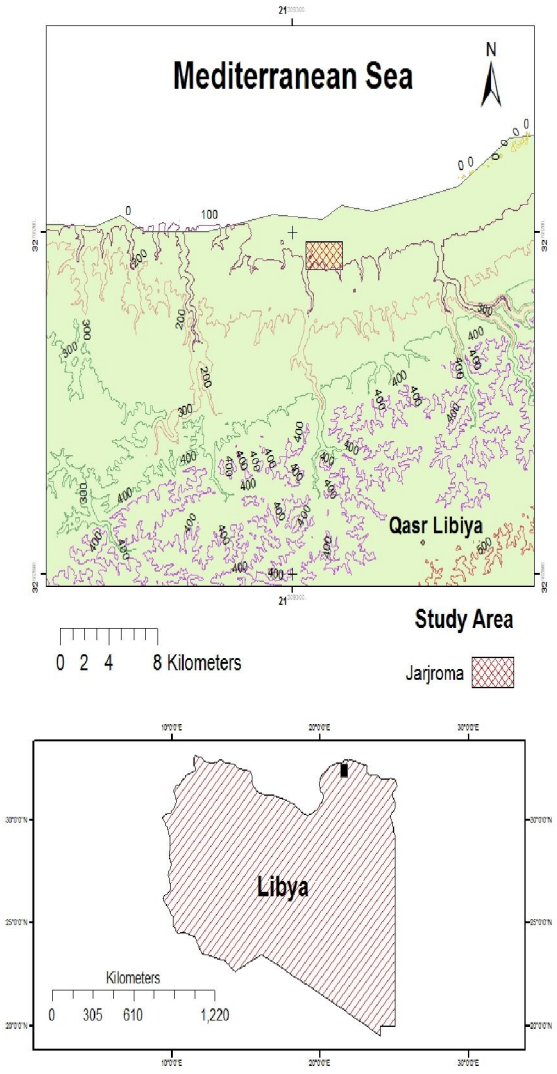

Fig. 1. Map of the Western Mediterranean sea coast region of Libya indicating the location Jarjr oma area in Al- Jabal Al- Akhdar.

Climatic: The maximum rainfall was Meteorological station Al Baida actress for Jarjr-oma region, 131.3 and 191.6 mm in December and January, respectively. The average rainfall 550.5 mm / year in Al Baida station for the period from 1999 to 2009. The lowest monthly average of rainfall 1.2 mm in July in Al Baida station. Temperature in the study area, the dry period extends from June to Augustus. The highest mean temperature meteorogical station Al Baida imitation Jarjr-oma for years 1999 to 2009 about 24 ˚C through Augustus month. The lowest mean temperature in Al Baida 10 and 9.7 ˚C in January and February, respectively.

Dunes cohesive Calcarenite arise dunes result weathering physical and erosion by wind rocks era tripartite era Cretaceous Supreme south coast at the top of the mountains and valleys and firmed this dune by materials carnivorous limestone and can be dubbed the dunes cohesive or rocks Calcarenite that exist along the coastal strip Green Mountain especially among Al Hania and Hamama and Jarjr-oma area (Al-Jabal Al-Akhdar south project, 2005).

2. Material and Methods

Vegetation study was undertaken during the autumn 2010 and winter, spring and summer 2011. A total of 24 stands in all season were sampled of Jarjr-oma from Al- Jabal Al-Akhdar (Figure 1). Stands and sites were selected as to represent the variation of vegetational, climatic and edaphic characteristics prevailing in the study area so that the location of stands was based on visual changes in habitats and plant communities along the transect. Examples of habitat classes include habitat types derived from Electric Conductivity (EC) classification schemes, habitat salinity EC from 6 – 9 ms/cm and habitat salt march from 11-36 ms/cm.

Sample collection: The floristic categories and chorology of species recorded in the study area were made with their characteristic distribution terms, the species were identified according to Jafri and El-Gadi (1977) and Boulos (1999, 2000, 2002 and 2005).

Three line transects at Jarjr-oma were chosen for this study. The take 500 meters for each transect the number of three transects and all transect four stands with an area of 5 × 5 m^2. In these stands, the quadrate method was used and the size of each analytic quadrate area was 1 m^2. The stands were selected on the basis of visual difference and change in their vegetation coverage. The species in each quadrate were listed. The number of individual of each species was counted. Salinity tolerance four habitats Sandy beach, Salt march, Saline land and Sand formation.

Therefore, for each stand the absolute frequency, absolute density, and absolute cover were determined. The sum of relative density, relative frequency and relative cover gave the importance value (Ludwig and Reynolds, 1988) for the different species as following:

Density/m^2 = number of individuals ÷ area sampled

Relative density = (density for a species ÷ total density for all species) × 100

Frequency = number of sampled quadrates in which a species occurs ÷ total number of quadrates in the stand
Relative frequency = (frequency for a species ÷ total frequency for all species) × 100
Cover = the area occupied by the species ÷ the whole investigated area
Relative cover = (coverage of a species in the sample m^2 ÷ total cover of all species in the sample m^2) × 100
Coverage = Dominance species = average area of spatial coverage × Number of individuals species in every 1 m^2 (Al Hawas, 2004).
Importance value (IV) = Relative density + Relative cover + Relative frequency
Data Analysis: Classification and ordination of communities (stands) followed two trends of multivariate analysis. The applied classification technique here was the Two-Way Indicator Species Analysis (TWINSPAN), a CAP Program (Henderson and Seaby, 1999). The applied ordination techniques were the Detrended Correspondence Analysis (DCA) and PCA (principal components analysis) the application of the techniques based on the importance value, dominance and density of the species. The statistical treatments applied were according to Nie *et al.*, 1975.

3. Results

Sandy beach

Three transects extended from the north to south with 12 stands. Vegetation in sandy beach habitat from autumn which differ in their characteristics and consequently association type. Ten species were recorded in the studied 12 stands. The application of TWINSPAN classification on the importance values of the recorded 33 species during four seasons in sandy beach by 12 stands led to the recognition of two associations. The importance value and density of the different two association type are presented in (Tables 1-6). Each type comprises a set of stands with greater homogeneity of vegetation.

Group A. The dominant species of this type is *Cynodon dactylon* (L.) Pers. and *Crucianella maritime* L. which attained the highest IV of 57 and density 0.28. Group B. The IV 100 of *Tamarix tetragyna* Ehrenb. It appears exclusive in sandy beach, association *Sarcopoterium spinosum* (L.) Spach, *Limonium sibthorpianum* and *Cichorium spinosum*.

The dominant species Sandy beach of this type is *Allium rumherianum* which attained the highest to 4.67, *Sarcopoterium spinosum* 0.4. Density of Sandy beach habitat of winter season *Cynodon dactylon* (L.) Pers. of 1.3 in group A and group B *Cichorium spinosum* L. 0.5. Density of spring season Fig 2 group A *Cynodon dactylon* (L.) Pers. 0.53 and group B *Cichorium spinosum* L. and *Elymus farctus* (Viv.) Runem. Ex Melderis 0.33 and 0.2, respectively. Group B of summer was *Euphorbia peplis* L. higher density.

In winter season Sandy beach gave perennials *Cynodon dactylon* and *Moraea sisyrinchium* highest density in group A and group B perennials *Limonium sibthorpianum* and *Elymus farctus*. As well as, spring season were *Cynodon dactylon* and *Triplachne nitens* its annual in group A and perennial *Cichorium spinosum* in group B. while in summer season was annuals *Euphorbia peplis* and *Salsola kali* in group B.

Table (1) Importance value of Sandy beach habitat of autumn season in Jarjr oma area

No.	Scientific name	Twinspan groups	
		A	B
1	*Suaeda vera* Forak. ex Gmel.		7.7 ±13.3
2	*Allium rumherianum* Asch.		10.7±18.6
3	*Cichorium spinosum* L.		15.2±26.4
4	*Colchium palaestinum* Baker.		5.7±8.1
5	*Juncus acutus* L.		11.5±19.9
6	*Limonium sibthorpianum* (Guss.) O. Ktze.		23.7±41.0
7	*Cynodon dactylon* (L.) Pers.	57.4±99.5	
8	*Sarcopoterium spinosum* (L.) Spach		25.4±44.1
9	*Crucianella maritime* L.	42.5±73.7	
10	*Tamarix tetragyna* Ehrenb.		100±173.2

Table (2) Dominance of Sandy beach habitat of autumn season in Jarjr oma area.

No.	Scientific name	Twinspan groups	
		A	B
1	*Suaeda vera* Forak. ex Gmel.		0.03±0.04
2	*Allium rumherianum* Asch.		4.67±8.08
3	*Cichorium spinosum* L.		0.005±0.008
4	*Colchium palaestinum* Baker		0.001±0.002
5	*Juncus acutus* L.		0.05±0.09
6	*Limonium sibthorpianum* (Guss.) O. Ktze.		0.22±0.38
7	*Cynodon dactylon* (L.) Pers.	0.02±0.03	
8	*Sarcopoterium spinosum* (L.) Spach		0.4±0.69
9	*Crucianella maritima* L.	0.05±0.09	
10	*Tamarix tetragyna* Ehrenb.		0.13±0.23

Table (3) Density per m^2 of Sandy beach habitat of autumn season in Jarjr oma area.

No.	Scientific name	Twinspan groups	
		A	B
1	*Suaeda vera* Forak. Ex Gmel.		0.03±0.05
2	*Allium rumherianum* Asch.		0.09±0.16
3	*Cichorium spinosum* L.		0.16±0.28
4	*Colchium palaestinum* Baker.		0.01±0.02
5	*Juncus acutus* L.		0.07±0.12
6	*Limonium sibthorpianum* (Guss.) O. Ktze.		0.13±0.23
7	*Cynodon dactylon* (L.) Pers.	0.28±0.48	
8	*Sarcopoterium spinosum* (L.) Spach		0.03±0.05
9	*Crucianella maritima* L.	0.01±0.02	
10	*Tamarix tetragyna* Ehrenb.		0.03±0.05

Table (4) Density per m^2 of Sandy beach habitat of winter season in Jarjr oma area.

No.	Scientific name	Twinspan groups	
		A	B
1	*Suaeda vera* Forak. ex Gmel.		0.01±0.02
2	*Allium roseum* L.		0.01±0.02
3	*Anthemis secundiramea* Biv.		0.01±0.02
4	*Cichorium spinosum* L.		0.52±0.90
5	*Launaea foxii* (Post) Eig.		0.01±0.02
6	*Silene colorata* Poiret		0.01±0.02
7	*Lotus halophilus* Boiss. Et Sprun		0.07±0.12
8	*Ononis vaginalis* Vahl.		0.04±0.07
9	*Moraea sisyrinchium* (L.)Ker Gaweler (Europe)	0.01±0.02	
10	*Juncus acutus* L.		0.04±0.07
11	*Limonium sibthorpianum* (Guss.) O. Ktze.		0.15±0.25
12	*Cynodon dactylon* (L.) Pers.	1.3±2.3	
13	*Elymus farctus* (Viv.) Runem. Ex Melderis		0.13±0.23
14	*Sarcopoterium spinosum* (L.) Spach		0.09±0.16
15	*Tamarix tetragyna* Ehrenb.		0.03±0.05
16	*Zygophyllum album* L.		0.04±0.07

Table (5) Density per m^2 of Sandy beach habitat of spring season in Jarjr oma area.

No.	Scientific name	Twinspan groups	
		A	B
1	*Suaeda vera* Forak. ex Gmel.		0.03±0.05
2	*Anthemis secundiramea* Biv.		0.01±0.02
3	*Cichorium spinosum* L.		0.33±0.58
4	*Silene colorata* Poiret		0.01±0.02

5	*Lotus halophilus* Boiss. Et Sprun		0.05±0.09
6	*Medicago polymorpha* L.		0.01±0.02
7	*Ononis vaginalis* Vahl.		0.04±0.07
8	*Trifolium purpureum* Lois.		0.01±0.02
9	*Trigonella stellata* Forsk.		0.15±0.25
10	*Frankenia hirsuta* L.		0.01±0.02
11	*Juncus acutus* L.		0.05±0.09
12	*Plantago ovata* Forskal		0.01±0.02
13	*Limonium sibthorpianum* (Guss.) O. Ktze.		0.16±0.28
14	*Cynodon dactylon* (L.) Pers.	0.53±0.92	
15	*Elymus farctus* (Viv.) Runem. Ex Melderis		0.2±0.35
16	*Triplachne nitens* (Guss.)Link	0.01±0.02	
17	*Emex spinosus* (L.) Camped		0.01±0.02
18	*Sarcopoterium spinosum* (L.) Spach		0.01±0.02
19	*Tamarix tetragyna* Ehrenb.		0.03±0.05
20	*Zygophyllum album* L.		0.05±0.06

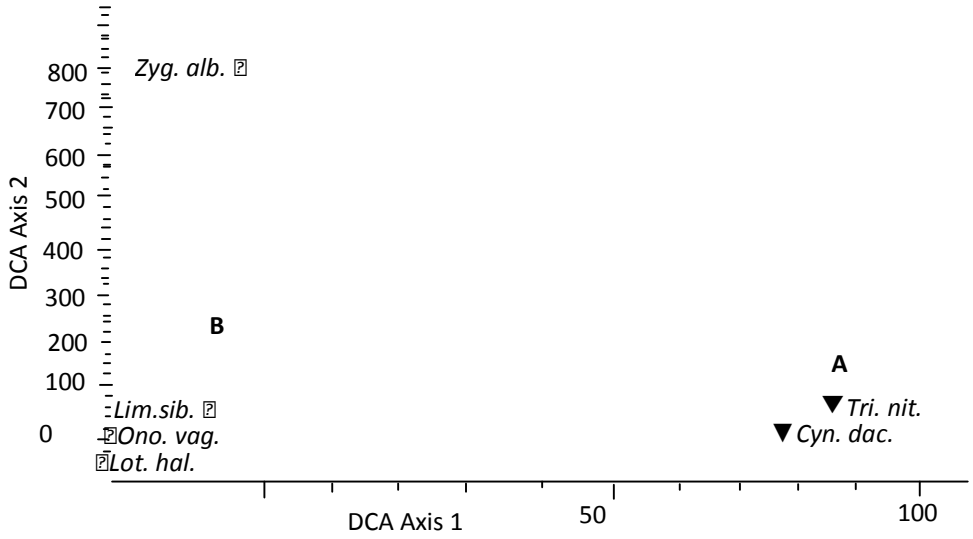

Fig. (2) Density of Sandy beach habitat of spring season in Jarjr-oma area.

Table (6) Density per m^2 of Sandy beach habitat of Summer season in Jarjr oma area.

No.	Scientific name	Twinspan groups	
		A	B
1	*Salsola kali* L.		0.12±0.21
2	*Suaeda vera* Forak. ex Gmel.	0.03±0.05	
3	*Cichorium spinosum* L.	0.33±0.58	
4	*Cakile aegyptica* (L.) Willd.		0.04±0.07
5	*Cressa cretica* L.	0.07±0.12	
6	*Euphorbia paralias* L.		0.03±0.05
7	*Euphorbia peplis* L.		0.2±0.35
8	*Ononis vaginalis* Vahl.		0.04±0.07
9	*Juncus acutus* L.	0.07±0.12	
10	*Limonium sibthorpianum* (Guss.) O. Ktze.	0.03±0.05	
11	*Cynodon dactylon* (L.) Pers.	3.15±5.07	
12	*Sporobolus pungens* (Schreb.) Kunth		0.09±0.16
13	*Polygonum maritimum* L.		0.11±0.18
14	*Tamarix tetragyna* Ehrenb.		0.03±0.05
15	*Zygophyllum album* L.		0.04±0.07

Salt march

Three transects extended from the north to south with 12 stands. Vegetation in salt march habitat from autumn which differ in their characteristics and consequently association type. Five species were recorded in autumn from total 19 species during four seasons in salt march by two association (Figs. 3 and 4) (Tables 7 - 12). Importance value and density Group A gave highest *Suaeda vera* Forak. ex Gmel. 150 and 1, respectively. Group B *Limoniastrum monopetalum* (L.) Boiss. gave IV 97.1 and Density 0.4 in autumn season. Dominance of Salt march habitat of autumn season in group A vegetation of this community the dominant species *Suaeda vera* Forak. ex Gmel. with 9.97, while dominant *Limoniastrum monopetalum* (L.) Boiss. with coverage 0.83 and *Lycium europaeum* with coverage 0.016.

Table (7) Importance value of Salt march habitat of autumn season in Jarjr oma area

No.	Scientific name	Twinspan groups	
		A	B
1	*Suaeda vera* Forak. ex Gmel.	150±212.1	
2	*Arisarum vulgare* Targ. Tozz		23.4±33.0
3	*Medicago polymorpha* L.		14.4±20.3
4	*Limoniastrum monopetalum* (L.) Boiss.		97.1±137.2
5	*Lycium europaeum* L.		15.3±21.6

In compare between Sandy beach habitat (a) and Salt march (b) in IV decrease number of species in Salt march by percent 27%, no indicator species exception *Suaeda vera* in both habitats Fig. 3. Results to environment stress in Salt March. Appear all seasons similar in results density of species perennial of Salt march habitat.

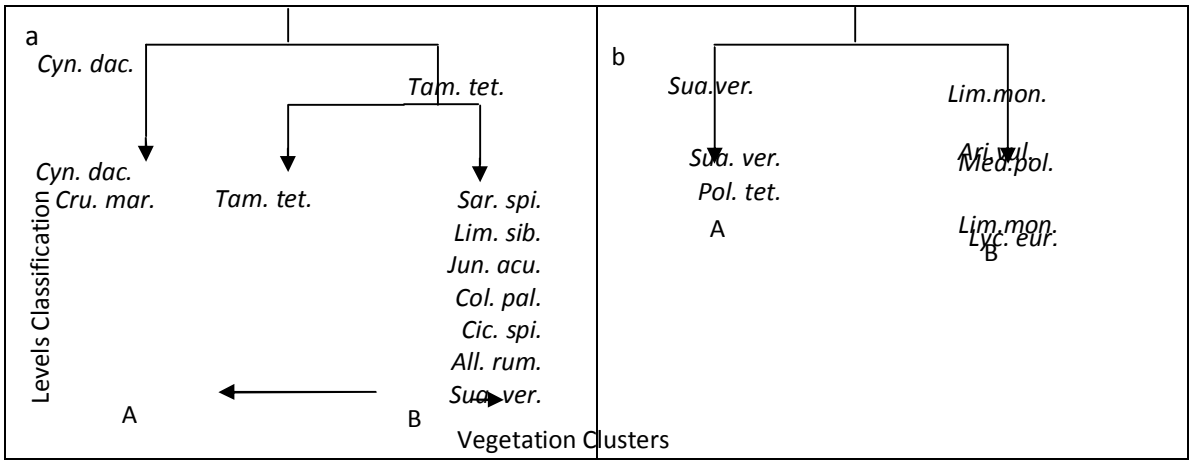

Fig. (3). Vegetation dendrogram of stands based on importance value of the species TWINSPAN classification 2 groups (A and B) of Sandy beach habitat (a) and Salt march habitat (b) in Jarjar oma area.

Table (8) Dominance of Salt march habitat of autumn season in Jarjr oma area.

No.	Scientific name	Twinspan groups	
		A	B
1	*Suaeda vera* Forak. ex Gmel.	9.97±14.1	
2	*Arisarum vulgare* Targ. Tozz		0.002±0.003
3	*Medicago polymorpha* L.		0.0012±0.002
4	*Limoniastrum monopetalum* (L.) Boiss.		0.83±1.17
5	*Lycium europaeum* L.		0.016±0.23

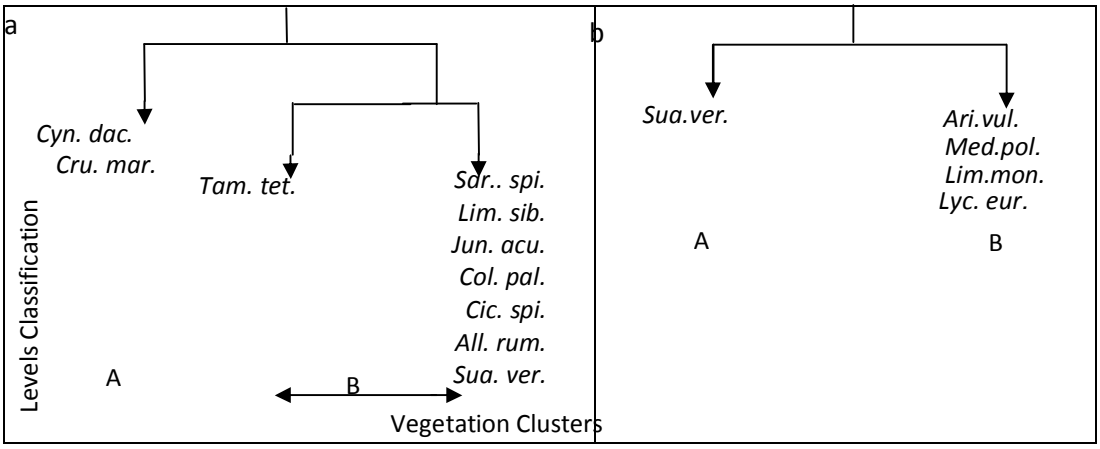

Fig. (4). Vegetation dendrogram of stands based on Dominance of the species TWINSPAN classification 2 groups (A and B) of Sandy beach habitat (a) and Salt march habitat (b) in Jarjar oma area.

Table (9) Density per m^2 of Salt march habitat of autumn season in Jarjr oma area.

No.	Scientific name	Twinspan groups	
		A	B
1	*Suaeda vera* Forak. Ex Gmel.	1±1.4	
2	*Arisarum vulgare* Targ. Tozz		0.12±0.17
3	*Medicago polymorpha* L.		0.02±0.03
4	*Limoniastrum monopetalum* (L.) Boiss.		0.4±0.6
5	*Lycium europaeum* L.		0.02±0.03

Table (10) Density per m^2 of Salt march habitat of winter season in Jarjr oma area.

No.	Scientific name	Twinspan groups	
		A	B
1	*Suaeda vera* Forak. ex Gmel.	0.68±1.0	
2	*Arisarum vulgare* Targ. Tozz		0.22±0.31
3	*Chlamydophora tridentata* Ehrenb. Ex Less.		0.24±0.34
4	*Lactuca saligna* L.		0.08±0.11
5	*Biscutella didyma* L.		0.02±0.03
6	*Sedum sediforme* (Jacq.) Pau		0.02±0.03
7	*Lathyrus aphaca* L.		0.02±0.03
8	*Anagallis arvensis* L.		0.08±0.11
9	*Limoniastrum monopetalum* (L.) Boiss.		0.7±1.0
10	*Brachypodium retusum* (Pers.) p. Beauv.		0.42±0.59
11	*Lycium europaeum* L.		0.02±0.03

Table (11) Density per m^2 of Salt march habitat of spring season in Jarjr oma area.

No.	Scientific name	Twinspan groups	
		A	B
1	*Mesembryanthemum nodiflorum* L.		0.02±0.03
2	*Suaeda vera* Forak. ex Gmel.	0.68±0.96	
3	*Chrozophora tinctoria* (L.) Juss.	0.04±0.06	
4	*Frankenia hirsuta* L.	0.06±0.08	
5	*Geranium molle* L.		0.02±0.03
6	*Plantago coronopus* L.		0.02±0.03
7	*Limoniastrum monopetalum* (L.) Boiss.		0.64±0.91
8	*Cynodon dactylon* (L.) Pers.	0.28±0.40	
9	*Hordeum marinum* Huds.		0.02±0.03
10	*Lycium europaeum* L.		0.02±0.03

Table (12) Density per m^2 of Salt march habitat of Summer season in Jarjr oma area.

No.	Scientific name	Twinspan one groups
1	*Suaeda vera* Forak. ex Gmel.	0.64±0.91
2	*Limoniastrum monopetalum* (L.) Boiss.	0.64±0.91
3	*Cynodon dactylon* (L.) Pers.	0.36±0.51
4	*Lycium europaeum* L.	0.02±0.03

Saline lands

Vegetation in saline lands habitat from autumn which differ in their characteristics and consequently association type. Twenty six species were recorded in autumn and 114 species during four seasons in saline lands of four associations (Figs. 5 and 6) (Tables 13-18). Each type comprises a set of stands with greater homogeneity of vegetation.

Group A. The dominant species of this type is *Polycarpon tetraphyllum* which attained the highest IV of 20.5. The indicator species is *Suaeda vera*. Group B Vegetation of this community *Onopordum cyrenaicum*, *Rumex bucephalophorus*. Group C the IV 53.6 *Sarcopoterium spinosum*. Association by *Mercurialis annua* and *Arisarum vulgare*. Group D this vegetation type the IV 24 of *Juniperus phoenicea* Association by *Anagallis arvensis*, *Bellevalia sessiliflora* and *Rhus tripartite*. Different between seasons.

Table (13) Importance value of Saline land habitat of autumn season in Jarjr oma area.

No.	Scientific name	Twinspan groups			
		A	B	C	D
1	*Suaeda vera* Forak. ex Gmel.	13.4±23.2			
2	*Pistacia lentiscus* L.				3.5±6.1
3	*Rhus tripartita* (Ucria) Grande				11.1±19.2
4	*Arisarum vulgare* Targ. Tozz			27.0±24.8	
5	*Bellevalia sessiliflora* (Viv.) Kunth				13.5±23.4
6	*Drimia maritima* (L.) Stearn			10.1±3.5	
7	*Leontedon tuberosus* L.				7.7±6.8
8	*Onopordum cyrenaicum* Maire & Weiller		14.4±19.2		
9	*Phagnlon ropestre* (L.) Dc.				2.4±4.9
10	*Sinapis alba* L.	2.4±4.9			
11	*Polycarpon tetraphyllum* (L.) L.	20.5±35.6			
12	*Umbilicus horizontalis* (Guss.) Dc.				7.8±6.7
13	*Juniperus phoenicea* L.				24.0±24.9
14	*Dioscorea communis* (L.) Caddick & Wilkin	2.4±4.9			
15	*Mercurialis annua* L.			27.9±39.5	
16	*Lotus ornithopodioides* L.				6.9±6.1
17	*Geranium molle* L.				3.8±6.6
18	*Phlomis floccosa* D. Don				2.4±4.2
19	*Prasium majus* L.				2.2±3.8
20	*Malva parviflora* L.	4.9±8.5			
21	*Anagallis arvensis* L.				18.1±31.3
22	*Oxalis corniculata* L.	2.8±4.9			
23	*Polygonum equisetiforme* Sm	3.5±6.0			
24	*Rumex bucephalophorus* L.		9.5±8.9		
25	*Sarcopoterium spinosum* (L.) Spach			53.6±2.9	
26	*Crucianella maritima* L.				0.6±1.0
27	*Asphodelus microcarpus* Salzm.& Viv.				2.3±4.0

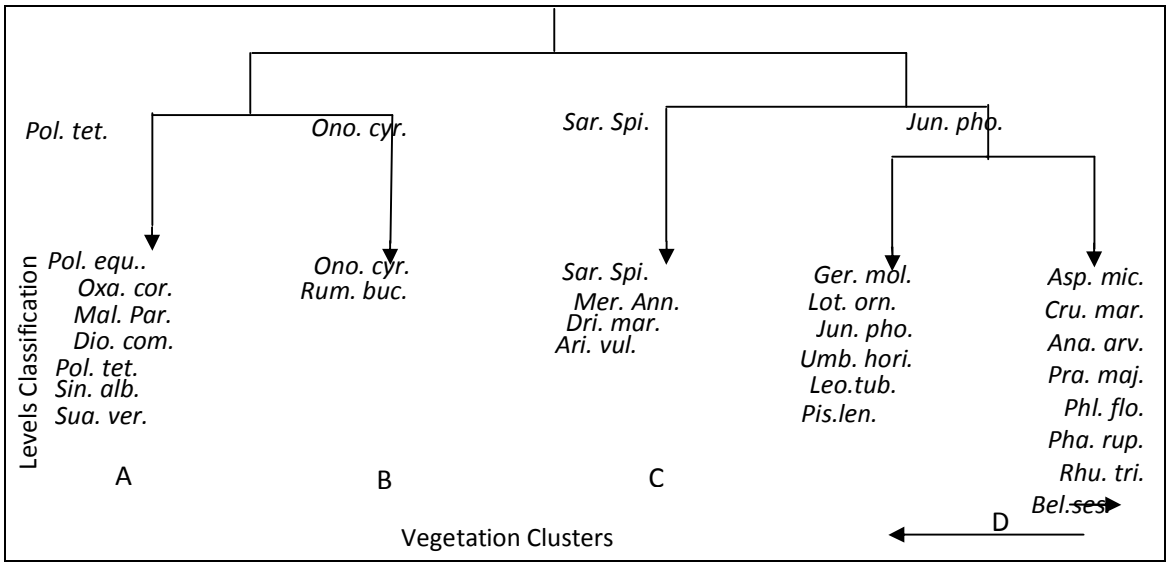

Fig. (5). Vegetation dendrogram of stands based on importance value of the species TWINSPAN classification 5 groups (A to D) of Saline Land habitat Jarjar oma area.

Table (14) Dominance of Saline land habitat of autumn season in Jarjr oma area.

No.	Scientific name	Twinspan groups			
		A	B	C	D
1	*Suaeda vera* Forak. ex Gmel.	0.20±0.34			
2	*Pistacia lentiscus* L.				0.001±0.001
3	*Rhus tripartita* (Ucria) Grande				0.22±0.38
4	*Arisarum vulgare* Targ. Tozz			0.12±0.15	
5	*Bellevalia sessiliflora* (Viv.) Kunth				0.01±0.02
6	*Drimia maritima* (L.) Stearn			0.04±0.03	
7	*Leontedon tuberosus* L.				0.02±0.02
8	*Onopordum cyrenaicum* Maire & Weiller		0.09±0.15		
9	*Phagnlon ropestre* (L.) Dc.				0.004±0.007
10	*Sinapis alba* L.	0.002±0.003			
11	*Polycarpon tetraphyllum* (L.) L.	0.03±0.05			
12	*Umbilicus horizontalis* (Guss.)Dc.				0.02±0.03
13	*Juniperus phoenicea* L.				0.43±0.45
14	*Dioscorea communis* (L.) Caddick & Wilkin	0.002±0.003			
15	*Mercurialis annua* L.		0.04±0.06		
16	*Lotus ornithopodioides* L.				0.0005±0.0004
17	*Geranium molle* L.				0.0012±0.0021
18	*Phlomis floccosa* D. Don				0.0003±0.0006
19	*Prasium majus* L.				0.001±0.001
20	*Malva parviflora* L.	0.01±0.02			
21	*Anagallis arvensis* L.				0.02±0.04
22	*Oxalis corniculata* L.	0.003±0.005			
23	*Polygonum equisetiforme* Sm.	0.01±0.01			
24	*Rumex bucephalophorus* L.		0.01±0.01		
25	*Sarcopoterium spinosum* (L.) Spach			0.97±0.14	
26	*Crucianella maritima* L.				0.01±0.03
27	*Asphodelus microcarpus* Salzm.& Viv.				0.001±0.002

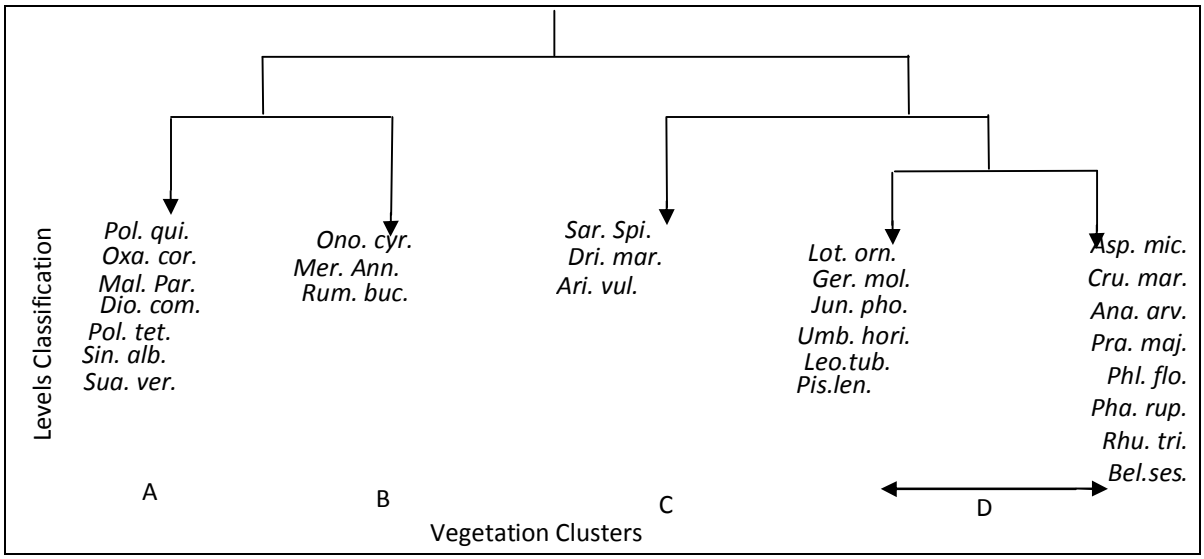

Fig. (6). Vegetation dendrogram of stands based on Dominance of the species TWINSPAN classification groups of 4 groups (A to D) of Saline Land habitat Jarjar oma area.

Increased number of species in saline habitat of winter and spring seasons of 71 and 65 species, respectively, gave summer season only 10 species. Density in autumn of *Mercurialis annua* reaches of group B to 2.0, *Anagallis arvensis* 1.9 group D, *Polycarpon tetraphyllum* 1.52 of Group A. In winter season *Leontedon tuberosus* group B, In spring season *Hordeum marinum* 2.7 of group A. summer season *Sarcopoterium spinosum*.

Table (15) Density per m^2 of Saline land habitat of autumn season in Jarjr oma area.

No.	Scientific name	Twinspan groups			
		A	B	C	D
1	*Suaeda vera* Forak. ex Gmel.	0.09±0.16			
2	*Pistacia lentiscus* L.				0.01±0.02
3	*Rhus tripartita* (Ucria) Grande				0.01±0.02
4	*Arisarum vulgare* Targ.Tozz			1.3±1.6	
5	*Bellevalia sessiliflora* (Viv.) Kunth				1.4±2.4
6	*Drimia maritima* (L.) Stearn			0.05±0.02	
7	*Leontedon tuberosus* L.				0.16±0.16
8	*Onopordum cyrenaicum* Maire & Weiller		0.5±0.8		
9	*Phagnlon ropestre* (L.) Dc.				0.07±0.1
10	*Sinapis alba* L.	0.01±0.02			
11	*Polycarpon tetraphyllum* (L.) L.	1.52±2.63			
12	*Umbilicus horizontalis* (Guss.)Dc.				0.17±0.21
13	*Juniperus phoenicea* L.				0.07±0.06
14	*Dioscorea communis* (L.) Caddick & Wilkin	0.01±0.02			
15	*Mercurialis annua* L.		2.0±3.2		
16	*Lotus ornithopodioides* L.				0.17±0.21
17	*Geranium molle* L.				0.04±0.07
18	*Phlomis floccosa* D. Don				0.04±0.07
19	*Prasium majus* L.				0.01±0.02
20	*Malva parviflora* L.	0.17±0.30			
21	*Anagallis arvensis* L.				1.9±3.3
22	*Oxalis corniculata* L.	0.01±0.02			
23	*Polygonum equisetiforme* sm.	0.05±0.09			
24	*Rumex bucephalophorus* L.		0.44±0.42		
25	*Sarcopoterium spinosum* (L.) Spach			0.28±0.14	
26	*Crucianella maritima L.*				0.01±0.02
27	*Asphodelus microcarpus* Salzm.& Viv.				0.03±0.05

Table (16) Density per m^2 of Saline land habitat of winter season in Jarjr oma area.

No.	Scientific name	Twinspan groups		
		A	B	C
1	*Beta vulgaris* L.			0.01±0.02
2	*Chenopodium murale* L.			0.01±0.02
3	*Suaeda vera* Forak. Ex Gmel.		0.11±0.18	
4	*Allium roseum* L.			0.01±0.02
5	*Pancratium maritimum* L.			0.01±0.02
6	*Pistacia lentiscus* L.		0.01±0.02	
7	*Bupleurum lancifolium* Hornem.			0.01±0.02
8	*Arisarum vulgare* Targ. Tozz		0.73±0.93	
9	*Bellevalia sessiliflora* (Viv.) Kunth			0.2±0.35
10	*Drimia maritima* (L.) Stearn		0.01±0.02	
11	*Calendula arvensis* L.		0.04±0.07	
12	*Carduus getulus* Pomel		0.01±0.02	
13	*Centaurea aegialophila* Boiss & Heldr.			0.01±0.02
14	*Centaurea alexandrina* Delile		0.05±0.09	
15	*Cynara cornigera* Lindley			0.05±0.09
16	*Leontedon tuberosus* L.		1.1±0.82	
17	*Matricaria aurea*(Loefl.) Sch. Bip.			0.01±0.02
18	*Onopordum cyrenaicum* Maire & Weiller		0.53±0.92	
19	*Phagnlon ropestre* (L.) Dc.			0.04±0.07
20	*Senecio gallicus* Chiax			0.01±0.02
21	*Biscutella didyma* L.			0.11±0.18
22	*Coronopus squamatus* (Forsk.) Ascherson			0.01±0.02
23	*Sinapis alba* L.			0.01±0.02
24	*Paronychia arabica* (Linn.) Dc.		0.29±0.30	
25	*Spergularia diandra* (Guss.) Heldr. & Sart.			0.01±0.02
26	*Convolvulus supinus* Coss. Et Kral.		0.07±0.08	
27	*Umbilicus horizontalis* (Guss.)Dc.			0.01±0.02
28	*Juniperus phoenicea* L.	0.05±0.05		
29	*Carex divisa* Huds.			0.01±0.02
30	*Mercurialis annua* L.	0.62±0.98		
31	*Anthyllis tetraphylla* L.			0.01±0.02
32	*Lotus ornithopodioides* L.		0.21±0.17	
33	*Lotus tetragonolobus* L.		0.01±0.02	
34	*Lupinus* L.		0.01±0.02	
35	*Medicago tornata* (L.) Mill.			0.01±0.02
36	*Ononis hispida* Desf.		0.01±0.02	
37	*Retama raetem* (Forsk.) Webb			0.01±0.02
38	*Vicia sativa* L.			0.04±0.07
39	*Vicia tetrasperma* (L.) Schreb.		0.01±0.02	
40	*Erodium malacoides* (L.) L'Herit.	0.19±0.18		
41	*Erodium moschatum* (L.) L'Herit.			0.01±0.02
42	*Erodium touchyanum* Delile			0.01±0.02
43	*Geranium molle* L.	0.41±0.42		
44	*Moraea sisyrinchium* (L.)Ker Gaweler (Europe)			0.01±0.02
45	*Micromeria nervosa* (Desf.) Benth.			0.01±0.02
46	*Phlomis floccosa* D. Don			0.03±0.05
47	*Prasium majus* L.			0.01±0.02
48	*Linum strictum var.spicatum* Pers.		0.01±0.02	
49	*Malva aegyptia* L.		0.04±0.07	
50	*Malva parviflora* L.		0.08±0.14	
51	*Anagallis arvensis* L.		0.15±0.10	
52	*Orobanche coelistis* (Reut.) Boiss. & Reut.			0.01±0.02
53	*Papaver hybridum* L.			0.01±0.02
54	*Plantago coronopus* L.			0.01±0.02
55	*Plantago cyrenaica* Durand & Barratte			0.01±0.02
56	*Plantago ovata* Forskal			0.01±0.02
57	*Brachypodium retusum* (Pers.) p. Beauv.		0.27±0.46	
58	*Elymus farctus* (Viv.) Runem. Ex Melderis			0.01±0.02
59	*Hordeum marinum* Huds.			0.01±0.02
60	*Emex spinosus* (L.) Camped			0.01±0.02
61	*Polygonum equisetiforme* sm.			0.01±0.02
62	*Adonis microcarpa* DC.			0.01±0.02
63	*Ziziphus lotus* (L.) Lam.			0.01±0.02
64	*Sarcopoterium spinosum* (L.) Spach		0.32±0.18	
65	*Crucianella maritima* L.			0.01±0.02
66	*Sherardia arvensis* L.		0.57±0.70	
67	*Theligonum cynocrambe* L.			0.01±0.02
68	*Lycium europaeum* L.		0.01±0.02	
69	*Urtica urens* L.			0.01±0.02
70	*Valerianella petrovichii* Ascherson		0.13±0.17	
71	*Zygophyllum album* L.			0.01±0.02

Table (17) Density per m^2 of Saline land habitat of spring season in Jarjr oma area.

No.	Scientific name	Twinspan groups		
		A	B	C
1	*Mesembryanthemum nodiflorum* L.	0.01±0.02		
2	*Beta vulgaris* L.	0.01±0.02		
3	*Chenopodium murale* L.			0.01±0.02
4	*Suaeda vera* Forak. ex Gmel.	0.15±0.25		
5	*Pancratium maritimum* L.			0.01±0.02
6	*Pistacia lentiscus* L.			0.01±0.02
7	*Caralluma europaea* (Guss.) N.E.Br.			0.01±0.02
8	*Arisarum vulgare* Targ. Tozz	0.01±0.02		
9	*Asparagus aphyllus* L.			0.01±0.02
10	*Carduus getulus* Pomel	0.04±0.07		
11	*Carlina lanata* L.			0.07±0.12
12	*Carthamus lanatus* L.	0.11±0.18		
13	*Cichorium endivia* L.	0.13±0.23		
14	*Crepis senecioides ssp.senecioides* Delile	0.41±0.28		
15	*Crepis vesicaria ssp. vesicaria* L.			0.01±0.02
16	*Cynara cornigera* Lindley			0.01±0.02
17	*Hedypnois cretica* (L.) Dum. – Courset			0.01±0.02
18	*Hypochaeris achyrophorus* L.			0.01±0.02
19	*Leontedon hispidulus* (Delile) Boiss.			0.01±0.02
20	*Leontedon tuberosus* L.			0.15±0.25
21	*Onopordum cyrenaicum* Maire & Weiller	0.13±0.23		
22	*Phagnlon ropestre* (L.) Dc.			0.05±0.09
23	*Silybum marianum* (L.) Gaertner	0.01±0.02		
24	*Urospermum dalechampii* (L.) Scop. ex F.W.Schmidt	0.01±0.02		
25	*Biscutella didyma* L.	0.03±0.05		
26	*Rapistrum rugosum* (L.) All.			0.01±0.02
27	*Herniaria cinerea* Dc.			0.01±0.02
28	*Herniaria glabra* Linn.			0.01±0.02
29	*Paronychia Arabica* (Linn.) Dc.	0.44±0.41		
30	*Polycarpon tetraphyllum* (L.) L.	0.25±0.44		
31	*spergularia diandra* (Guss.) Heldr. & Sart.	0.28±0.48		
32	*Convolvulus althaeoides* L.			0.01±0.02
33	*Sedum sediforme* (Jacq.) Pau			0.01±0.02
34	*Juniperus phoenicea* L.		0.05±0.05	
35	*Scabiosa arenaria* Forskal	0.05±0.09		
36	*Mercurialis annua* L.		0.16±0.21	
37	*Anthyllis tetraphylla* L.			0.01±0.02
38	*Ceratonia siliqua* L.			0.01±0.02
39	*Lotus edulis* L.			0.01±0.02
40	*Medicago polymorpha* L.	0.01±0.02		
41	*Retama raetem* (Forsk.) Webb			0.01±0.02
42	*Trifolium scabrum* L.	0.01±0.02		
43	*Trifolium stellatum* L.	0.03±0.05		
44	*Trifolium tomentosum* L.	0.01±0.02		
45	*Centaurium pulchellum* (Swartz) Druce			0.03±0.05
46	*Geranium molle* L.	0.04±0.07		
47	*Micromeria juliana* (L.) Benth. Ex Reichenb.			0.01±0.02
48	*Micromeria nervosa* (Desf.) Benth.			0.01±0.02
49	*Phlomis floccosa* D. Don			0.03±0.05
50	*Prasium majus* L.			0.01±0.02
51	*Linum strictum var.spicatum* Pers.			0.01±0.02
52	*Cyclamen rohlfsianum* Aschers.			0.01±0.02
53	*Orobanche coelistis* (Reut.) Boiss. & Reut.			0.01±0.02
54	*Glaucium flavum* Crantz			0.01±0.02
55	*Limoniastrum monopetalum* (L.) Boiss.			0.03±0.05
56	*Brachypodium retusum* (Pers.) p. Beauv.	0.13±0.23		
57	*Bromus madritensis* L.	0.01±0.02		
58	*Hordeum marinum* Huds.	2.7±4.6		
59	*Phalaris minor* Retz.	0.93±1.62		
60	*Stipa capensis* Thunb.	0.31±0.53		
61	*Polygonum equisetiforme* sm.	0.03±0.02		
62	*Rumex crispus* L.			0.01±0.02
63	*Sarcopoterium spinosum* (L.) Spach	0.35±0.14		
64	*Smilax aspera* L.			0.01±0.02
65	*Lycium europaeum* L.	0.01±0.02		

Table (18) Density per m^2 of Saline land habitat of Summer season in Jarjr oma area.

No.	Scientific name	Twinspan groups	
		A	B
1	*Suaeda vera* Forak. ex Gmel.	0.11±0.18	
2	*Pistacia lentiscus* L.		0.01±0.02
3	*Rhus tripartita* (Ucria) Grande		0.01±0.02
4	*Juniperus phoenicea* L.		0.05±0.05
5	*Juncus acutus* L.		0.11±0.18
6	*Phlomis floccosa* D. Don		0.03±0.05
7	*Limoniastrum monopetalum* (L.) Boiss.		0.04±0.07
8	*Polygonum equisetiforme* sm.	0.01±0.02	
9	*Sarcopoterium spinosum* (L.) Spach	0.4±0.29	
10	*Lycium europaeum* L.		0.01±0.02

Sand formations

Vegetation in Sand formation habitat from autumn which differ in their characteristics and consequently association type. Six species were recorded in the studied 12 stands. The application of TWINSPAN classification on the importance values of the recorded eight species during four seasons in sand formation by 12 stands led to the recognition of one association (Tables 19 - 21).

Group A. The dominant species of this type is *Carex divisa* Huds. which attained the highest density of 0.6 in winter and spring. The indicator species are *Pancratium maritimum* L. Different number of species between seasons non annuals in all seasons in Sand formation.

Table (19) Density per m^2 of Sand formation habitat of autumn season in Jarjr oma area.

No.	Scientific name	Twinspan groups
1	*Retama raetem* (Forsk.) Webb	0.12
2	*Nitraria retusa* (Forsk.) Aschers.	0.08
3	*Crucianella maritima* L.	0.12

Table (20) Density per m^2 of Sand formation habitat of winter season in Jarjr oma area.

No.	Scientific name	Twinspan groups
1	*Pancratium maritimum* L.	0.6
2	*Centaurea aegialophila* Boiss & Heldr.	0.28
3	*Carex divisa* Huds.	0.4
4	*Retama raetem* (Forsk.) Webb	0.12
5	*Nitraria retusa* (Forsk.) Aschers.	0.08
6	*Crucianella maritima* L.	0.12
7	*Zygophyllum album* L.	0.08

Table (21) Density per m^2 of Sand formation habitat of spring season in Jarjr oma area.

No.	Scientific name	Twinspan one groups
1	*Pancratium maritimum* L.	0.6
2	*Centaurea aegialophila* Boiss & Heldr.	0.2
3	*Carex divisa* Huds.	0.6
4	*Retama raetem* (Forsk.) Webb	0.12
5	*Nitraria retusa* (Forsk.) Aschers.	0.08
6	*Posidonia oceanica* (L.) Delile	0.16
7	*Zygophyllum album* L.	0.08

Table (22) Density per m^2 of Sand formation habitat of Summer season in Jarjr oma area.

No.	Scientific name	Twinspan one groups
1	*Retama raetem* (Forsk.) Webb	0.12
2	*Nitraria retusa* (Forsk.) Aschers.	0.08
3	*Crucianella maritima* L.	0.12
4	*Zygophyllum album* L.	0.08

Soil-vegetation Relationship

The different soil characteristics in the community representing the different vegetation are recorded in Table 23. The mechanical analysis of the soil samples for the vegetation community showed habitats site variations in four habitats Jarjr-oma.

Table 23. Physical and chemical analysis of soil samples for four habitats in Jarjr-oma area. Community based on vegetation groups resulting from TWINSPAN.

Soil variable		Classification community				
Habitat		S. B	S. F	S. M	Sa.	
Community		*Cyn. dac.*	*Ret. rae.*	*Sua. ver.*	*Sar. spi*	*Jun. acu.*
Soil fraction	Sand	0.53	0.81	0.37	0.79	0.19
	Silt	0.11	0.03	0.07	0.05	0.11
	Clay	0.36	0.16	0.56	0.16	0.70
Soil texture		Loam	Loamy sand	Silty loam	Loamy sand	Silty loam
pH		8.05	7.74	7.08	8.14	7.83
EC (mmohs/cm)		6.61	11.29	36.2	11.36	9.39
N %		0.16	0.03	0.13	0.10	0.12
MC %		1.65	0.38	0.36	0.29	3.59
$NaCl^-$ %		8.1	15.1	48.5	1.2	11.8
Anions (mg/L.)	Cl^-	290	490	390	530	450
	$Co3^{--}$	0	0	0	0	0
	$So4^{--}$	15.99	1902.15	1300	1922.15	1900
Cations (m.eq./L.)	Na^+	39.1	78.3	573.9	5.7	83.5
	K^+	1.5	2.1	2.6	0.8	1.5
	Ca^{++}	1.92	11.12	19.45	2.18	6.04
	Mg^{++}	7.60	12.28	8.98	3.46	8.76

S.B.= Sandy beach, S.F.= Sand formation, S.M.= Salt march and S.=Saline

The principal components analysis) for the vegetation habitats-soil relationships distinguished that the highest affinity for sand and clay soil content were recorded in all habitats Figs (7 - 9). The maximum mean value for Cl^-, Na^+, $So4^{--}$ and EC. The species *Suaeda vera* Forak. ex Gmel., *Retama raetem* (Forsk.) Webb, *Cynodon dactylon* (L.) Pers. and *Juncus acutus* L. preferred to grow in coarse sand soil.

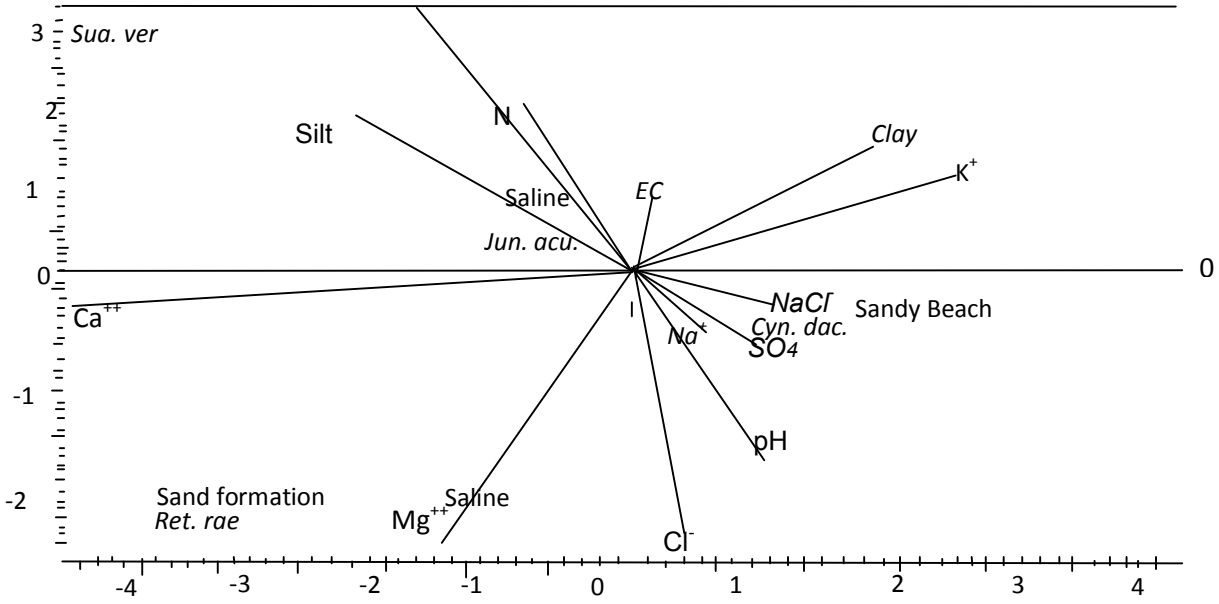

Fig. 7. PCA (principal components analysis) correlation ordination diagram with vegetation groups-soil in four habitats Jarjr-oma area.

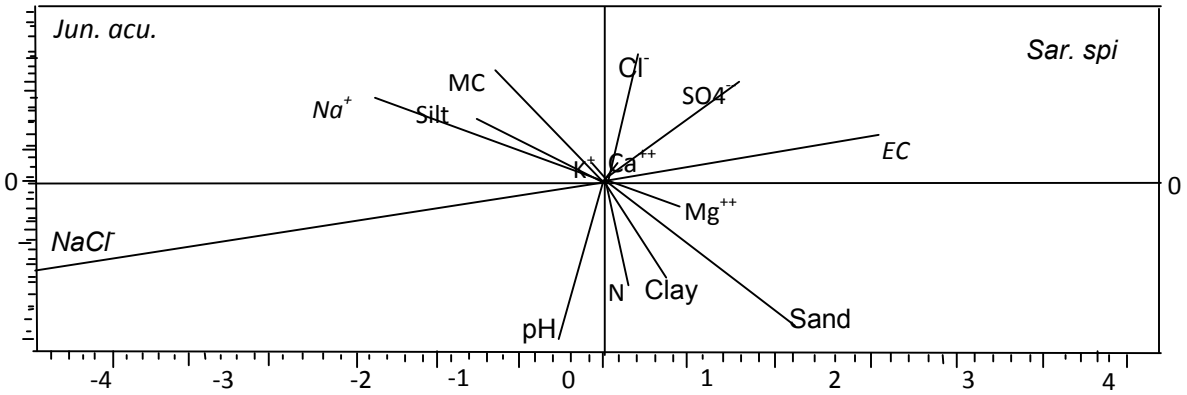

Fig. 8. PCA (principal components analysis) correlation ordination diagram between the different soile variables to stands with vegetation groups from TWINSPAN classification of the vegetation in Saline habitat Jarjr-oma area.

Jarjr-oma Saline habitat winter 2011

Salt March Winter Jarjr-oma.

Jarjar oma Autumn 2010

Jarjar oma Autumn 2010

Figs. 9. Pictures of some habitats in Jarjr-oma area of Al- Jabal Al- Akhdar.

4. Discussion

Although poor in species, the vegetation composition of the saltmarshes in is a Jarjr-oma of two plant communities. Succulence is a common phenomenon in the vegetation of Saline habitats (Fahmy, 1986). *Suaeda vera*, *Bellevalia sessiliflora*, *Drimia maritima*, *Umbilicus horizontalis*, *Asphodelus microcarpus*, *Allium roseum*, *Cyclamen rohlfsianum*, *Pancratium maritimum* and *Zygophyllum album*. Succulent perennial shrubs growth form e.g. *Tamarix tetragyna*, *Nitraria retusa* and *Juncus acutus*.

The vegetation distribution pattern in the study areas was mainly related to amount salinity and sand.

The annuals occurring in saline areas could be divided into three categories non-halophilous therophytes, spring halophytic therophytes and late summer annual halophytic chenopods (Akhani and Ghorbanli, 1993). Leaf growth rate per shoot was generally 100% higher in sandy habitats than in rocky areas (Bandeira, 2002). A comparison of the annual precipitation with the distribution of saline soils shows that a majority of the areas have total annual precipitation of less than 250 mm (Akhani and Ghorbanli, 1993). The dominating life forms are chamaephytes in sites of high salinity, and therophytes in sites of low salinity. Spatial and temporal variations in the standing crop biomass were pronounced (Ayyad and El-Ghareeh, 2004). Saline habitat increased number of species of winter and spring seasons of 71 and 65 species, while, Sandy beach increase in spring season to 20 species, in Salt march 11 and 10 of winter and spring, in summer season equal winter and spring the number of species.

In Libya, several thousand hectares of mixed stands of *Acacia saligna* syn, *A.cyanophylla* and *Atriplex canexens* have been established in large fenced areas to provide supplementary grazing in autumn and spring (Choukr-Allah, 1997).

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