Journal of Phytology 2010, 2(3): 39–50
An Open Access Journal
ISSN: 2075-6240
Available Online: www.journal-phytology.com

REGULAR ARTICLE

RELATIVE IMPORTANCE OF SALT MARSHES AS RANGE RESOURCES IN THE NORTH WESTERN MEDITERRANEAN COAST OF EGYPT

M.H.M. El-Morsy
Range Management Unit, Desert Research Center, Cairo, Egypt

SUMMARY

The present investigation was carried out to study the relative importance of range plants in Abu Lahu Bahary and Sidi Abd El-Rahman salt marshes, on the Northwestern Coast of Egypt from spring 2005 to autumn 2006. Fifteen plant species belonging to 7 families were found (15 in the first salt marshes and 14 in the second one). Thirteen species were perennials and two species were annuals. According to palatability five plant species (33.3%) were palatable and ten plant species (66.7%) were unpalatable.

Fresh and dry foliage yield, species density, frequency, coverage and the importance value (IV) as well as their relative values were determined in both sites. The highest value of studied parameters was recorded in Abu Lahu Bahary (West Site) in spring seasons during both years (2005 and 2006). Meanwhile, the lowest values of all these traits were recorded in Sidi Abd El-Rahman (East Site) during autumn seasons. No significant difference was found between both years.

Significant interaction was noticed among the studied factors i.e. year, location and season in both salt marshes. The highest figure of importance value (IV) was contributed by *Halocnemum strobilaceum* (33.75) followed by *Arthrocnemum glaucum* (33.13) and *Anabasis articulata* (31.58) in the first sites. In the second location (East Site salt marshes) the highest values were found in *Halocnemum strobilaceum* (39.77) followed by *Anabasis articulate* (36.68) and *Salicornia fruticosa* (34.35).

Keywords: Halophyte, Range plants, Fresh and dry foliage yield, Cover, density

M.H.M. El-Morsy. Relative Importance of Salt Marshes as Range Resources in The North Western Mediterranean Coast of Egypt. J Phytol 2/3 (2010) 39-50
Author, Email: elmorsy101@yahoo.com

1. Introduction

Coastal salt marshes or Sabkha (Sabkha is an Arabic term for coastal and inland saline areas that contain shallow, sometimes extensive, depressions) are usually formed in coastal areas of arid regions where net evaporation is high and washing of soil is negligible due to limited freshwater supplies coupled with scanty rainfall and poor soil drainage. No profitable agricultural activity can be carried out in these areas. It is imperative to study these salt marshes to determine their ecological and potential economic value to the country (El- Shaer and El- Morsy 2008).

The salt marsh ecosystems are characterized by a very high percentage of insoluble and soluble salts, diversified types of plant communities, and varying soil condition (i.e. soil texture and total salinity) and water quality.

The shortage of animal feed is the main constraint to increase indigenous animal production, particularly in arid and semi-arid regions. Animal production, as the main source of income for nomads, is based mostly on the natural vegetation for feeding sheep, goats and camels. The palatable plant species are always overgrazed due to the grazing pressure of animals. However,

unpalatable and less- palatable halophytes are widely distributed in salt marshes throughout Egypt. Halophytic plants such as *Suaeda* spp., *Atriplex spp., Nitraria retusa, Salsola spp,* are generally the most palatable chenopod shrubs in several salt marshes (El-Shaer, 1981), which always disappear fast due to overgrazing. Such plants are extremely valuable as a fodder reserve particularly during drought season. Factors influencing grazing and nutritive values of halophytes are the plant species, ecotypes, stage of growth (Abd El-Aziz, 1982 and El-Shaer, 1986), season of use (wet season versus dry season), environmental factors (El- Bassosy, 1983 and Ibrahim, 1995), and location (El-Morsy, 2002).

In general halophytes, especially when green show some degree of unpalatability. However, when they are no longer green or mixed with other feed their palatability improves. Therefore, these plants should be considered vital resource for range production especially during summer season where food shortage is even more problematic.

The main objective of this study is to focus on the relative importance of salt marsh plants (halophytes) as range resources.

2. Materials and methods

2.1. Study area:

This investigations were conducted in spring (April) and autumn (October) 2005 and 2006, in the sea shore Salt Marshes are located at Abu Lahu Bahary (West Site), is separated from the Sea by lime rocks, about 45 km west of Marsa Matrouh City and the second site at Sidi Abd El-Rhman (East Site), directly on the sea shore, about 150 km east Marsa Matrouh city on the Mediterranean sea coastal, Northwestern Coast of Egypt.

2.2. Climate:

Climate of the study area belongs to the Mediterranean coastal region of Egypt which is warm coastal desert climate. The occasional short rainstorms occur in winter and most of the days are sunny with mild temperature. Generally, the rainy season occurs during the winter and is characterized by great fluctuation in distribution and intensity of rainfall from one year to another. The monthly variation of some climatic factors of Abu Lahu Bahary (West Site) and Sidi Abd El-Rhman (East Site) are shown in Table1.

Table 1. Monthly and annual averages for climatic factors at Mersa Matrouh and Sidi Abd El-Rahman.

Month	Abu Lahu Bahary, Mersa Matrouh (West Site)						Sidi Abd El-Rahman (East Site)					
	Air Temperature (°C)		WS m/s	RH %	P mm	Dew Point	Air Temperature (°C)		WS m/s	RH %	P mm	Dew Point
	Max.	Min.					Max.	Min.				
Jan.	17.79	9.17	4.90	69.8	37.3	7.4	18.25	10.00	4.4	59.9	21.8	7.0
Feb.	18.53	9.11	5.13	66.8	20.7	7.0	17.40	9.93	3.6	58.3	18.5	7.1
Mar.	20.01	10.47	5.17	65.7	10.9	8.4	20.76	10.63	3.6	56.7	4.8	8.3
Apr.	22.98	12.63	4.84	64.9	3.3	10.6	22.97	13.	4.0	55.0	1.0	10.5
May	25.34	15.37	4.19	70.2	1.9	14.1	25.17	16.13	3.4	56.8	1.5	14.1
Jun.	28.12	18.79	4.31	70.5	0.0	17.4	28.07	19.03	3.8	61.4	0.0	18.6
Jul.	29.05	21.08	4.52	73.5	0.0	19.9	30.11	21.20	3.1	64.2	0.0	20.7
Aug.	29.80	21.57	4.02	72.6	0.4	20.2	30.37	21.87	3.6	65.1	0.0	21.6
Sep.	28.89	19.26	3.69	67.7	2.0	18.2	29.80	20.90	3.7	61.4	0.8	18.2
Oct.	26.70	15.51	3.61	68.2	17.0	15.4	26.45	18.67	3.7	60.0	11.7	15.1
Nov.	22.99	13.83	3.96	68.8	18.7	11.8	23.47	15.47	3.7	62.4	19.1	11.8
Dec.	19.48	10.49	4.84	67.1	31.6	8.1	19.42	11.37	3.8	62.1	29.2	8.5
Annual	24.14	15.02	4.43	68.8	149.3	13.2	24.35	15.68	3.7	60.3	108.4	13.74

Where P: precipitations (mm), WS: wind speed (m/sec.) and relative humidity (%).

2.3. Soil properties:

Soil samples were taken from both experimental sites and mechanical analyses of soils were conducted using the international pipette method as described by Soil Conservation Service 1984 (Table 2). Chemical determinations of the saturated

extract and the soil were carried out according to Jackson, 1956 (Table 3).

Table 2. Physical properties of soil at salt marshes in west and east sites of Mersa Matrouh.

Study area	Depth (cm)	Particle-size distribution of soil (%)				Texture
		Coarse sand	Fine sand	Silt	Clay	
Abu Lahu Bahary (West Site)	0-30	54.20	33.50	5.60	6.70	Sandy
Sidi Abd El-Rahman (East Site)	0-30	61.30	31.70	3.40	3.60	Sandy

Table 3. Chemical properties of soil at salt marshes in west and east sites of Mersa Matrouh.

Study area	Depth (cm)	pH	EC mmhos/cm	Anions meq L^{-1}			Cations meq L^{-1}				$CaCO_3$ %
				So_4	Cl	HCo_3	K	Na	Mg	Ca	
West Site	0-30	7.67	76.2	29	740	4	23	420	170	230	38.2
	30-60	7.79	76.5	36	730	5	27	563	140	150	22.1
East Site	0-30	7.68	76.7	28	760	5	21	412	160	200	31.4
	30-60	7.81	77.1	35	750	6	23	542	120	100	20.6

2.4. Pasture samples and measurements:

At the beginning of the study 20 quadrats 5X5 m (25 m^2) were selected randomly in each site. In each season, both years, only new regrown parts were harvested for determination of fresh and dry weight.

The following measurements were done in each time of this study, fresh and dry foliage (forage) yield. Pasture measurements were done according to Mueller-Dombois & Ellenberg, 1974, as follows:

Density = number of individuals / area sampled

Relative density = density for a species / total density for all species x 100

Frequency = number of sampled quadrats in which species occurs / total number of quadrates sampled

Relative frequency = frequency value for a species / total quadrate area x 100

Cover = total of quadrat area for a species / total quadrat area x 100

Relative cover = total of quadrat area for a species / total of quadrate area for all species x 100

Importance value = Relative density + Relative frequency + Relative cover

The importance value (IV) was determined according to Ludwing & Reynolds (1988) by calculating sum of relative density, relative frequency and relative cover for different species.

The quadrats locations were random in the first time (Spring 2005) and the following times sample taken from the same quadrats.

2.5. Floristic identifications:

The plant species in this study is wild (naturally established). Plant species and families were fully identified to the family level, and named according to Täckholm (1974) updated by Boulos (1995).

2.6. Statistical analysis:

The experiment was laid out in split plot design location in the main, while seasons in the sup. Data subjected to analyses by M-STAT C, (Russell, 1991). The differences among the means were performed by least significant difference (LSD) at 5% level.

3. Results and discussion

3.1. Botanical composition, palatability and life duration:

The results in Table 4 revealed that fifteen species belonging to seven families were found under both studied sites at West Site and East Site, for spring and autumn seasons. The majority of the plant species that exist in both sites were perennial and unpalatable. The Chenopodiaceae family has a wide distribution (seven plant species 46.7%), followed by Poaceae family (three species, 20%) and one plant species for the rest of the families. The perennial species represent 86.7% (13 plant species) where the annuals were 13.3% (2 plant species).

Five plant species (33.3%) were palatable and ten plant species (66.7%) were unpalatable in fresh condition (Table 4).

Furthermore, some species: *Zygophyllum album*, *Thymelaea hirsuta* and *Tamarix nilotica*

was found in the transitional area between sand plan and adjacent salt marshes.

Tamarix nilotica were found in the first salt marsh site (West Site) where absence in the second site (East Site); this may be attributed to the differences of the soil sector and/or increase of precipitation rates in the first site which influences it's partial decrease of salt concentration especially with the absence information about *Tamarix nilotica* plantations in these area. Also, it may be due to lime rocks which separate the first salt marshes from the sea shore while the second one is directly on the shore of the Mediterranean Sea which increases the salt concentration of soil solution (Table 3).

Table 4. Botanical composition, palatability and life duration of plant species recorded in salt marshes (West and East Sites) from spring 2005 to autumn 2006 seasons.

Family Name	Scientific Name	Palatability	Life Duration	Vernacular Name
	Anabasis articulata	UP	Per.	Agram
	Arthrocnemum glaucum	UP	Per.	Khreiza
	Atriplex halimus	P	Per.	Qataaf
Chenopodiaceae	*Halocnemum strobilaceum*	UP	Per.	Hatab ahmar
	Salicornia fruticosa	UP	Per.	Hatab
	Salsola vermiculata	P	Per.	Salsola
	Suaeda vermiculata	UP	Per.	Soweid
	Aeluropus lagopoides	P	Per.	Molleih
Poaceae	*Setaria verticillata*	P	Ann.	Yadaab
	Inula crithmoides	UP	Per.	Hatab zeiti
Aizoaceae	*Mesembryanthemum nodiflorum*	UP	Ann.	Ghasool
Plumbaginaceae	*Limoniastrum monopetalum*	UP	Per.	Zeiti
Tamaricaceae	*Tamarix nilotica*	P	Per.	Abal
Thymelaceae	*Thymelaea hirsuta*	UP	Per.	Mithnaan
Zygophyllaceae	*Zygophyllum album*	UP	Per.	Ratrayt

P	Palatable	Ann.	Annual
UP	Un-palatable	Per.	Perennial

3.2. Plant coverage percentage:

Table 5a, b and c shows plant coverage percentage of both salt marches studied; no significant differences were found between both years and location although the coverage percentage in 2005 was higher than 2006. West Site was higher than East Site (Table 5a).

There were significant differences between seasons; spring season was higher than fall season in both studied years. The interaction among different studied factors was significant (Table5a).

Table 5a. Plant cover (%) affected by year, season, location, and their interaction in salt marshes (West and East Sites) from spring 2005 to autumn 2006 seasons.

	West Site	East Site	
Seasons	Year x Location x Season means		Year x Season mean
Spring 2005	41.06	37.78	39.42
Autumn 2005	26.68	23.06	24.87
Spring 2006	39.64	33.28	36.46
Autumn 2006	27.01	23.32	25.17
Years	Year x Location means		Years means
2005	33.87	30.42	32.15
2006	33.33	28.30	30.82
Seasons	Season x Location means		Seasons means
Spring	40.35	35.53	37.94
Autumn	26.85	23.19	25.02
Location mean	33.60	29.36	31.48

$LSD_{0.05}$ season = 5.653 $LSD_{0.05}$ location = NS $LSD_{0.05}$ year = 5.653 $LSD_{0.05}$ year× location7.994
$LSD_{0.05}$ season × location = 7.994 $LSD_{0.05}$ season × year = 7.994 $LSD_{0.05}$ year× season × location = 11.3

Table 5b. Cover percentage of plant species recorded in salt marshes (West and East Sites) from spring 2005 to autumn 2006 seasons.

Scientific Name	2005				2006			
	Spring		Autumn		Spring		Autumn	
	West	East	West	East	West	East	West	East
Anabasis articulata	3.28	3.60	2.18	2.24	3.01	3.60	2.20	2.97
Arthrocnemum glaucum	3.32	3.90	2.47	2.39	3.22	3.00	2.34	2.53
Atriplex halimus	2.45	2.84	2.16	2.54	2.64	2.28	2.17	2.11
Halocnemum strobilaceum	4.79	6.51	3.96	4.90	4.70	4.97	4.17	4.15
Salicornia fruticosa	4.68	5.37	3.02	3.97	4.35	4.46	3.15	3.98
Salsola vermiculata	0.54	0.43	0.12	0.28	0.45	0.34	0.31	0.30
Suaeda vermiculata	1.96	2.29	1.80	1.84	0.42	2.46	1.32	2.27
Aeluropus lagopoides	0.34	0.29	0.06	0.04	0.45	0.40	0.04	0.03
Setaria verticillata	0.80	0.73	0.00	0.00	0.81	0.65	0.00	0.00
Inula crithmoides	2.48	2.53	1.58	1.96	2.76	2.70	0.83	0.63
Mesembryanthemum nodiflorum	3.18	2.86	0.00	0.00	3.35	2.96	0.00	0.00
Limoniastrum monopetalum	4.27	4.91	2.24	1.84	4.60	3.85	3.16	3.22
Tamarix nilotica	7.74	0.00	6.35	0.00	7.56	0.00	6.57	0.00
Thymelaea hirsuta	0.36	0.33	0.20	0.21	0.51	0.35	0.22	0.22
Zygophyllum album	0.87	1.19	0.54	0.85	0.81	1.26	0.53	0.91
Total	41.06	37.78	26.68	23.06	39.64	33.28	27.01	23.32

Table 5c. Relative cover percentage of plant species recorded in salt marshes (West and East Sites) from spring 2005 to autumn 2006 seasons.

Scientific Name	2005				2006			
	Spring		Autumn		Spring		Autumn	
	West	East	West	East	West	East	West	East
Anabasis articulata	7.99	9.53	8.17	9.71	7.59	10.82	8.15	12.74
Arthrocnemum glaucum	8.09	10.32	9.26	10.36	8.12	9.01	8.66	10.85
Atriplex halimus	5.97	7.52	8.10	11.01	6.66	6.85	8.03	9.05
Halocnemum strobilaceum	11.67	17.23	14.84	21.25	11.86	14.93	15.44	17.80
Salicornia fruticosa	11.40	14.21	11.32	17.22	10.97	13.40	11.66	17.07
Salsola vermiculata	1.32	1.14	0.45	1.21	1.14	1.02	1.15	1.29
Suaeda vermiculata	4.77	6.06	6.75	7.98	1.06	7.39	4.89	9.73
Aeluropus lagopoides	0.83	0.77	0.22	0.17	1.14	1.20	0.15	0.13
Setaria verticillata	1.95	1.93	0.00	0.00	2.04	1.95	0.00	0.00
Inula crithmoides	6.04	6.70	5.92	8.50	6.96	8.11	3.07	2.70
Mesembryanthemum nodiflorum	7.74	7.57	0.00	0.00	8.45	8.89	0.00	0.00
Limoniastrum monopetalum	10.40	13.00	8.40	7.98	11.60	11.57	11.70	13.81
Tamarix nilotica	18.85	0.00	23.80	0.00	19.07	0.00	24.32	0.00
Thymelaea hirsuta	0.88	0.87	0.75	0.91	1.29	1.05	0.81	0.94
Zygophyllum album	2.12	3.15	2.02	3.69	2.04	3.79	1.96	3.90
Total	100	100	100	100	100	100	100	100

The highest coverage percentage was found in *Tamarix nilotica and Halocnemum strobilaceum* in West Site and East Site, respectively in both years. In the contrary, the lowest coverage percentage was found in *Aeluropus lagopoides* plant in both years and sites (Table 5b).

The data in Table 5c showed that the relative coverage percentage takes the same trend of coverage percentage and the interaction among different studied factors was significant (Table 5c).

The difference in vegetation cover percentage in the first season compared to the second season in the same habitat could be caused by the variation between the canopy growth traits of individual species and different plant densities. These results

are in accordance with those obtained by Rogers and King (1972). In addition, growth stage, grazing activities and precipitation average could affect coverage. Abou-Deya (1984) indicated that individual plant canopy, spacing between adjacent plants and grazing system caused the difference in coverage from one site to another.

3.3. Plant density:

The data in Table 6a show that there were significant differences between both studied seasons where the density percentage mean increase by 43.48% in spring season as compared in autumn season, whereas there were no significant differences between both years and location.

Table 6a. Plant density (plant m^{-2}) affected by year, season, location, and their interaction in salt marshes (West and East sites) from spring 2005 to autumn 2006 seasons.

	West site	East site	
Seasons	Year x Location x Season means		Year x Season mean
Spring 2005	3.65	2.98	3.32
Autumn 2005	2.43	2.00	2.22
Spring 2006	3.66	2.89	3.28
Autumn 2006	2.63	2.13	2.38
Years	Year x Location means		Years means
2005	3.04	2.49	2.77
2006	3.15	2.51	2.83
Seasons	Season x Location means		Seasons means
Spring	3.66	2.94	3.30
Autumn	2.53	2.07	2.30
Locations means	3.10	2.51	2.80

$LSD_{0.05}$ season = 0.8534 $LSD_{0.05}$. location = 0.8860 $LSD_{0.05}$ year = NS $LSD_{0.05}$ year× location = 1.207
$LSD_{0.05}$ season × location = 1.207 $LSD_{0.05}$ season × year = NS $LSD_{0.05}$ year× season × location = 1.707

Table 6b. Plant density of plant species recorded (plant m^{-2}) in salt marshes (West and East Sits) from spring 2005 to autumn 2006 seasons.

Scientific Name	2005				2006			
	Spring		Autumn		Spring		Autumn	
	West	East	West	East	West	East	West	East
Anabasis articulata	0.62	0.53	0.51	0.43	0.63	0.51	0.54	0.49
Arthrocnemum glaucum	0.35	0.29	0.30	0.27	0.36	0.29	0.37	0.31
Atriplex halimus	0.16	0.12	0.08	0.03	0.16	0.11	0.07	0.03
Halocnemum strobilaceum	0.31	0.27	0.29	0.24	0.31	0.28	0.28	0.27
Salicornia fruticosa	0.34	0.29	0.27	0.22	0.33	0.30	0.25	0.20
Salsola vermiculata	0.25	0.19	0.11	0.07	0.25	0.25	0.12	0.06
Suaeda vermiculata	0.38	0.31	0.28	0.24	0.37	0.30	0.30	0.25
Aeluropus lagopoides	0.23	0.19	0.11	0.12	0.23	0.18	0.21	0.16
Setaria verticillata	0.17	0.14	0.00	0.00	0.15	0.09	0.00	0.00
Inula crithmoides	0.10	0.12	0.08	0.11	0.11	0.10	0.09	0.10
Mesembryanthemum nodiflorum	0.32	0.23	0.00	0.00	0.34	0.20	0.00	0.00
Limoniastrum monopetalum	0.28	0.21	0.26	0.20	0.26	0.19	0.25	0.17
Tamarix nilotica	0.07	0.00	0.07	0.00	0.07	0.00	0.07	0.00
Thymelaea hirsuta	0.04	0.05	0.04	0.04	0.06	0.05	0.05	0.05
Zygophyllum album	0.03	0.04	0.03	0.03	0.03	0.04	0.03	0.04
Total	3.65	2.98	2.43	2.00	3.66	2.89	2.63	2.13

Table 6c. Relative density of plant species (%) recorded in salt marshes (West and East Sits) from spring 2005 to autumn 2006.

Scientific Name	2005				2006			
	Spring		Autumn		Spring		Autumn	
	West	East	West	East	West	East	West	East
Anabasis articulata	16.99	17.79	20.99	21.50	17.21	17.65	20.53	23.00
Arthrocnemum glaucum	9.59	9.73	12.35	13.50	9.84	10.03	14.07	14.55
Atriplex halimus	4.38	4.03	3.29	1.50	4.37	3.81	2.66	1.41
Halocnemum strobilaceum	8.49	9.06	11.93	12.00	8.47	9.69	10.65	12.68
Salicornia fruticosa	9.32	9.73	11.11	11.00	9.02	10.38	9.51	9.39
Salsola vermiculata	6.85	6.38	4.53	3.50	6.83	8.65	4.56	2.82
Suaeda vermiculata	10.41	10.40	11.52	12.00	10.11	10.38	11.41	11.74
Aeluropus lagopoides	6.30	6.38	4.53	6.00	6.28	6.23	7.98	7.51
Setaria verticillata	4.66	4.70	0.00	0.00	4.10	3.11	0.00	0
Inula crithmoides	2.74	4.03	3.29	5.50	3.01	3.46	3.42	4.69
Mesembryanthemum nodiflorum	8.77	7.72	0.00	0.00	9.29	6.92	0.00	0.00
Limoniastrum monopetalum	7.67	7.05	10.70	10.00	7.10	6.57	9.51	7.98
Tamarix nilotica	1.92	0.00	2.88	0.00	1.91	0.00	2.66	0
Thymelaea hirsuta	1.10	1.68	1.65	2.00	1.64	1.73	1.90	2.35
Zygophyllum album	0.82	1.34	1.23	1.50	0.82	1.38	1.14	1.88
Total	100	100	100	100	100	100	100	100

Also, no significant difference was observed between years x seasons, year x location and year x location x seasons, while there were significant differences between seasons x location. The highest plant density was found in Abu Lahu Bahary site during spring 2006 (3.66 plant m^{-2}).

Anabasis articulata has the highest plant density in studies years, seasons and locations while, *Zygophyllum album* has the lowest density under the same factors (Table 6 b).

Species with high density may be considered to be dominant (Maroof 1978, Abou-Deya 1984, and El-Morsy 2002).

The relative plant density has the same trend (Table 6c).

3.4. Plant frequency percentage:

The data in Table 7a, b and c recorded the plant frequency and relative frequency percentage, which was higher in 2006 than 2005 by 8.75%, and Abu Lahu Bahary site, was higher than Sadi Abd El-Rhman by 13.75% also, the spring season was higher than fall season by 168.75%. The highest plant frequency was detected at Abu Lahu Bahary site in spring season in 2005 which reached to 575.0 (table 7 a).

Table 7a. Plant frequency (%) affected by year, season, location, and their interaction in salt marshes (West and East Sites) from spring 2005 to autumn 2006 seasons.

	West Site	East Site	
Seasons	Year x Location x Season means		Year x Season mean
Spring 2005	575.0	570.0	572.5
Autumn 2005	400.0	395.0	397.5
Spring 2006	595.0	555.0	575.0
Autumn 2006	415.0	410.0	412.5
Years	Year x Location means		Years means
2005	487.5	482.5	485.00
2006	505.0	482.5	493.75
Seasons	Season x Location means		Seasons means
Spring	585.0	562.5	573.75
Autumn	407.5	402.5	405.00
Locations means	496.25	482.5	489.38

Table 7b. Frequency of plant species (%) recorded in salt marshes (West and East Sits) from spring 2005 to autumn 2006 seasons.

Scientific Name	2005				2006			
	Spring		Autumn		Spring		Autumn	
	West	East	West	East	West	East	West	East
Anabasis articulata	20	35	20	25	25	30	25	25
Arthrocnemum glaucum	65	45	60	40	70	45	60	40
Atriplex halimus	35	30	30	30	35	35	30	20
Halocnemum strobilaceum	50	55	50	50	50	55	50	50
Salicornia fruticosa	35	45	30	40	35	40	35	40
Salsola vermiculata	35	25	35	30	40	25	30	40
Suaeda vermiculata	55	45	35	30	55	40	35	35
Aeluropus lagopoides	55	45	35	40	50	45	40	45
Setaria verticillata	25	25	00	00	30	25	00	00
Inula crithmoides	55	45	25	20	55	55	25	25
Mesembryanthemum nodiflorum	45	60	0.00	0.00	45	50	0.00	0.00
Limoniastrum monopetalum	40	55	40	50	40	50	40	45
Tamarix nilotica	05	0.00	05	0.00	05	0.00	05	0.00
Thymelaea hirsuta	20	25	20	20	20	25	20	20
Zygophyllum album	35	35	15	20	40	35	20	25
Total	575	570	400	395	595	555	415	410

The highest value of frequency percentage was noticed in *Arthrocnemum glaucum* in the first location while *Halocnemum strobilaceum* in the second location, whereas, *Thymelaea hirsuta* has lowest value of frequency percentage (Table 7 b).

Relative plant frequency percentage takes the same trend of plant frequency percentage (Table7c).

Table 7c. Relative frequency of plant species (%) recorded in salt marshes (West and East Sits) from spring 2005 to autumn 2006 seasons.

Scientific Name	2005				2006			
	Spring		Autumn		Spring		Autumn	
	West	East	West	East	West	East	West	East
Anabasis articulata	3.48	6.14	5.00	6.33	4.20	5.41	6.02	6.10
Arthrocnemum glaucum	11.30	7.89	15.00	10.13	11.76	8.11	14.46	9.76
Atriplex halimus	6.09	5.26	7.50	7.59	5.88	6.31	7.23	4.88
Halocnemum strobilaceum	8.70	9.65	12.5	12.66	8.40	9.91	12.05	12.20
Salicornia fruticosa	6.09	7.89	7.5	10.13	5.88	7.21	8.43	9.76
Salsola vermiculata	6.09	4.39	8.75	7.59	6.72	4.50	7.23	9.76
Suaeda vermiculata	9.57	7.89	8.75	7.59	9.24	7.21	8.43	8.54
Aeluropus lagopoides	9.57	7.89	8.75	10.13	8.40	8.11	9.64	10.98
Setaria verticillata	4.35	4.39	0.00	0.00	5.04	4.50	0.00	0.00
Inula crithmoides	9.57	7.89	6.25	5.06	9.24	9.91	6.02	6.10
Mesembryanthemum nodiflorum	7.83	10.53	0.00	0.00	7.56	9.01	0.00	0.00
Limoniastrum monopetalum	6.96	9.65	10.00	12.66	6.72	9.01	9.64	10.98
Tamarix nilotica	0.87	0.00	1.25	0.00	0.84	0.00	1.20	0.00
Thymelaea hirsuta	3.48	4.39	5.00	5.06	3.36	4.50	4.82	4.88
Zygophyllum album	6.09	6.14	3.75	5.06	6.72	6.31	4.82	6.10
Total	100	100	100	100	100	100	100	100

Sanford, et. al. (1990) concluded that the distribution of plants is largely determined by moisture availability and the activities of pastoralists and their herds rather than by soil or land form. While, Tag EL-Din et. al. (1994) pointed to the influence of soil properties on the distribution of different plant communities .Same results were found by El-Morsy, (2002).

3.5. Importance value (IV):

Importance value (IV) is the efficiency method to compare among species by studying the relative density, relative coverage and relative frequency for each species. Importance value provides information that could help in determining which species from which habitat type is the most adapted and tolerant to environment stresses and the opposite is true.

The importance value (IV) of plant species recorded in both locations of salt marshes is shown in Table 8. The highest value of IV was observed in the first location (west site) were *Halocnemum strobilaceum* (33.75) followed by *Arthrocnemum glaucum* (33.13) and *Anabasis articulate* (31.58). In the second location (east site) the highest value of IV was found in *Halocnemum strobilaceum* (39.77) followed by *Anabasis articulate* (36.68) and *Salicornia fruticosa* (34.35), whereas lowest IV was detected in both sites and years were *Thymelaea hirsuta* followed by *Zygophyllum album* (Table 8).

Table 8. Importance value (IV) of plant species recorded in salt marshes (West and East Sits) from spring 2005 to autumn 2006 seasons.

Scientific Name	West Site					East Site					Mean
	2005		2006		Mean	2005		2006		Mean	
	Spr.	Aut.	Spr.	Aut.		Spr.	Aut.	Spr.	Aut.		
Anabasis articulata	28.46	34.16	29.00	34.7o	31.58	33.46	37.54	33.88	41.84	36.68	34.13
Arthrocnemum glaucum	28.98	36.61	29.72	37.19	33.13	27.94	33.99	27.15	35.16	31.06	32.10
Atriplex halimus	16.44	18.89	16.91	17.92	17.54	16.81	20.10	16.97	15.34	17.31	17.425
Halocnemum strobilaceum	28.86	39.27	28.73	38.14	33.75	35.94	45.91	34.53	42.68	39.77	36.76
Salicornia fruticosa	26.81	29.93	25.87	29.60	28.05	31.83	38.35	30.99	36.22	34.35	31.20
Salsola vermiculata	14.26	13.73	14.69	12.94	13.91	11.91	12.30	14.17	13.87	13.06	13.49
Suaeda vermiculata	24.75	27.02	20.41	24.73	24.23	24.35	27.57	24.98	30.01	26.73	25.48
Aeluropus lagopoides	16.70	13.5	15.82	17.77	15.95	15.04	16.30	15.54	18.62	16.38	16.17
Setaria verticillata	10.96	0.00	11.18	0.00	11.07	11.02	0.00	9.56	0.00	10.29	10.68
Inula crithmoides	18.35	15.46	19.21	12.51	16.38	18.62	19.06	21.48	13.49	18.16	17.27
Mesembryanthemum nodiflorum	24.34	0.00	25.30	0.0 0	24.82	25.82	0.00	24.82	0.00	25.32	25.07
Limoniastrum monopetalum	25.03	29.10	25.42	30.85	27.60	29.70	30.64	27.15	32.77	30.07	28.84
Tamarix nilotica	21.64	27.93	21.82	28.18	24.89	0.00	0.00	0.00	0.00	0.00	12.45
Thymelaea hirsuta	5.46	7.40	6.29	7.53	6.67	6.94	7.97	7.28	8.17	7.59	7.13
Zygophyllum album	9.03	7.00	9.58	7.92	8.38	10.63	10.25	11.48	11.88	11.06	9.72

Spr. = spring Aut. = autumn

These species with the highest value are typical salt marsh plants due to their tolerance and adaptation to the high content of soluble salts (from EC 77.1 to 76.2 mmhos/cm, Table 2) and low to moderate content of $CaCO_3$ in the soil of salt marshes. These species were surveyed and identified in many studies Zahran and Willis (1992), Mashaly (2001) and Abas (2006).

Further, the promising plant species should be used as a basis for planning future research programs making use of these halophytes. Also, these halophytes can be classified as xerohalophytes (plants in dry saline habitat) and hygrohalophy (plant in wet saline habitats). The conservation of promising halophytes may be an appropriate way to combat desertification and promote greenery in the coastal and inland sabkhas.

3.6. Fresh and dry foliage yields:

The fresh and dry foliage yield of plant species which was recorded in both salt marshes sites are shown in Table 9 a, b, and 10 a and b. The results indicated that fresh and dry foliage yield increased significantly in spring seasons and decreased in autumn of both sites and years. This reduction may be due to the increase of evaporation rate in the dry period (summer and autumn) which leads to increase the salt in the soil solution.

Table 9a. Fresh weight of plant species (g m^{-2}) affected by year, season, location, and their interaction in salt marshes (West and East Sites) from spring 2005 to autumn 2006 seasons.

	West site	East site	
Seasons	Year x Location x Season means		Year x Season mean
Spring 2005	177.93	127.56	152.75
Autumn 2005	58.73	39.74	49.24
Spring 2006	172.47	114.35	143.41
Autumn 2006	53.96	39.83	46.90
Years	Year x Location means		Years means
2005	118.33	83.65	100.99
2006	113.22	77.09	95.16
Seasons	Season x Location means		Seasons means
Spring	175.20	120.96	148.08
Autumn	56.35	39.79	48.07
Locations means	115.78	80.35	98.08

$LSD_{0.05}$ season =18.11 $LSD_{0.05}$ location = 23.07 $LSD_{0.05}$ year = NS $LSD_{0.05}$ year× location = 25.62
$LSD_{0.05}$ season × location = 25.62 $LSD_{0.05}$ season × year = 25.62 $LSD_{0.05}$ year× season × location = 26.23

The West Site had significantly higher fresh weight than the East Site may be this reduction return to the EC was higher in the second site than the first (Table 2) and/or precipitation increased during favorable winter season compared with the first one which influence on environmental conditions for best grow of plants (stands) during winter and spring seasons especially with partially decrease of salt concentration in the soil in the first sites (Table 1). There were no significant differences between both studied years. A slight decrease in foliage yield was shown in the second year compared with the first one.

Table 9b. Fresh weight of plant species (g m^{-2}) recorded in salt marshes (West and East Sites) from spring 2005 to autumn 2006 seasons.

Scientific Name	2005				2006			
	Spring		Autumn		Spring		Autumn	
	West	East	West	East	West	East	West	East
Anabasis articulata	18.35	14.49	7.76	7.58	15.3	12.72	7.47	6.6
Arthrocnemum glaucum	21.46	17.26	8.84	6.34	18.43	16.47	7.72	7.42
Atriplex halimus	8.24	5.74	2.43	2.05	8.15	4.79	2.84	1.92
Halocnemum strobilaceum	18.26	16.18	5.82	4.63	19.2	16.16	5.34	4.42
Salicornia fruticosa	4.04	1.88	0.64	0.35	3.54	2.28	0.76	0.67
Salsola vermiculata	5.94	3.87	1.67	1.58	5.40	3.92	1.63	1.64
Suaeda vermiculata	11.46	12.32	5.42	3.78	12.52	11.08	4.61	3.77
Aeluropus lagopoides	3.29	4.63	0.48	0.36	3.52	2.49	0.61	0.29
Setaria verticillata	4.66	4.40	0.00	0.00	2.91	2.83	0.00	0.00
Inula crithmoides	14.28	15.89	6.68	4.61	13.8	15.24	5.9	5.27
Mesembryanthemum nodiflorum	4.66	4.40	0.00	0.00	4.76	3.87	0.00	0.00
Limoniastrum monopetalum	14.00	13.51	4.36	4.49	14.47	12.09	4.59	3.77
Tamarix nilotica	39.11	0.00	11.25	0.00	41.26	0.00	9.57	0.00
Thymelaea hirsuta	4.24	5.63	0.85	1.13	3.58	4.18	0.64	0.86
Zygophyllum album	5.94	7.36	2.53	2.84	5.63	6.23	2.28	3.20
Total	177.93	127.56	58.73	39.74	172.47	114.35	53.96	39.83

A significant interaction was found among sites and seasons, years and seasons, years and site, and years, sites and seasons during the studied years.

Table 10a. Dry weight of plant species (g m^{-2}) affected by year, season, location, and their interaction in salt marshes (West and East Sites) from spring 2005 to autumn 2006 seasons.

	West Site	East Site	
Seasons	Year x Location x Season means		Year x Season mean
Spring 2005	46.38	29.32	37.85
Autumn 2005	10.58	5.65	8.12
Spring 2006	39.85	23.31	31.58
autumn 2006	14.31	8.36	11.34
Years	Year x Location means		Years means
2005	28.48	17.49	22.99
2006	27.08	15.84	21.46
Seasons	Season x Location means		Seasons means
Spring	43.12	26.32	34.72
Autumn	12.45	7.01	9.73
Locations mean s	27.79	16.67	22.23

$LSD_{0.05}$ season = 2.282 $LSD_{0.05}$ location = 7.996 $LSD_{0.05}$ year = NS $LSD_{0.05}$ year× location = 3.227
$LSD_{0.05}$ season × location =3.23 $LSD_{0.05}$ season × year = 3.227 $LSD_{0.05}$ year× season × location = 4.560

Table 10b. Dry weight of plant species (g m^{-2}) recorded in salt marshes (West and East Sits) from spring 2005 to autumn 2006 seasons.

Scientific Name	2005				2006			
	Spring		Autumn		Spring		Autumn	
	West	East	West	East	West	East	West	East
Anabasis articulata	2.48	2.09	1.10	0.94	2.62	2.24	1.34	1.12
Arthrocnemum glaucum	4.22	3.00	1.90	1.35	5.23	4.38	1.65	1.66
Atriplex halimus	1.60	1.02	0.32	0.28	2.09	1.17	0.64	0.47
Halocnemum strobilaceum	5.18	3.82	0.71	0.54	4.06	3.93	1.42	1.20
Salicornia fruticosa	0.74	0.53	0.20	0.10	1.07	0.43	0.18	0.13
Salsola vermiculata	1.19	0.89	0.32	0.24	1.28	0.85	0.35	0.38
Suaeda vermiculata	7.04	6.57	0.13	0.08	2.43	2.68	1.03	0.98
Aeluropus lagopoides	3.96	2.98	0.24	0.15	4.14	2.76	0.23	0.12
Setaria verticillata	0.76	0.74	0.00	0.00	1.21	1.08	0.00	0.00
Inula crithmoides	2.14	2.23	1.07	0.83	0.02	0.02	0.90	0.85
Mesembryanthemum nodiflorum	0.83	0.67	0.00	0.00	0.61	0.59	0.00	0.00
Limoniastrum monopetalum	2.59	2.24	0.43	0.39	2.22	0.00	0.71	0.63
Tamarix nilotica	11.25	0.00	3.46	0.00	10.25	0.00	5.31	0.00
Thymelaea hirsuta	1.83	1.96	0.51	0.53	2.01	2.44	0.30	0.45
Zygophyllum album	0.57	0.58	0.19	0.22	0.61	0.74	0.25	0.37
Total	46.38	29.32	10.58	5.65	39.85	23.31	14.31	8.36

The highest fresh yield was *Tamarix nilotica* in the first site in both years followed by *Arthrocnemum glaucum,* while *Arthrocnemum glaucum* followed by *Halocnemum strobilaceum* was the highest in the second site in both years (Table 9b)

The same plant recorded variations in dry yield production between first and second season that may be due to the fresh weight of the plant. El-Morsy (2002) mentioned that the dry foliage yield almost had the same trend of fresh foliage yield. However the results showed that the spatial differences caused the values of fresh and dry weight to have separate trends.

4. References

Abas, M. S. 2006. Ecological and chemical studies on some common rangeland plants in Egypt and Libya. M.Sc. Thesis. Institute of African Research and Studies, Cairo University, Egypt.

Abd El-Aziz, H. M. 1978. The chemical content and nutritive value of some forage plants of the North Western Coast of UAR . M.Sc. Thesis, Fac. of Agric. Ain Shams Unvi. Egypt.

Abou Deya, I. B. 1984. Studies on distribution and adaptation of range plants in Sinai. Ph. D. Thesis. Faculty of Agriculture. Cairo Univ. Egypt.

Boulos, L. 1995. Check list Flora of Egypt. Vol. one. Al-Hadara Publishing, Cairo, Egypt.

El Shaer, H.M. (1986). Seasonal variation of the mineral composition of the natural pasture of Southern Sinai grazed by sheep. Proc. of the 2nd Egyptian - British Conf. on Animal and Poultry Production. August 26-28, 1986, Bangor, Gwynedd, UK.

El-Bassosy, A. A. 1984. Study of the nutritive value of some range plants from saloom to Marsa Matrouh. Ph.D. Thesis, Fac. of Agric. Ain Shams Unvi. Egypt.

El-Shaer, H. M and M. H. M. El-Morsy. 2008. Potentiality of Salt Marches in North Mediterranean Coastal Area of Egypt. In: Ch. Abdelly, M. Öztürk, M. Ashraf, and C. Grignon [EDS]. Biosaline agriculture and high salinity tolerance. Switzerland: Veriage Birkhäuser Press. P. 207-219.

El-Shaer, H. M and El-Morsy, M. H. M. 2006. Potentiality of Salt Marches in North Mediterranean Coastal Area of Egypt. International Conference on Biosaline Agriculture & High Salinity Tolerance & the first international Symposium Sabkha Management. TUNISIA. 3-8 November 2006. Pp.26.

El-Share, H. M. 1981. A comparative nutrition study on sheep and goats grazing Southern Sinai desert range with supplements. Ph.D. Thesis, Fac. of Agric. Ain Shams Unvi. Egypt.

Ibrahim, K. M. A. 1995. Productivity and nutritive value of some range plants of the north western Coast of Egypt. M.Sc. Thesis, Fac. of Agric. Ain Shams Univ., Egypt.

Jakson, M. L. 1956. Soil chemical analysis advanced course. Published by the author, Dept. soils, Wisconsin Univ. Madison, USA.

Ludwig, J. A. and Reynolds, J. F. 1988. Statistical Ecology: a primer on methods and computing. New York, USA.

Maroof, S. S. 1978. Some studies on distribution and adaptation of grasses in northern Iraq. M. Sc. Thesis. Collage. agric. and forestry. Mosul Univ. Iraq. (cf. M. K., Al-Syoof, 1988, M. Sc. Fac. Agric. Univ. Jordan)

Mashaly, I. A. 2001.Contribution to the Ecology of the Deltaic Mediterranean Coast, Egypt. J. Biological Sci. 1, 7: 628-635, Egypt.

Mueller-Dombois, D. and Ellenberg, H. 1974. Aims and methods of vegetation ecology. Pub. John Wiley & Sons, Inc. New York. USA.

Rogers, J. A. and King, J. 1972. The distribution and abundance of grass land species in hill pasture in relation to soil aeration and base status. J. Ecol. 60, 1:18-20.

Russell, D. F. 1991.MSTAT C, Directory crop soil science dept. Michigan Unvi. UAS.

Sanford, W.; Abdel-Samad, F. A., and Ismail, T. 1990. A contribution to the study of the vegetation of North-Central Saudi Arabia. Proc. 4th Conf. Agron. Cairo, Vol II: 643-654. Egypt.

Soil Conservation Service. 1984. Soil survey laboratory methods and procedure for collecting soil samples. Soil Survey Investigations, Report No. 1(Revised 1984), U.S. Dept. Agric., Washington, D. C., USA.

Tackhölm, V. 1974. Student's flora of Egypt. Cairo University Pub. Egypt.

Tag El-Din, S. S., Assaeed, A. M. and Al-Seick, A. 1994. Distribution of range plant communities as influenced by edaphic factors in Raudhat Khuraim. Egypt J. Appl. Sci. 9, 10: 69-82. Egypt.

Zahran, M.A. & Willis, A.J. (1992). The vegetation of Egypt. Chapman and Hall Pub. London, 429. UK.