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Ecological Study on Two Grass Species in the Coastal Wetlands of the Nile Delta, Egypt

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ABSTRACT

This work studied the forage quality of two grass species growing on coastal wetlands of the Nile Delta. These species are namely: *Leptochloa fusca* (L.) *Kunth* and *Echinochloa stagnina* (Retz) P.Beauv. Thirty-six associated species were recorded in the study area, life form ranging from Therophytes to hemicryptophytes and Phanerophytes. The CCA-biplot ordination revealed that *Leptochloa fusca* (L.) had an intermediate correlation with Na^+ and Ca^{2+} and strong correlation with K^+ and organic matter. The productivity of the studied species increased during the spring and summer. This means that they can cover the summer needs for forage. The pH of the soil varied from 7.14 to 8.25 for the different habitats of study area. The soil electrical conductivity varied from 0.19 to 4.00 ds m^-. K^+ concentration of the soil ranged from 23.59 to 54.11 mg g^{-1}, that of Na^+ from 2.52 to 4.37 mg g^{-1}, and of Ca^{2+} from 2.88 to 3.99 mg g-1. . For plant *L. fusca* (L.).*E. stagnina*, respectively. The chemical characteristics of the shoot samples collected from both the natural grass. *L. fusca (L.)* and *E. stagnina* .A slight increase in the proportion of.% Ash ,% Fat g/100g, % crude fiber, % carbohydrates, K^+, Na^+, and Ca^{+2},For a plant *E. Stagnina* About *L.Fusca (L.).*In general, these ratios are acceptable when using these plants as feed. Compared to international standards. The obtained results of the present study will be useful for the agro-agricultural application of these natural forages in particular in summer season.

Keywords: Wild fodder; *Leptochloa fusca* (L.); *Echinochloa stagnina*; Forage; grasses; Wetlands

INTRODUCTION

The world's population is expected to reach 9 billion in 2050 (United Nations, 2013). This increase, together with the enhanced urbanization, water scarcity, desertification and the impact of climate change on water resources, will exert increasing demand on food, forage and fuel, and critically undermine the efforts for sustainable development (IPCC, 2007). With the current climate warming and increased evapotranspiration, global salinization will steadily continue (Rozema and Flowers, 2008). Moreover, currently at least 97% of the global water are seawater, 20% of the world's irrigated land is salt-affected and/or being irrigated with saline waters (ICBA, 2010). An integrated approach for solutions is urgently needed through economic, social and environmentally sustainable developmental opportunities. Egypt, located in the arid or semi-arid region of the world, is facing a problem of feed supply shortage, which is maximized by the high cost of fodder, especially the green summer fodder (Shaltout *et al*., 2009). The main causes of this problem involve population increase, frequent drought, limited land cultivated with forages and expansion of urbanization at the expense of agriculture areas. This problem reduces the enhancement of animal/meat production. Therefore, calls for searching for other non-conventional novel alternative sources of fodder become urgent. Cultivation of salt-tolerant plant species seems to be an ideal management practice of such soil types, particularly under scarcity of fresh water supplies (González *et al*., 2005). Forage plant species such as *Leptochloa fusca* and, *Echinochloa stagnina* are promising salt-tolerant forage grasses, that can establish in coastal salt marshes. (Tawfik *et al*., 2011) The two grasses can guarantee environmental sustainability and tolerate the impact of climate change and its consequences, which can be manifested as water stress, salt stress and high temperature stress (FAO, 2010). The present study evaluates two nontraditional forage plant species, viz. *Leptochloa fusca* and, *Ehinochloa stagnina* in terms of biomass productivity and nutritive value in the Nile Delta coast, Egypt. This will allow utilization of these two species to fill the gap in forage summer.

The major objective of the present study is to shed light on the ecology and associated flora of two grasses species in the wetlands of the coastal area of the Nile Delta.

MATERIALS AND METHODS

Study area

The study area occupies the northern coastal zone of the Nile Delta, between longitudinal lines 32° E and 31° 30′ west, and between latitudes 31° south to 30° 30′ north. The area is bordered from the east by the New Damietta city, from the west by Gamasa city, from the south by South Gamasa City and by the Mediterranean Sea from the north (Fig. 1). The climatic conditions are that of the Mediterranean basin with a minimum temperature of 10 °C in winter and a maximum temperature of 40 °C in summer. Most of the rain occurs during winter, ranging between 23 and 100 mm/year (Shaltout *et al*., 2013).

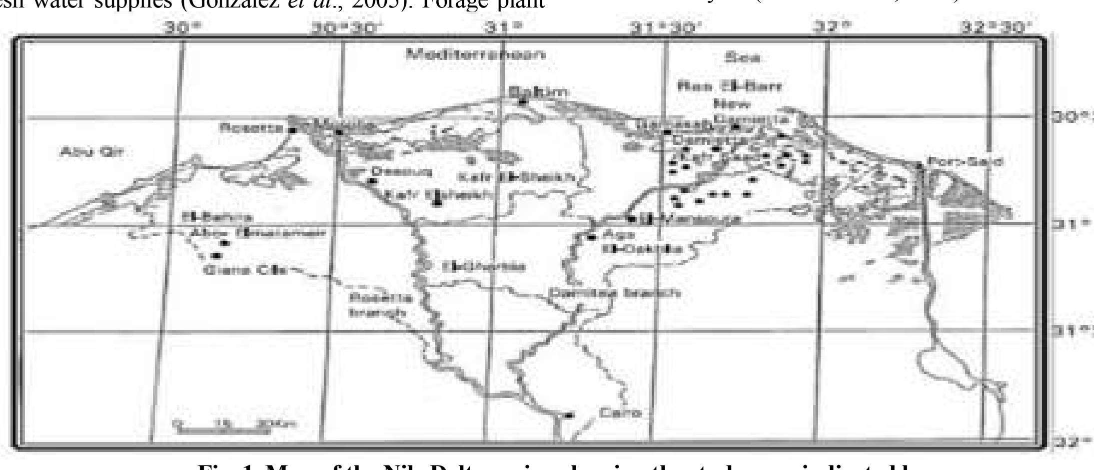

Fig. 1. Map of the Nile Delta region showing the study area indicated by

Collection and preparation of plant samples

Foliage samples of *L. fusca* and *E. stagnina* were collected from 0.5 m × 0.5 m area during summer of 2016 across the Nile Delta coast from Gamasa city in the west to Damietta city in the east. After washing under running tap water, plants, were rinsed with distilled water and left to dry in the air under sunlight conditions. The air-dried plant material was oven-dried at 65 $^{\circ}$C for 72 hours and then grinded to a fine powder prior to analysis. Chemical analysis of the plant material for estimation of protein, fat, ash, fiber and carbohydrates was performed according to A.O.A.C. (2008)

Soil analysis

Forty soil samples were collect from the root zone. Soil texture was determined by the hydrometer method. Organic carbon was determined using Walkely and Black's rapid titration method as mentioned by Piper (1947). Total soluble nitrogen was determined by the micro-Kjeldahl method. Soil samples were extracted in distilled water in w: v ratio of 1:5. The electrical conductivity of the soil extract was measured using conductivity meter (YSI Incorporated Model 33) and the pH by using pH meter (Model Lutron pH 206). Bicarbonates were determined by titrating the soil extract against 0.1 N HCl. Total dissolved phosphorus was estimated by the direct stannous chloride method. Na^{+} K^{+} and Ca^{2+} were determined using a Jenway PFP7 flame photometer, The procedures followed in physical and chemical analyses of soil samples were according to Piper (1974), Jackson (1962), Allen *et al*. (1974), AOAC (1990) and Stefan *et al*. (2013).

Chemical constituents analysis

Ash content (AC), crude fiber (CF) and total nitrogen content of the plant material were estimated according to the standard procedures of AOAC (1990). Crude protein (CP) was calculated by multiplying total nitrogen by the factor of 6.25 (AOAC, 1990). Total carbohydrates (TC) as percentage of DM was calculated according to equation of Le Houerou, (1980):

TC = 100 - (CP + EE + AC),

While digestible carbohydrates (DC) as percentage of DM was calculated as:

= DC = TC - CF (AOAC, 1990).

Na^{+}, K^{+} and Ca^{2+} contents of the plant material were estimated by using a Jenway PFP7 flame photometer

Statistical analysis

Mean values and standard errors were obtained using Microsoft Office Excel, 2010. The species and environmental data matrices were analyzed by using CANOCO software version 4.5 to investigate the relationship between environmental variables and species composition and distribution pattern.

RESULTS AND DISCUSSION

Species composition

Thirty-six plant species were collected from the study area, belonging to 15 families. The topmost dominant families were Poaceae (seven species), followed by Chenopodiaceae (five species), Asteraceae (four species) and Cyperaceae (four species), in addition to six families, each represented by one species. (Table 1).

Table 1. Plant species, life form, Life span, floristic category, and families associated with *Echinochloa stagnina* and *Leptochloa fusca* in the Nile Delta coast.

Species	life form	Life span	Floristic category	*Family*
Arthrocnemum macrostachyum	Ch	Per	Me+SA-SI	Chenopodiaceae
Atriplex portulacoides L.	Ch	Per	ME+SR-ER+IR-TR	Chenopodiaceae
Bassia indica	Th	Ann	SU–ZA + IR-TR	Chenopodiaceae
Chenopodium album	Th	Ann	COSM	Chenopodiaceae
Chenopodium murale (L.)	Th	Ann	COSM	Chenopodiaceae
Convolvulus arvensis L.	He	Per	PAN	convolvulaceae
Cynancum acutum	Ph	Per	ME+IR-TR+ ER-SR	Asclepiadaceae
Cynodon dactylon	Ph	Per	ME+IT	Asclepiadaceae
Cyperus articulatus L.	G - He	Per	COSM	Cyperaceae
Cyperus rotundus L.	Cr	Per	PAN	Cyperaceae
Echinochloa crus-galli	Th	Ann	ME+IR-TR+ ER-SR	Poaceae
Echinochloa stagnina	Th	Per	PAL	Poaceae
Eichhornia crassipes	Hy	Per	NEO	Pontederiaceae
Heliotropium curassavicum	Ch	Per	NEO	Boraginaceae
Heliotropium supinum L.	Ch	Ann	ME +IR–TR+SU–ZA	Boraginaceae
Imperata cylindrical (L.)	G - He	Per	ME + IR-TR + SA -AR+PAL + NEO	Poaceae
Ipomoea carnea Jacq.	Ch	Per	NEO	Convolvulaceae
Juncus acutus	Cr	Per	ME+ES+IT	Juncaceae
Lactuca serriola L.	Th	Ann	ME + IR-TR + ER-SR+ SU – ZA	Asteraceae
Leptochloa fusca (L.)	G - He	Per	PAL	Poaceae
Limbarda crithmoides (L.)	Ch	Per	ME	Asteraceae
Lolium temulentum	Th	Ann	ER-SR+ME+IR-TR	Poaceae
Melilotus indicus (L.) All.	Th	Ann	ME +IR-TR + SA- AR	Leguminosae
Persicaria salicifolia .	Cr	Per	PAL	Polygonaceae
Phragmites australis	Cr	Per	COSM	Poaceae
Polypogon monspeliensis	Th	Ann	COSM	Poaceae
Portulaca oleracea	Th	Ann	COSM	Portulacaceae
Rumex dentatus	Th	Ann	ME+IT+ES	Polygonaceae
Rumex pectus	Th	Ann	ME+SA-AR	Polygonaceae
Scirpus supinus	Th	Ann	ME+S-Z	Cyperaceae
Silybum marianum (L.)	Th	Ann	ME+S-Z	Cyperaceae
Solanum lycopersicum	He	Per	IR-TR+ER-SR+ ME	Asteraceae
Solanum nigrum	Th	Ann	ME+ER-SR+IR-TR	Solanaceae
Sonchus oleraceus L.	Th	Ann	COSM	Asteraceae
Spergularia marina (L.)	Th	Biennial	ER-SR+ME+IR-TR	Caryophyllaceae
Tamarix tetragyna	Ph	Per	ME+SA-AR	Tamaricaceae

Life form

The plant species were classified according to Raunkiaer (1934) classification into seven life form classes. These were represented in the present work as therophytes, (47%), ge-helophytes (6%), chamaephytes (17%), hemicryptophytes, (6%), cryptophytes, (11) and phanerophytes, (8%) (Figure 2)

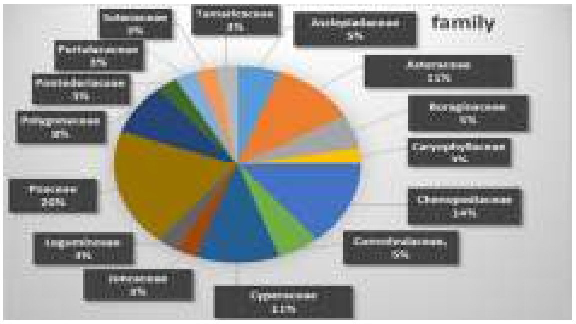

Figure 2. Floristic Composition of the Species recorded in Study area

Plant life span

The 36-recorded species can be classified, based on life span, into three groups: perennials (53%), annuals (44%) and biennials (3%) (Figure 3). Most of the recorded species are perennials and annuals, with few biennials. These results are consistent with those of Boulos, (1999& 2005).

Figure 3. Life form spectrum of the species recorded in the study area (as a percentage of 36 plant species).

Ordination

The ordination diagram provided by the first two axes of canonical correspondence analysis (CCA-biplot) (Figure 4) displays the species-environment relationships. The ordination diagram provided by the first two axes of canonical correspondence analysis (CCA-biplot) ordination is shown in Figure 4. This diagram displays the species-environment relationships, and consisted of species, they represented by points, and environmental variables, which are represent by arrows. The angle between an arrow and each axis is a reflection of its degree of correlation with the axis. Thus, the soil variables e.g. carbonate and Calcium carbonate, EC, and phosphorus In addition, silt and clay are highly correlated with axis (1) The CCA-biplot (Figure.) showed that the species as Arthrocnemum macrostachyum, Juncus acutus and Cynanchum acutum are found along higher gradients of salinity (EC), $CaCO_3$ and clay in the soil. As can be seen through the ordination axis (2), pH, potassium, calcium, Sodium, and organic carbon content are associated with mainly with summer weeds e.g. *Echinchloa crus galli*, Solanum nigrum and *Portulaca oleracea*. *Leptochloa fusca* and *Echinochloa stagnina* are fond at intermediate values along the gradient of most soil variables studied. This indicates that the plant *L. fusca*. Bears moderate salinity. The plant *Echinochloa stagnina* has a correlation with nitrogen and phosphorus element. In addition, little tolerance to salinity Figure (4).

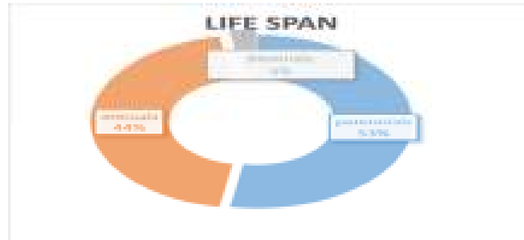

Figure 4. Life span spectrum of the species Area. Collections from the Study area

Modelling species response curves

This model is use to describe the relationship between a quantity of a particular species and the environmental gradients of community variation. The wetland habitat of study area the leads to little variations. The important value index of *L.Fusca* is negatively correlated with the sand, EC, HCO_3 and PO_4. The important value index of *L. Fusca* is positively correlated with organic matter, silt, and pH, N, Na^+, K^+, and Ca^{2+}. The important value index of *E. stagnina* is negatively correlated with the sand, clay, EC, $CaCO_3$, PO_4. The important value index of *E. stagnina* positively correlated with the silt, HCO_3, N, Na^+, K^+, and $Ca^{2+}$and organic Matter. The relationship between a quantity of a particular species and the environmental gradients of community variation did not affected by increase or decrease the environmental factor. For example, *L. fusca* does not increase or decrease the clay factor and calcium carbonates. As well as *Echinochloa stagnina* plant is not affected by high or low pH (Figure 5)

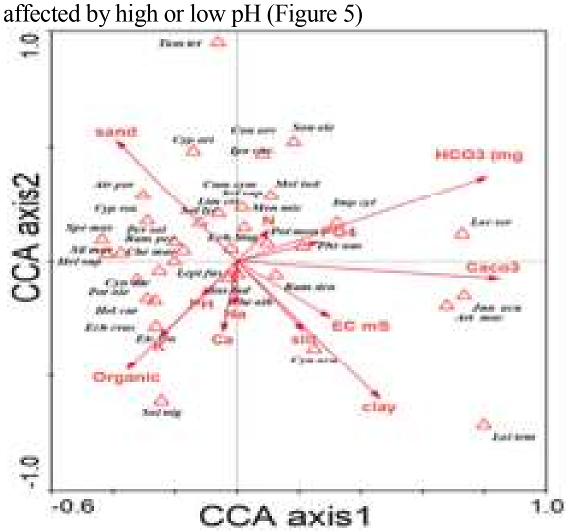

Figure .5. CCA-ordination diagram with 13 soil factors represented by arrows and plant species represented by points. Species names are abbreviate to the first three letters of genus and species names respectively.For complete species, names see table

Soil analysis

The physical and chemical characteristics of the soil samples collected from the natural habitats of *L. fusca* and *E. stagnina* are shown in Table 2.Coarse fractions, Medium fractions, this indicates that grasses tend to live in the sandy wetlands. The pH of the soil varied from 7.14 to 8.25 with a mean value of 7.88. The soil conductivity varied from 0.19 to 4.00 with a mean, value of 1.15. We noted an increase in the organic matter in the soil of t *E, stagnina* .calcium carbonate, Nitrogen, Dissolved phosphorus, There are no significant differences ,Monovalent (K^+ & Na^+), and bivalent (Ca^{2+}) showed rise values for both *Leptochloa fusca* (L.) and *Echinochloa stagnina*

Table 2.physic chemical properties of soil samples collections from the rhizosphere of *Leptochloa fusca*(L.) and *Echinochloa stagnina* EC= Electrical conductivity O.C= Organic matter

variable	*Leptochloa fusca* (L.)				*Echinochloa stagnina*			
	minima	maximum	Average	S.E	minima	maximum	Average	S.E
sand %	73.10	97.00	90.81	1.67	80.00	99.00	90.12	8.60
silt %	1.00	24.90	6.02	1.26	0.00	22.00	7.21	1.50
clay %	0.32	16.00	3.01	0.98	0.00	12.00	2.59	0.90
pH	7.14	8.25	7.88	0.06	6.75	8.49	7.76	0.09
EC mScm	0.19	4.00	1.15	0.24	0.35	5.18	2.01	0.36
HCO_3^- (mg/g)	0.77	4.19	2.20	0.26	1.20	3.65	2.33	0.19
O. C %	0.77	2.65	1.70	0.15	0.84	5.57	2.27	0.32
$Caco_3^{-2}$ %	3.50	32.00	14.20	1.81	9.00	24.50	14.58	1.27
N %	0.84	4.46	2.12	0.23	0.33	3.93	1.89	0.22
pO_4 (mg/g)	1.23	45.25	7.89	2.17	0.61	11.81	5.25	0.71
mg Na^+/g soil	0.13	27.53	2.52	1.35	0.22	19.00	4.37	1.15
mg K^+/g soil	0.98	100.95	23.95	4.98	1.14	259.37	54.11	14.82
mg Ca^{+2}/g soil	0.43	10.87	2.99	0.67	0.59	13.89	3.99	0.82

Biomass Production

Figures 6 & 7 show the quarterly variations in above ground biomass (height, fresh weight, succulence, &dry weight) which approached maxima of 120.8 cm, 2.5 kg/m², 2.6 and 1.1 kg/m², respectively for *Leptochloa fusca* during the spring, then decreased in the summer, except for succulence which was non-significantly increased during the summer (Figure 8). Similarly, *Echinochloa stagnina* exhibited maximal plant height, fresh and dry weights during the summer of 143 cm, 2.60 kg/m² and 0.80 kg/m², respectively, with minimum succulence of 3.10.

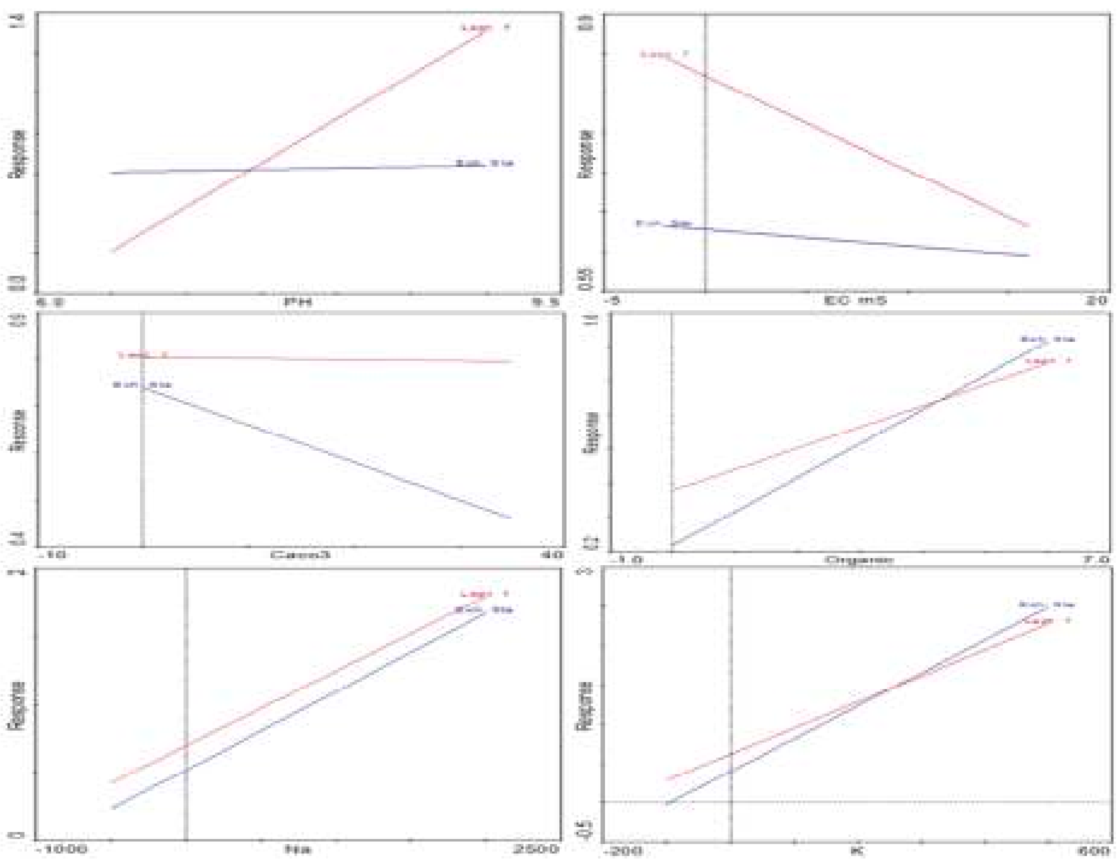

Figure 6. Modelling species response curves

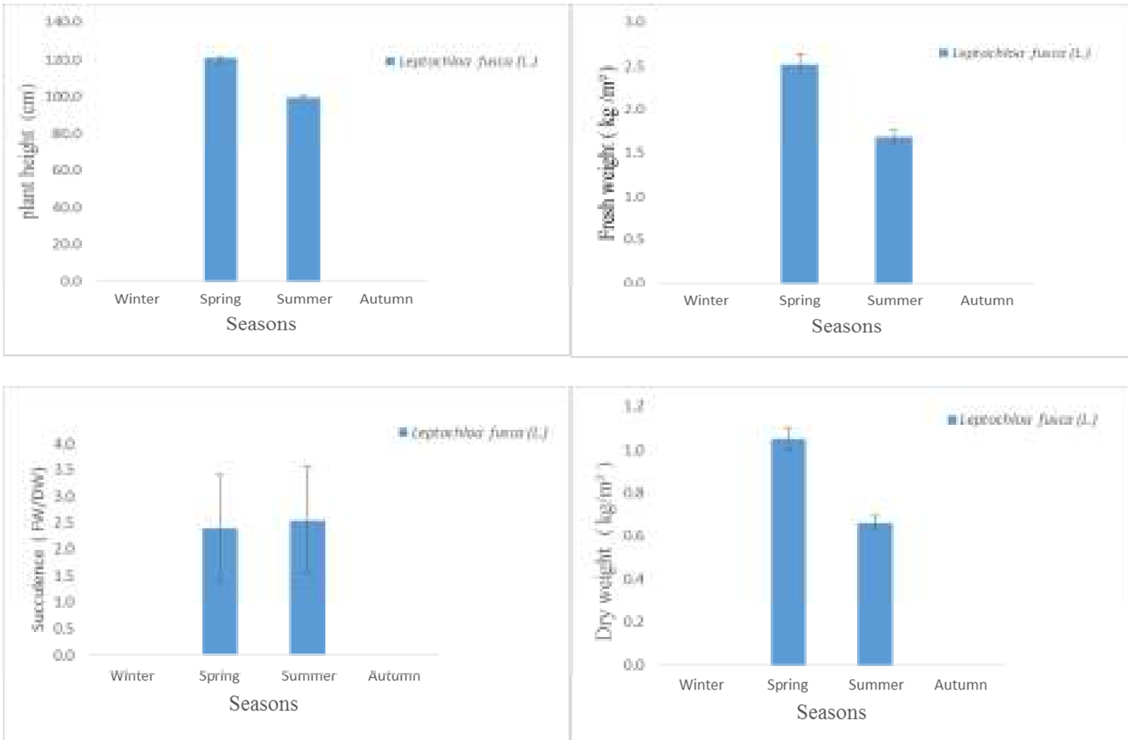

Figure 7. Seasonal variation in mean height (cm), succulence, fresh weight (Kg/m^2), dry weight (Kg/m^2) of *Leptochloa fusca* in the Nile Delta coast.

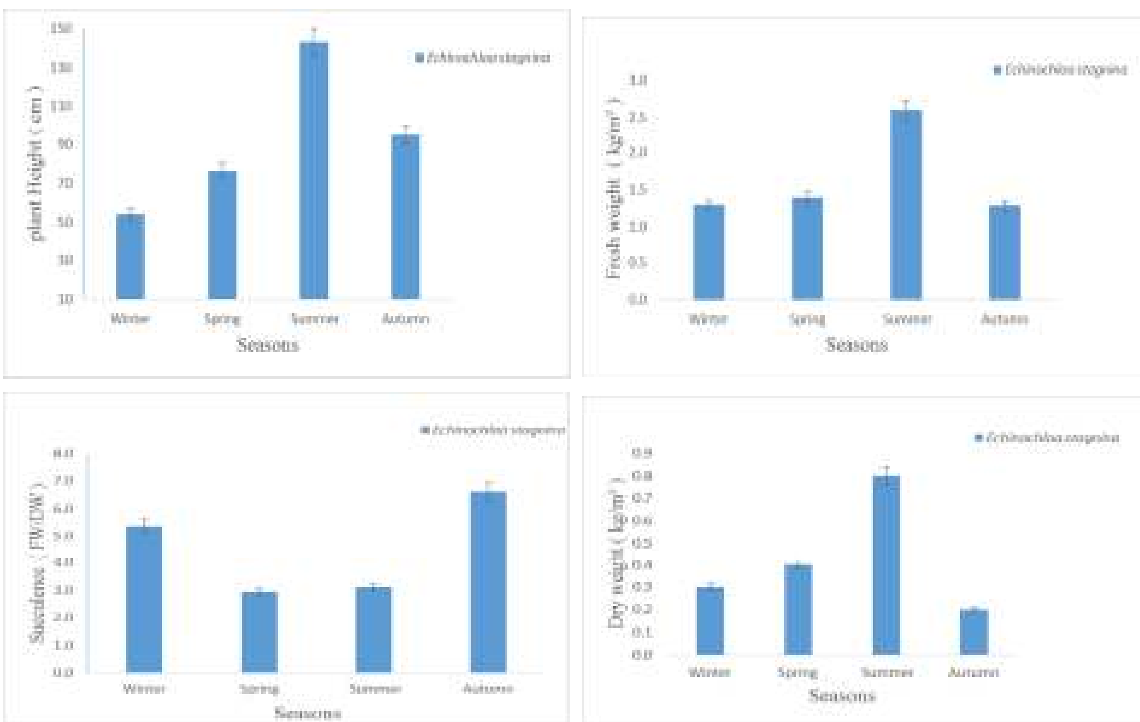

Figure 8.Seasonal variation in mean height (cm), succulence, fresh weight (Kg/m^2), dry weight (Kg/m^2) of *Echinochloa stagnina* in the Nile Delta coast.

Plant analysis

The chemical characteristics of the shoot samples of *Leptochloa fusca* and *Echinochloa stagnina* are shown in Table 3. A slight increase in the proportion of % Ash ,% Fat g/100g of % crud fiber, % carbohydrates, K^+, Na^+, and Ca^{+2},For a plant *Echinochloa stagnina* About *Leptochloa fusca* (L.).In general, these ratios are acceptable when using these plants as feed. Compared to international standards.

Table 3. Chemical Composition of the foliage *Leptochloa fusca* (L.) and *Echinochloa stagnina* of the study area

variable	*Leptochloa fusca* (L.)				*Echinochloa stagnina*			
	minima	maximum	Average	S.E	minima	maximum	Average	S.E
% Ash	6.65	14.46	9.64	1.70	5.70	13.27	10.00	1.77
%Fat g/100g	0.35	1.25	0.78	0.24	0.95	1.32	1.15	0.08
Protein%	8.75	24.06	16.63	3.41	4.38	15.31	9.19	2.74
%crud fiber	9.40	33.85	23.35	6.35	14.85	38.25	26.17	5.26
%Carbohydrate	32.69	67.05	49.60	7.40	34.21	67.33	53.49	7.16
K^+ ppm	0.95	2.11	1.66	0.26	0.72	3.47	2.00	0.74
Na^+ ppm	0.84	4.27	2.80	0.96	0.27	9.66	3.53	2.45
Ca^{+2} ppm	5.03	28.88	13.45	5.54	1.81	33.89	14.05	7.49
PO_4 (mg/g)	0.09	3.49	1.05	0.80	0.08	3.87	1.43	0.84

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دراسة بيئية على بعض نباتات العلف البرية بالمنطقة الساحلية لدلتا النيل

ممدوح محمد سالم سراج ، عبد الحميد عبد الفتاح خضر ، هبة المتولي السيد شعبان وعمر الطاهر عمر الهلاك
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تهدف هذه الدراسة إلى دراسة نمو نباتين نجلين ينموان. في الأراضي الرطبة في المناطق الساحلية شمال دلتا النيل. هما نبات السيفون ونبات الأمشوط هذه الأعشاب تنتمي إلى عائلة من العشب النجيلية. تم جمع الأجزاء الخضراء الهوائية من مجموعات طبيعية من موائل بنوك القناة في دلتا النيل الشمالي من مصر. ثم إجراء تحليل فلوري على الأعشاب المذكورة. كما ثم دراسة خصائص التربة في منطقة الدراسة. واجراء تحليل على النباتات المذكورة لتقييم محتواها الكيميائي وقد أظهرت النتائج ان نبات السيفون والأمشوط يحتوي على العديد من المواد الغذائية الرئيسية مثل الكربوهيدرات والبروتينات والالياف والدهون بنسب عالية مقارنة بالمواصفات الدولية. وعلى الجانب الاخر حقق نبات السيفون اعلي القيم في نسبة البروتين مقارنة بنبات الأمشوط. بينما حقق نبات الأمشوط اعلي النسب في الدهون مقارنة بنات السيفون وتعتبر الأجزاء الرعوية للحشائش المختارة مصدر غني بالمواد الغذائية العضوية وغير العضوية.والنتائج المتحصل عليها سوف تفيد في التطبيق الزراعي لنبات السيفون والأمشوط كأعلاف غير تقليدية وبالذات في فصل الصيف حيث يوجد نقص في الاعلاف