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in

Porqueddu C. (ed.), Tavares de Sousa M.M. (ed.).
Sustainable Mediterranean grasslands and their multi-functions

Zaragoza : CIHEAM / FAO / ENMP / SPPF
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 79

2008
pages 389-393

Ecological studies in coastal sand dune rangelands in the north-west of Egypt

M.S. Abbas*[1], M.H. El-Morsy, M.A. Shahba*[2], F.I. Moursy***
*Department of Natural Resources, Institute of African Research and Studies,
Cairo University, 12613 Giza, Egypt
**Desert Research Center, Cairo, Egypt.
[1]Corresponding author, E-mail: msaelsarawy@yahoo.com
[2]Current address: Department of Horticulture and Landscape Architecture,
Colorado State University, Fort Collins, CO, 80523-1173.

SUMMARY – The present work was carried out in coastal sand dunes along the north-west coast of Egypt during the springs of 2005 and 2006 in order to study the relationships between some common range plants and environmental factors, in terms of botanical structure, productivity, nutritive value and their ability to sustain and renew themselves in coastal sand dune habitats. Twenty-four plant species were identified belonging to sixteen families. According to palatability, fifteen species (about 62.5%) were palatable and nine species (about 37.5%) were unpalatable. In terms of life duration, twenty plant species were perennials (about 83%) and only four species (about 17%) were annuals. The studied characteristics of range plants were frequency, abundance, plant density, cover percentage, importance value and productivity. All characteristics showed differences between plants in coastal sand dune habitats.

Keywords: Frequency, abundance, density, cover, importance value, fresh yield and dry yield.

RESUME *– "Etudes écologiques dans les dunes côtières dans le Nord-Ouest de l'Egypte". La présente enquête a été effectuée dans les dunes de sable côtières du nord-ouest de la côte de l'Égypte au cours des printemps 2005 et 2006 pour évaluation de la relation entre certaines plantes et les facteurs environnementaux en termes de botanique structurelle, productivité, valeur nutritive et de leur capacité à maintenir et à se renouveler elles-mêmes sous les dunes de sable des habitats côtiers. Les résultats ont montré que sont identifiées vingt-quatre espèces de plantes appartenant à seize familles. Selon l'appétence, une quinzaine d'espèces (environ 62,5%) étaient acceptables et neuf espèces (environ 37,5%) étaient non appétentes. En termes de durée de vie, vingt espèces de plantes sont pérennes (environ 83%) et seules quatre espèces (environ 17%) sont annuelles. L'étude des caractéristiques des plantes consiste en l'évaluation des gammes de fréquences, de l'abondance, la densité végétale, le pourcentage de couverture, l'importance et la valeur de productivité. Toutes les caractéristiques ont montré des différences entre les plantes dans les habitats sous les dunes de sable côtières.*

Mots-clés : *Fréquence, abondance, densité, couverture, importance de valeur, rendement en frais et en sec.*

Introduction

Rangeland ecosystems are co-adapted and co-evolved to increase the land use efficiency in the Egyptian deserts which involved native palatable plants that can provide economic continuous forage supply for domestic grazing animals. Although the natural plant cover of Egyptian deserts is quite low and scattered, the flora in the North West coast is relatively rich and diverse. The Western Mediterranean Coastal land is one of the richest phytogeographical regions in Egypt because of its relatively high rainfall. It contains 50% of the total flora of Egypt. The most important land-use in this area is grazing.

Sand dunes along the Western Mediterranean coast of Egypt are formed of loose oval pseudo-oolitic grains consist of calcium carbonate. These dunes are close to the sea and as a result they are humid, exposed to northerly winds and affected by sea spray. Plants growing in sand dunes are highly adapted and have the ability to grow vertically and tolerate the exposure of their underground organs.

The current work represents one of the contributions to the study of the vegetation of this

important, rich and diverse phytogeographical region in Egypt in order to (i) solve the problem of the deteriorated rangelands, (ii) restore its potential productivity and (iii) for better understanding of the relationship between some common range plants and environmental factors in term of botanical structure, productivity, and their ability to sustain and renew themselves.

Material and methods

This study was conducted at the coastal sand dunes of the North West Coast of Egypt in Matrouh Governorate environs. All sampling and measurements were done during the springs of 2005 and 2006. Fresh forage yield (g/m), Dry forage yield (g/m), Plant density (plant/m), Relative density, Coverage percentage, Frequency percentage, Relative frequency, Importance value, Abundance and Palatability of all identified plant species were determined. Quadrates (5m x 5m) were used to determine fresh, dry foliage yields, cover percent and plant density. Ten replicates of 100 m length transects were used to determine plant abundance and frequency percentages. Shoot parts of annual plants were clipped and new growths of perennials were cut. Measurements were done according to Hanson and Churchill (1961) and Mueller-Dombois and Ellenberg (1974).

Study area: Coastal sand dunes situated about 25 km West of Marsa Matrouh (the coastal of El-Qasr) and at latitudes of 31º21' 005'' and longitudes of 27º05' 389''. Egyptian coastlines comprise more than 3000 km along the Mediterranean and the Red Sea. Along the western Mediterranean coast of Egypt lies a chain of white calcareous dunes made up of granules drifted and washed up by the sea. These dunes form a rather continuous ridge with undulating surface and present a type of habitat described by El-Ghonemy (1973). The belt along the whole coast varies in width from few meters to 2 km; these dunes are formed of coarse, pseudo-oolitic calcareous sand with about 75% calcium carbonate and low salinity. The recently formed dunes towards the sea are loose and mobile, while the southern part is consolidated (El-Batanouny, 1973).

Climate: The Mediterranean coastal region of Egypt lies in Meig's "warm coastal deserts" Meigs (1973): summer warmest month with mean temperature less than 30ºC, and winter coldest month with mean temperature above 10ºC, though occasional short rainstorms occur in winter, most of the days are sunny and mild from the map of the world distribution of arid regions UNESCO (1977). The Mediterranean Coastal Zone of Egypt receives noticeable amounts of rainfall, especially in winter. The rainy months are October, November, December, January and February. In summer, no or few rains are recorded, while in autumn, occasional heavy rain may occur. About 75% of the total amount of rain falls from November to February, and only about 10% falls during spring. December and January are the rainiest months. Monthly variation is also, great. Any month may be absolutely dry or abnormally rainy (Badly,1965).

Soil: Physical and chemical properties of soil were analyzed for two different depths (0-30 and 30-60 cm) of the soil in coastal sand dunes. The beach deposits are composed of loose and snow-white, coarse calcareous sand, thus the texture was sandy in both depths. The pH varied from 8.45 to 8.50 in coastal sand dunes. The electrical conductivity was high in salt marshes 0.98-1.6 µs/cm. On the other hand, the total $CaCO_3$ formed more than 85 % of the coastal sand dunes.

Fresh yield: Browse and herbage are available and provide food for animals by grazing or being harvested for feed. The weight of forage is produced within a designated period of time on a given area.

Result and discussion

Botanical composition, palatability and life duration: The present investigation reveals that the natural plant wealth of the study area was composed of twenty four plant species belonging to sixteen families (Table1). The Poaceae family has highest number of species (four species) followed by Fabaceae and Brassicaceae families (three species for each), then Asteraceae family (two species) and one plant for the remaining families. Tackholm (1974) and Boulos (1995) indicate that Fabaceae and Asteraceae are the largest families in Egypt and had the greatest number of plant species. According to palatability, fifteen species (about 62.5%) were palatable and nine species (about 37.5%) were un-palatable. While, in life duration, twenty plant species were perennials (about 83%) and only four species (about 17%) were annuals.

Table 1. List of species, palatability and life duration of plant species recorded in coastal sand dunes during spring 2005 and 2006

Family name	Scientific name	Palatability*	Life duration**	Vernacular name
Poaceae	*Aeluropus lagopoides*	P	Per.	Molleih
	Ammophila arenaria	P	Per.	Gazzoof
	Lophochloa cristata	P	Ann.	Deal elcoat
	Phragmites australis	P	Per.	Hagna
Brassicaceae	*Cakile maritima*	P	Ann.	Figl el-gamal
	Diplotaxis acris	P	Ann.	Yahaq
	Moricandia nitens	Up	Per.	Rakham
Fabaceae	*Lotus polyphyllus*	P	Per.	Qarn el gamal
	Lygos raetam	P	Per.	Retem
	Ononis vaginalis	P	Per.	Hotteiba
Asteraceae	*Silybum marianum*	Up	Per.	Shoak el gamal
	Varthemia candicans	Up	Per.	Za'atr el-Hommar
Apiaceae	*Eryngium campestre*	Up	Per.	Shaqaqeel
Boraginaceae	*Echium sericeum*	P	Per.	Saaq el-hamam
Caryophyllaceae	*Silene Succulenta*	Up	Per.	Khobezyet el-bahr
Euphorbiaceae	*Euphorbia paralias*	Up	Per.	Sakraan
Geraniaceae	*Erodium hirtum*	P	Per.	Timmeir
Labiatae	*Saliva lanigers*	P	Per.	Mariamiya
Amaryllidaceae	*Pancratium maritimum*	Up	Per.	Bosseil
Resedaceae	*Reseda decursiva*	P	Ann.	Rigl el ghraab
Solanaceae	*Lycium shawii*	P	Per.	Awseeg
Tamaricaceae	*Tamarix nilotica*	P	Per.	Abal
Thymelaceae	*Thymelaea hirsuta*	Up	Per.	Mithnaan
Zygophyllaceae	*Zygophyllum album*	Up	Per.	Ratrayt

*P: Palatable; Up: Un-palatable.
**Ann.: Annual; Per. :Perennial.

Coverage: Concerning coverage in coastal sand dunes, the total coverage increased significantly from 21.96% to 23.13% in spring 2005 and 2006 (Table 2). The highest coverage percentage was attained in *Tamarix nilotica* (6.78%), *Ononis vaginalis* (4.70%) and *Euphorbia paralias* (2.14%) in the second season. In contrast, the lowest coverage percentage was recorded with *Lophochloa cristata* (0.02%), *Erodium hirtum* (0.05%), *Phragmites australis* (0.06%) and *Aeluropus lagopoides* (0.06%) in the first season, and *Erodium hirtum* (0.05%) in the second season. The difference in vegetation cover percentage in the first season compared to the second season, in the same habitat, could be reasoned to the variation between the canopy growth traits of individual species and different plant densities. Those 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 for individual plant canopy, spacing between adjacent plants and grazing system caused the difference in coverage from one site to another.

Table 2. Means and level of significance of some plant characteristics

Character Year	Coverage	Plant density	Fresh weight	Dry weight
2005	21.967	21	124	37.130
2006	23.135	24	127	35.460
	S	NS	NS	NS

S: Significant (5%) ; NS: Non- Significant.

Concerning the frequency percentage of plant species, the highest figure appeared with *Ononis vaginalis* (80%) and *Ammophila arenaria* (70%) in the second season. In contrast, the lowest figures were attained with *Tamarix nilotica* (10%) and *Silene succulenta*, *Zygophyllum album* (20%), for each, in the second season and *Moricandia nitens* (20%) in the first season. 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.

The highest record of the abundance appeared in *Ammophila arenaria* (26 plants), *Ononis vaginalis* (23 plants) and *Euphorbia paralias* (23 plants) in the second season. On the contrary, the lowest record of the abundance was attained from *Tamarix nilotica*, *Moricandia nitens*, *Zygophyllum album* and *Reseda decursiva* in the first season.

In relation to plant density, non-significant differences are revealed between first season (21 plant/m^2) and second season (24 plant/m^2) (Table2). However, the highest figure of plant density was observed in *Ammophila arenaria* (2.6 plant/m^2) followed by *Euphorbia paralias* and *Ononis vaginalis* (2.3 plant/m^2), all of them in spring 2006. On the contrary, the lowest figure of plant density was attained from *Tamarix nilotica* (0.2 plant/m^2) and *Moricandia nitens* (0.2 plant/m^2) in spring 2005. In the present study, differences in plant growth variables between the first and second season may be due to edaphic factors and/or the annual average precipitation which increased substantially from 99.5 mm in the rainy period (from November, 2004 to April, 2005) in the first season to 112.4 mm in the same period (from October, 2005 to May, 2006) in the second season.

Concerning the importance value of plant species in coastal sand dunes, the highest record was contributed by *Ononis vaginalis* (38.43) followed by *Tamarix nilotica* (32.05), *Euphorbia paralias* (25.33), *Pancratium maritimum* (25.01), *Ammophila arenaria* (18.87) and *Lotus polyphyllus* (15.25). These species are typical coastal sand dunes plants due to their tolerance and adaptation to the high content of $CaCO_3$ (85%), alkalinity and low soluble salts in the soil of coastal sand dunes. These results are in harmony with results of Migahid and Elhaak (2001) and Migahid *et al.* 1996). The other species showed less tolerance as indicated by their low relative density, coverage, frequency and importance value in the coastal sand dunes habitat.

The fresh foliage yields were influenced by climatic factors (especially average of rainfall) and soil quality; these results are in line with Le Houérou (1980), Helmy *et al.* (1989) and El-Monayeri *et al.* (1989). The plant species in the western Mediterranean desert area exhibit different growth and productivity characteristics (Elhaak, 1986). Fresh weight mean was (124 g/m^2) in spring 2005 and (127 g/m^2) in spring 2006. Statistical analysis showed non-significant different between the two seasons at coastal sand dunes (Table 2). However, the highest plant productivity was observed in *Tamarix nilotica* (22.15 g/m^2) followed by *Pancratium maritimum* (13.57 g/m^2) and *Ononis vaginalis* (12.86 g/m^2) in the second season. Whereas, the lowest plant fresh weight was detected in *Erodium hirtum* (1.41 g/m^2) in the second season (spring of 2006) followed by *Saliva lanigers* (1.48 g/m^2) in the first season (spring of 2005).

Concerning the dry yield in coastal sand dunes, the difference from 37.13 g/m^2 to 35.46 g/m^2 in spring 2005 and 2006 respectively, was non-significant difference (Table 2). The highest dry yield is attained with *Tamarix nilotica* (6.31 g/m^2), in the second season, followed by *Ononis vaginalis* (6.28 g/m^2) and *Euphorbia paralias* (2.88 g/m^2), in the first season. In contrast, the lowest dry yield was recorded in *Erodium hirtum* (0.30 g/m^2) followed by *Moricandia nitens* (0.34 g/m^2) in the first season and *Cakile maritima* (0.43 g/m^2) in the second season.

The same plant recorded variations in dry yield production between first and second season; this 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.

Conclusions

Following an optimized grazing system can ensure the high productivity of Egyptian pasture lands and the protection of natural vegetation from extinction. Both *Ononis vaginalis* and *Ammophila*

arenaria can be used in reclaiming coastal sand dune pastures, taking mixed planting into consideration to benefit both (since one of them belong to family Poaceae and the other belong to family Fabaceae) and to guarantee a complete nutritional meal for the grazing animal.

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