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SEASONAL CHANGES IN THE NUTRIENT ELEMENT CONCENTRATION IN *ECHINOPUS SPINOSISSIMUS* TURRA

BY

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ABSTRACT

Temporal variation in nutrient budget and uptake were assessed for *E. spinosissimus* of the calcareous sand dune habitat in the western Mediterranean coastal desert of Egypt.

Nitrogen (4.8-16.6 mg/g) had by far showed the highest concentration among elements in different plant organs, followed by Mg, P, and Na in leaves and by Na and K in root and stem. The concentration of macroelements (N,P,Mg and K) were higher in leaves and root than that of the skeletal part (stem). In the plant organs microelement concentration (Fe,Zn,Cu & Mn) ranged from 0.0072 - 0.457 mg/g. Macroelements showed a low values of coefficient of variation than that of microelements. *E. spinosissimus* accumulates N,P,Fe,Na & Mg in their tissue with higher levels than that of the soil underneath. The major elements contributing as available nutrients in the soil are Ca,N and K (234, 37.8 and 20.9 and mg/100 g, respectively). N,P and Zn showed major uptake during March till July correspondingly with the flowering and fruting activity, high correlation coefficients were found between the uptake of N and Mg, and between Ca, Mg and K. There was no significant correlation between the uptake of elements and their absolute soil content.

INTRODUCTION

Nutrient budgets provide a covnenient and biologically meaningful context for demonstrating what is known about a system's biogeochemical cycles, help to put nutrient pools and fluxes into prespective, and can land considerable insight into processes that regulate the nturient cycling. Such context would help to guide system mangement decisions and direct the coruse of future research.

In Egypt, few research had been done in the field of nutrient dynamics of desert plants [9,12,19,20].

The present study aims at elucidating the dynamics of nutrient cycling in an ecosystem of *Echinopus spinosissimus* on the coastal dunes of the western Mediterranean desert of Egypt. It includes assessments of monthly variation in the content of macronutrients and some micronutrients in different plant organs and in the soil underneath, with special emphasis on the uptake rate of different nutrients. Such information would be valuable in assessing the nutrient requirements and the nturient-use efficiency of <u>Echinopus spinosissimus</u> under the prevailing environmental conditions of the desert ecosystem.

Geology and Physiography

The Study area

The area of this study is a part of the western Mediterranean coastal land of Egypt. It is located at about 53 km west of Alexandria and 7 km north of Gharbaniat village (Fig.1). It extends along the sea coast for about 2 km, with an average depth of about one-half km inland.

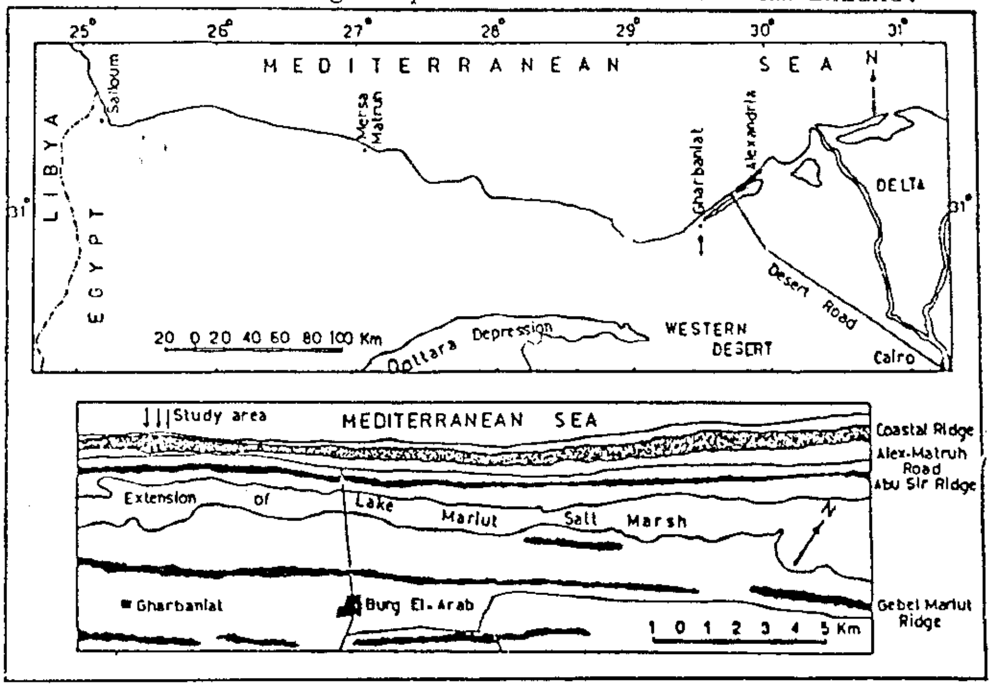

Fig.1. Map of the western Mediterranean coastal region of Egypt, and a detailed sector indicating the location of the study area.

Geological studies on the western Mediterranean coast of Egypt suggest that formation in the study area are esseentially Quarternary and Tertiary [18,22,23]. The geological map prepared by Shata [22] indicates that the sub-surface is formed of Miocene strata, about 30 m in thickness, overlain by pink limestone, tentatively assigned to Pliocene, surface deposits are Pleistocene.

Physiographically, the eastern part of this region (between Alexandria and Alamein) is formed of a coastal plain which may be distinguished into frontal and foreshore sections. The former is the mian centre of agricultural activity and leads to the Mariut tableland to the south. The foreshore plain is characterized by prominent topographic configurations. These are a series of elongate ridges alternating with depressions, all oriented in a north-east-south-west direction (Fig.1). The site selected for the present study is located on the coastal ridge. This ridge reaches up to 15 m in height and 400 m in width. Philip [34] refers it to Late Monasterian. It consists mainly of false-bedded grains which are made up essentially of carbonate. These grains are poorly cemented by widely spaced needle-like crystals of calcite causing friability of rock. Carbonate grains form about 70% of the rock, while the cements form about 26%. The rock is very poor in organic remains. Drifted carbonate grains in the form of dunes lie unconformably on this ridge. These grains are described by Shukry et al. [23] as true colites having up to 42 concentric layers of carbonate around a nculeus of calcite, cryptocrystalline carbonate, quartz, formanifera or shell fragments. Shata [22] suggested that these were foremd under shallow and warm water conditions near the shore, there after transported by wind to form loose dunes.These gradually become cemented by needle-like cystals of calcite to form the friable rock of the coastal ridge which may be considered as the first stage in the evolution of inland ridges. Ayyad [4] presented a botanical evidence indicating that dunes and the coastal ridge may be of a common origin supporting the idea that the coastal ridge is a product of consolidation of dunes; most of the typical pionear species in dune succession, as well as a great number of species common on more stable dunes were found to abound on the exposed coastal ridge. However, this does not exclude the possibility that active erosion of the coastal ridge may produce enough sand to re-initiate the process of dune formation.

Dunes are fashioned by the influence of on shore winds which are predominantly north-western. Sand moves inland in a series of transverse dunes. Close to the shore, they are relatively small and active. Further inland, they become larger, being more heavily covered by vegetation and tend to become more or less stabilized. They exhibit a typical dune form with gentle windward slopes and steep leeward slopes. In the shelter of stabilized dunes, active deposition of sand in front of steep leeward slopes results in the formation of sand shadows [4]. The soils of the coastal ridge are mainly semistatic calcic Ergosols of zonal soils [10]. They belong to Harga's Agami series [16] which includes young coils characterized by the absence of diagnostic horizons and are formed of pure whitish oolitic loose or moderately consolidated clacareous sand grains. These grains are coarse to mdoerately fine in texture, consisting of more than 90% $CaCO_3$ and are almost free from salts, with pH around 8.5.

Vegetation

The ecosystem of the coastal zone in the western desert of Egypt is characteried by a marked physiographic heterogeneity which leads to distinct local variations in the distribution of vegetation [4]. The vegetation is differentiated into groupings dominated by *Elymus farctus*, *Ammophila arenaria*, *Crucianella maritima*, *Pancratium maritimum*, *Echinops spinosissimus*, *Euphorbia paralias*, and *Ononis vaginalis* [21]. The vegetational composition is related to five physiographic categories which represent different stages of dune stabilization and consolidation. At its initial stage of formation the dune is unstable and is dominated by *Ammophila arenaria* which is capable of sand-binding, resistance to burial and utilization of moisture in coarse substarates. During succession, *Euphorbia paralias*, *Elymus farctus*, *Crucianella maritima*, and *Echinops spinosissimus* become more and more common, untill they dominate stable dunes and protected deep sand sheets (sand shadows). This coincides with results of vegetation analysis by Ayyad and El-Bayyoumy [5].

Climate

The study area belongs to the dry arid climatic zone of Koppen's classification system (as quoted by Trewartha, [28], the arid mesothermal province of Thornthwaite [25], and the Mediterranean arid bioclimatic zone of Emberger [14]. The recent bioclimatic map of the Mediterranean zone prepared by the UNESCO/FAO [35] indicate as it is of a sub-desertic warm climate. It is characterized by one rainy season. Most of the rain falls during the period between October and February, with a mean annual of 168.0 (Table 1). However, the amount of rainfall varies considerably around this mean from one year to the other. In some years it reaches 250 mm while in others it hardly exceeds 50 mm.

TABLE 1

Meteorological data of the Burg El-Arab area (averages of 15 years from 1950 to 1964)

Month	Temperature, °C			R.H.* %	Evap. mm/day	Wind km/h	Annual rainfall mm
	max	min	mean				
January	18.5	8.4	13.2	65.4	5.8	16.2	38.4
February	18.7	9.0	14.0	63.7	6.7	15.8	21.5
March	21.3	10.8	15.4	62.8	7.2	15.8	[illegible]
April	22.5	12.4	17.6	64.2	7.5	15.5	[illegible]
May	25.4	15.4	20.0	65.8	8.1	14.3	1.1
June	27.8	19.2	23.6	70.0	7.2	15.0	[illegible]
July	29.2	21.6	25.2	71.2	8.3	15.4	0.0
August	30.0	22.4	26.0	72.0	9.0	14.0	0.0
September	28.3	21.4	24.5	69.7	8.4	11.5	0.7
October	27.2	17.3	21.6	60.5	7.3	10.2	22.1
November	20.3	14.0	18.6	66.1	6.8	13.6	28.6
December	19.5	10.2	14.2	63.3	6.1	16.0	43.5
Total							168.9

* R.H. is relative humidity.

The montly mean temperature varies between 13.2°C in January and 26.0°C in August. The monthly maxima and minima are again the lowest in January and the highest in August. The relative humidity is higher in summer than in winter. It attains a minimum range of 60.5% in October. As may be expected, evaporation is greater during the summer than in wintem months. It ranges between 5.8 mm day^{-1} in January and 9.0 mm day^{-1} in August. Variation in wind velcoity are less distinct than those of other climatic features; only of note is that autumn months are distinguished by low averages when compared with other months.

A water balance sheet was worked out by Ayyad (5) for Burg El-Arab ([illegible] of the [illegible] according to the procedure of Thornthwaite and Mather [26,27], to provide an approximate assessment of moisture conditions in the western Mediterranean coast of Egypt. According to this sheet, the water balance of the study area may be divided into : (1) The period from December to February when precipitation exceeds water-need as expressed by potential evapotranspiration, but with no moisture surplus, since the excess is sued up to recharge the dry soil, and (2) a drying season which extends from February to November when the water need greatly exceeds precipitation, and the actual evapotranspiration falls much below the potential resulting in a severe moisture deficiency. The deficiency amounts to about 800 mm which is more than four times as much as the mean annual rainfall.

MATERIALS AND METHODS

Echinops spinosissimus Turra (=*E. spinosus* L.) : This species is a perennial desert plant, common in the calcareous sand dune habitat [5] thistles without latex, flowers blue, pink or white, each surrounded by a spacial involucre, forming together a large, compound globose head. Richly branched leaf-lobes narrow, linear revolute-marginal, terminated by rigid spines [24].

The sampling period extended for one year from

January to December 1985. During this period, representative samples of the plant and soil underneath were taken every fortnight. Twenty-five randomly chosed medium-size individuals were dug out, each was separated into leaf, stem and root then rinsed with dionized water. Samples of plant organs were weighed, then oven - dired at 65°C to a constant weight. All samples were powdered using metal-free plastic mill. The plant samples we analysed for the determination of Na,K,Mg,Cu,Fe,Mn, and Zn using a Shimadzu Atomic Absorpition Spectrophotometer. Model AA-640-12. Mixed acid digestion method was used for preparing the sample solution of each element. Phosphorus was estimated by the Molybdenum Blue Method, and nitrogen by the Indo-Phenl Blue Method. All these procedure are according to Allen et al. [3].

Soil was sampled at same dates of plant sampling. Two samples were collected from depths 0-25 cm and 25-50 cm. Extraction of the available nutrients. 0.5 gm was achieved using different kinds of solution. Ammonium acetate solution of pH 7 was used for the extraction of Na,K,Ca,Mg and Mn, 2.5% v/v glacial acetic acid for Cu and Fe, and Olsen's solution for P. Semimicro Kjeldahl apparatus was used for the determination of total N.

The degree of association between the standardized

Table 2: Monthly variation in nutrient concentration (mg/g) in the leaves of the *Echinops spinosissimus*. The enrichment ratio is the tissue element concentration (mg/g) divided by the soil element concentration (mg/100g)x100.

Month element	N	P	Na	K	Ca	Mg	Fe	Zn	Cu	Mn
Jan.	23.79	6.3	5.22	3.3	0.21	2.34	0.226	0.045	0.0147	0.014
Feb.	24.18	6.4	4.86	2.58	0.36	4.28	0.395	0.058	0.0168	0.0166
Mar.	23.00	6.0	1.71	2.46	0.66	6.36	0.432	0.065	0.0211	0.0174
Apr.	23.40	4.4	3.00	2.19	0.30	2.51	0.282	0.045	0.0232	0.0098
May	18.52	4.2	5.43	0.91	3.93	3.08	0.282	0.063	0.0189	0.0098
Jun.	12.48	3.1	3.45	2.04	4.70	4.20	0.489	0.067	0.0252	0.0159
Jul.	12.20	2.7	2.10	2.10	0.30	3.10	0.319	0.089	0.0189	0.0120
Aug.	13.80	3.0	1.90	1.50	0.36	2.99	0.582	0.081	0.0147	0.0195
Sep.	14.01	3.5	4.44	1.53	0.78	5.13	0.732	0.079	0.0275	0.0210
Oct.	9.8	3.5	4.35	2.58	4.56	8.7	0.395	0.062	0.0189	0.0220
Nov.	10.14	3.6	1.44	2.00	0.66	3.80	0.657	0.082	0.0126	0.0180
Dec.	15.22	3.6	2.55	2.16	1.30	2.16	0.695	0.078	0.0147	0.0232
Nutrient mean	16.69	4.2	3.37	2.11	1.51	4.31	0.457	0.068	0.0189	0.0220
Standard deviation (SD)	5.52	2.5	1.4	0.610	1.77	2.19	0.173	0.143	0.0046	0.0170
coefficient of Variation	33.10	29.92	42.96	29.13	117.50	53.96	37.42	21.059	24.40	86.24
Enrichment ratio	45.1	110	44.9	10.0	0.6	19.9	231.9	-	23.0	3.6

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Table 3: Monthly variation in nutrient concentration (mg/g) in root of the Echinops spinosissimus. The enrichment ratio is the tissue element concentration (mg/g) divided by the soil element concentration (mg/100g) x100.

Month element	N	P	Na	K	Ca	Mg	Fe	Zn	Cu	Mn
Jan.	6.12	3.7	5.07	2.16	0.39	1.72	0.657	0.038	0.0081	0.0061
Feb.	5.33	3.7	4.98	3.08	1.02	3.40	0.432	0.048	0.0104	0.0088
Mar.	3.77	2.9	6.12	2.85	1.44	2.40	0.657	0.017	0.0105	0.0073
Apr.	3.31	3.8	4.86	2.30	0.84	1.70	0.545	0.048	0.0062	0.0069
May	4.59	4.1	4.20	2.51	0.87	2.02	0.420	0.039	0.0083	0.0065
Jun.	3.90	4.1	2.10	2.88	0.36	1.92	0.414	0.024	0.0104	0.0069
Jul.	4.48	4.7	3.24	1.20	0.51	1.90	0.395	0.061	0.0168	0.0070
Aug.	4.65	4.6	5.85	2.70	0.99	2.73	0.432	0.048	0.0126	0.0066
Sep.	4.64	4.8	6.33	2.31	1.26	2.66	0.225	0.022	0.0168	0.0076
Oct.	5.51	4.4	6.06	2.79	1.17	2.9	0.339	0.047	0.0081	0.0062
Nov.	3.56	4.4	5.25	2.28	1.29	-.8	0.295	0.025	0.0105	0.0085
Dec.	4.55	4.8	2.73	2.04	0.24	2.4	0.376	0.034	0.0126	0.0088
Nutrient mean	4.85	4.2	4.83	1.67	0.86	2.50	0.428	0.037	0.0109	0.0072
Standard deviation (SD)	0.9	0.86	1.40	0.75	0.40	0.67	0.14	0.013	0.0033	0.0009
Coefficient of Variation	20.2	20.6	29.7	28.3	47.01	26.70	31.90	36.32	30.300	13.0000
Enrichment ratio	12	100	63	12	0.4	40	200	-	12	.1

Table 4: Monthly variation in nutrient concentration (mg/g) in stem of the Echinops spinosissimus. The enrichment ratio is the tissue element concentration (mg/g) divided by the element concentration (mg/100g) x100.

Month element	N	P	Na	K	Ca	Mg	Fe	Zn	Cu	Mn
Jan.	10.83	3.70	3.54	2.22	0.60	1.70	0.357	0.074	0.0110	0.0070
Feb.	10.00	4.30	3.72	3.84	2.10	1.83	0.282	0.030	0.0081	0.0088
Mar.	8.68	4.30	4.11	1.17	0.54	2.08	0.393	0.056	0.0105	0.0053
Apr.	6.92	3.0	2.67	1.68	0.21	1.50	0.318	0.080	0.0110	0.0074
May	7.90	3.26	4.50	2.64	1.59	1.52	0.226	0.050	0.0168	0.0078
Jun.	4.03	4.25	3.75	2.25	0.30	2.47	0.339	0.090	0.0105	0.0072
Jul.	8.48	4.50	4.47	2.97	2.25	5.20	0.357	0.066	0.012	0.0085
Aug.	7.95	3.83	3.42	2.58	0.86	5.32	0.395	0.060	0.0211	0.0134
Sep.	7.15	4.11	4.95	2.85	0.96	2.65	0.357	0.061	0.0126	0.0082
Oct.	6.93	3.75	5.89	1.59	1.80	2.61	0.132	0.062	0.0062	0.0037
Nov.	5.82	4.20	4.80	2.08	2.58	0.301	0.303	0.033	0.0126	0.0108
Dec.	6.00	4.15	3.87	2.55	1.62	3.80	0.282	0.095	0.0168	0.0088
Nutrient mean	7.56	3.94	4.1	2.36	1.29	2.5	0.312	0.063	0.0124	0.0081
Standard deviation (SD)	1.8	0.4	0.84	0.71	0.82	1.5	0.07	0.019	0.0041	0.0014
Coefficient of Variation	24.75	11.5	20.5	30.10	63.30	60.2	24.10	31.72	32.87	30.31
Enrichment ratio	20.4	103.4	54.6	11.2	0.5	40.2	158.4	-	13.7	1.17

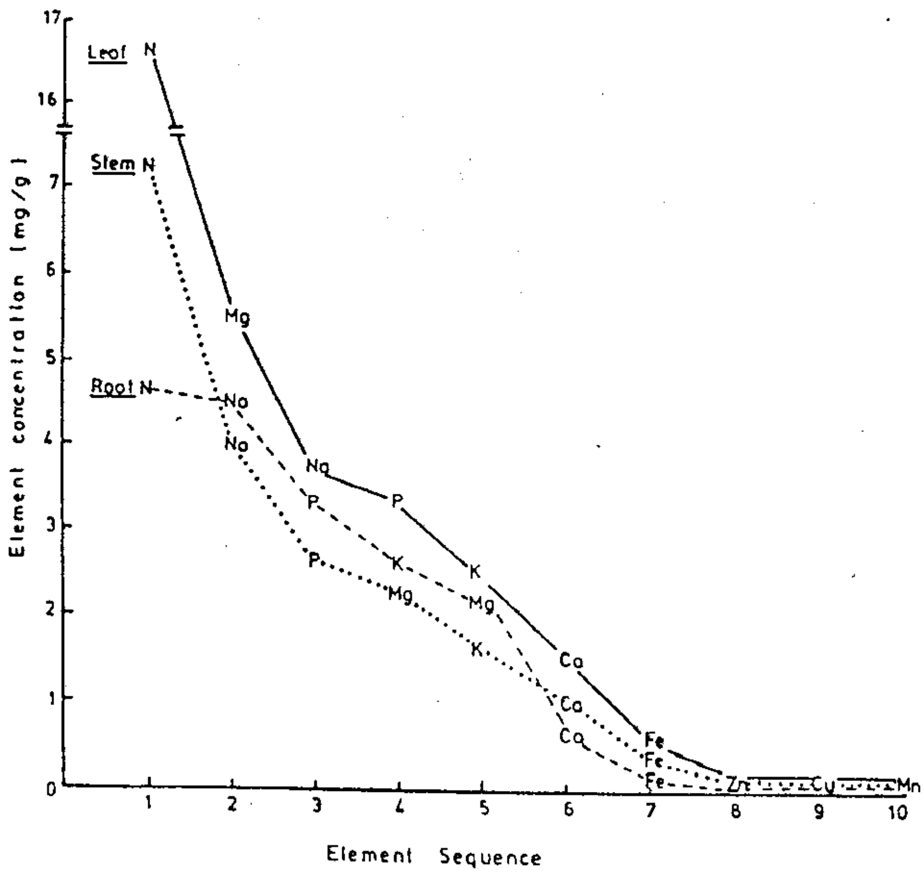

Fig. 2. Sequence in mean annual nutrient concentration (mg/plant) in different organs of *Echinops spinosissimus*.

uptake of pair-wise combination of various elements was evaluated by calculating simple linear correlation coefficients. The multidimensional oridnation geometrically determinates similarity relationships between element contents during the study period, using the formula C=2W(a+b) x100 [7], where C is the similarity coefficient, a and b are the sum of the quantitative element content measures for the two elements, and W is the sum of shared (lesser) values between these two elements. Elements are positioned along the ordination axis (X) by using Beal's formula : $X = L + (dA)^2 - (dB)^2 / 2L$. For the construction of the Y and Z ordination axes as described by Muller and Elenberg [33].

RESULTS AND DISCUSSION

Tissue Nutrient Concentration :

Nitrogen was the most abundant nutrient in different organs of *E. spinosissimus* (4.85-16.69 mg/g dry weight), followed by Mg,P and Na in the leaves while by Na,P and K in stem and root, (Tabel 2,3,4 and Fig.2). It is remarkable that the concentration of macro-elements were higher in current organs (leaves and roots) than in the skeletal parts (stem). Several studies have confirmed this trend in different life-forms of desert plants [1,12,17,29]. Woodwell *et al*. [40] postulaed that the critical nutrients are used more sparingly (in the sense of low concentration) in woody parts than in other active parts of plant. A comparison of the sequence of macro-nutrient concentration indicated that E. spinosissimus had the highest in P,Na and Mg, compared with other plants at different communities; Desert community [12]; Aquatic community [2]; and Quercus-Pinus forest community [40]. N,K and Ca were lesser than in other desert and aquatic vegetation, while most species of the calcareous sand duen habitat of the study area are characterized by higher levels of calcium [12].

Tissue concentration of micro-nutrients decreased in different plant organs (leaf, stem and root) in the order : Fe > Zn > Cu > Mn. The same sequence of element abundance was observed in most calcareous sand duen plant species [11,12,20]. These micro-elements were more abundant in leaves followed by stem and root, except Fe which showed higher concentration in root than in stem.

Patterns of Nutrient Variation :

The coefficient of variation (CV) in tissue elements concentration of the different plant organs varied greatly depending on the element (Tabel 2,3,4). Differences were great within successive months. Leaf, stem and root attained higher values of CV (117.5, 63.3 and 47.0 respectively) for micro-elements. P,N and K showed a relatively low coefficient of variation (CV = 29.1 - 33.0). Auclair [2]

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had obtained similar results and suggested that tissue N, P and K were much more carefully regulated in the system in terms of plant physiological needs and retention.

The temporal variation in the content of most nutrients in plant tissues seem to be a function of phenology [8,30]. In the present study E. spinosissimus exhibits a similar relationship between the variation in nutrient concentration in their organs and the phenological activity of the plant. In general, higher concentration of essential elements (N,P,K, and Mg) were retianed in leaves during January, February, and March, in correspondance with the vegetative stage of the plant.

Tissue Nutrient Relationships-Enrichment Ratio (ER) :

P and Fe concentration were higher in the plant tissue than that of the soil (Tabel 2,3, and 4). This agreed with Larcher, [31]; Garten, [15]; Auclar, [2]; Binet, [6] who reported that arid ecosystem, where nutrient resources are meager some desert vegetation can accumulate higher quantities of element in their tissue. [2,6.15,31]. N and Mg showed a low value of ER in leaves. In this regard Willis and Yemm [39] postulated that a large portion of available supply of critical elements is locked up at any given time in either living or dead material and partly decomposed remains and West [38] confirmed this conclusion. Again in all plant organs Ca showed a lower ER value.

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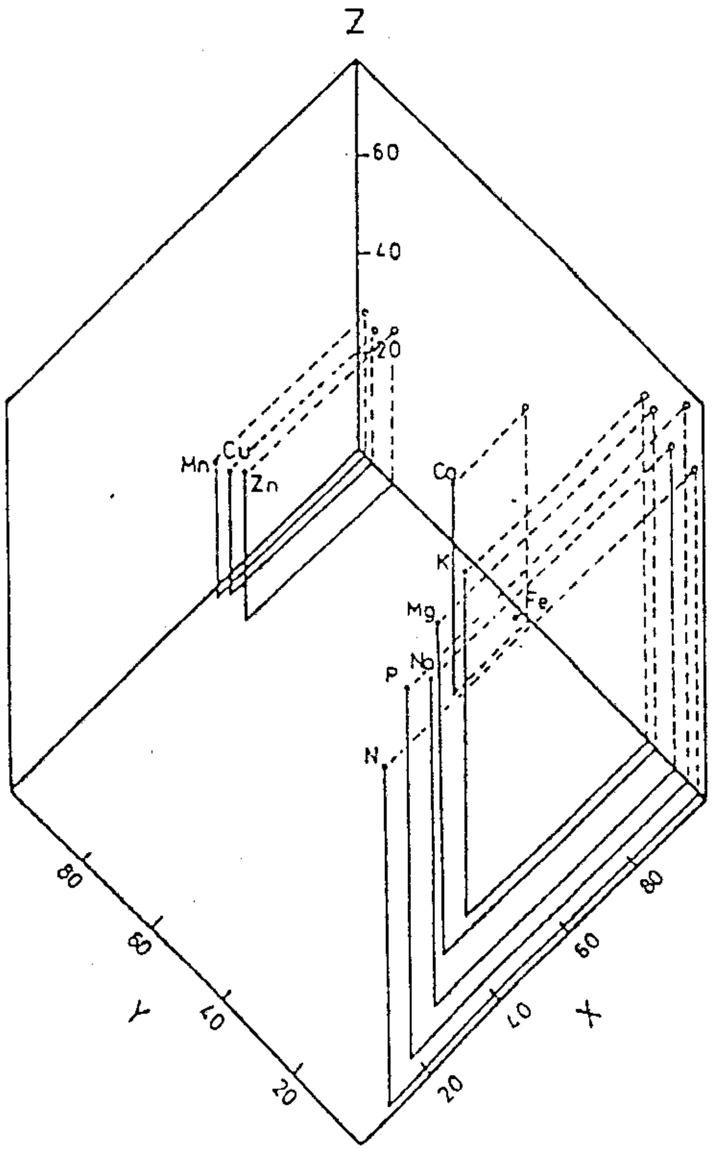

Fig.3. Three dimensional ordination for the 10 studied elements

Table 5: Monthly variation in nutrient concentration (mg/100g) in the soil under *Echinops spinosissimus*.

Month element	N	P	Na	K	Ca	Mg	Fe	Zn	Cu	Mn
Jan.	38.8	3.6	6.4	20.8	224	5.85	0.169	-	0.0635	0.1270
Feb.	39.9	3.8	6.7	19.9	253	5.85	0.229	-	0.0650	0.1280
Mar.	39.6	3.9	8.1	20.0	221	5.51	0.215	-	0.0657	0.131
Apr.	36.2	3.0	7.4	20.2	245	5.61	0.200	-	0.0650	0.130
May	34.8	3.4	9.2	28.0	225	6.34	0.125	-	0.0665	0.134
Jun.	38.0	3.7	7.7	22.4	248	7.08	0.199	-	0.0675	0.136
Jul.	34.1	5.0	7.5	22.6	207	5.80	0.169	-	0.0600	0.134
Aug.	36.9	3.6	7.6	20.2	237	5.98	0.157	-	0.0645	0.136
Sep.	40.8	3.5	6.6	18.3	246	6.01	0.278	-	0.065	0.145
Oct.	39.8	3.3	6.2	18.0	230	6.47	0.176	-	0.0660	0.200
Nov.	36.6	3.3	8.3	20.8	231	6.10	0.241	-	0.0700	0.146
Dec.	38.8	3.7	7.7	20.5	248	7.18	0.234	-	0.0739	0.200
Nutrientmean	37.8	3.6	7.45	20.9	234.0	6.14	0.198	-	0.0660	0.1535
Standard deviation (SD)	2.05	0.47	0.83	2.47	13.4	0.51	0.031	-	0.0032	0.054
Coefficient of variation	5.42	13.05	11.12	11.8	5.7	8.3	15.7	-	4.95	34.60

Soil Nutrient Status :

The major contribution of available nutrients in soil were Ca, N, and K (Table 5). Ca was again the only element with considerably high concentration. The soil solution of sand dunes in the present study exhibited lower P concentration compared to all other macro-nutrients, while that of N was higher. Nevertheless, nitrogen concentration was much higher in plant materials than that in the soil, which may confirm the idea that organic pool represents the reservoir of N in soil. This in turn may explain the conclusion of Willis and Yemm [39] that growth of plants on the coastal dunes of Branton Burrows is oftenly limited by soil fertility. In general, arid soil is usually poor in nitrients, except Ca in calcareous soils, as indicated in the present study.

A three-dimensional ordination of the ten studied elements in terms of mg/g/plant was consturcted (Fig.3). The correlation coefficients between each element behaviour and elements position on each axis of the ordination are given in Tabel 6. The three axes were responsible for the separation and location of each element groups (macro- and micro- elements) within the ordination space. The X-axis show a strong positive correlation with elements concentration in the plant organs and nutrient uptake.The Y-axis, on the other hand show positive correlation with the nutrient enrichment ratio. The separation of the elem-

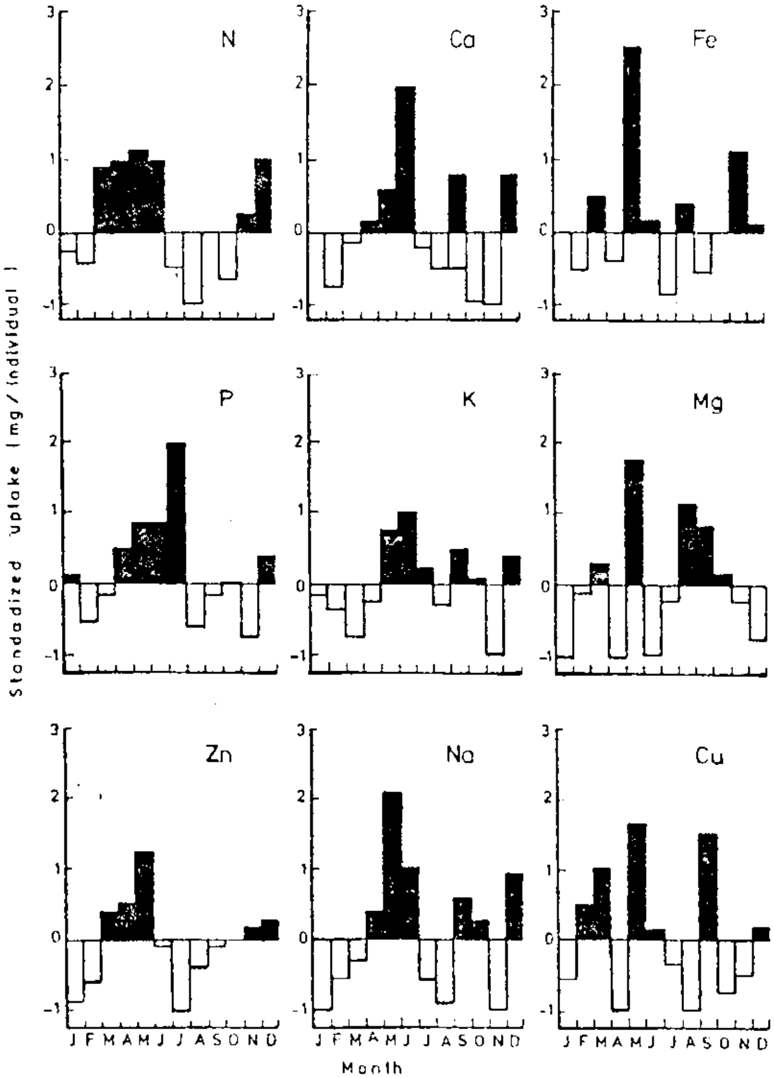

Fig. 4. Variations in the standized values of the monthly averages of uptake of different nutrients by Echinops spiosissimus. (Horizontal lines represent the annual mean values).

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Table 6 : Correlation coefficient between each element variable and position of the 10 studied elements on each axis of the ordination.

Axis	Concentration			Coefficient of variation			Enrichment ratio			Uptake
	leaf	stem	root	leaf	stem	root	leaf	stem	root	
X	0.720**	0.800**	0.906**	-0.171	-0.130	-0.119	0.050	0.119	0.045	0.841***
Y	0.507	-0.723*	0.806**	-0.152	-0.049	-0.228	0.653*	0.749**	0.600*	0.721*
Z	0.520	0.707*	0.814**	0.891	-0.614*	-0.611*	0.698*	0.491*	0.603	0.657*

* = $p<0.05$ ** = $p<0.01$ *** = $p<0.001$

Concentration, coefficient of variation, enrichment ratio and uptake, expressed as in the table 2,3,4 and Fig. 4.

ent on the basis of coefficient of variation is better acheived through the Z-axis which show a positive correlation with this variable.

Nutrient Uptake:

The trend of temporal variation in the nutrient uptake would be more comparable when dealing with their standardized values (i.e. with mean equals zero and unit variance) rather than with their absolute values (Fig.4). Accordingly, three possible trends may be distinguished. One of these trends was exhibited by the uptake of N,P and Zn with the major uptake taking place during the period extending from March until July, when E. spinosissimus started its folwering and fruiting activity. The same nutrient exhibited pronounced uptake during November and December when the plant starting the vegetative activities and leafing out. Wadern and Flowerday [37] reported that N-uptake by winter wheat was most rapid during the vegetative stage and that 8% of its total accumulation in the plant occurred in the grain-filling stage. The second trend of variation in nutrient uptake was exhibited by Ca,K and Na with the major uptake occurring once during May and June (fruiting stage), second time in September (dormancy stage), and a third time in December when the plant resuming its vegetative activity. The third trend was that of Fe, Mg, and Cu with uptake taking place at consecutive times during the study period, which resemble other nutrients in the pronounced uptake at the fruiting stage. Salem [19] found similar high uptake in barly during its fruiting stage, and El-Darier [9] and Mengel [32] reported a distinguished uptake in relation to the prevailing phenological activity.

The degree of association between the standardized uptake of different elements showed high correlations (r= 0.844) (Table 7) which are will represented by the pair-wise combination between the uptake of N and Mg, (r= 0.88) and between K and each of Ca & Mg. Viets [36] found that calcium increased the rate of potassium uptake which agreed with the present data.

In the present study there was no significant correlation between element uptake and their absolute soil content. El-Ghonemy [11] reported that the uptake of a given element by plants may be not directly related to the absolute content of this element in the soil, but rather to the relative proportion of that element to other elements in the soil solution.

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Table 7 : Simple correlation coefficients between the standardized uptake of different elements in E. Spinosisimus.

	N	P	Na	K	Ca	Mg	Fe	Zn	Cu
N	1								
P	0.736**	1							
Na	0.751**	0.820**	1						
K	0.652*	0.230	0.603*	1					
Ca	0.433	0.752*	0.644*	0.874***	1				
Mg	0.883***	0.821**	0.577	0.724**	0.325	1			
Fe	0.372	0.290	0.865***	0.393	-0.580	0.808**	1		
Zn	-0.290	0.748*	-0.478	-0.800**	-0.796*	0.369	0.342	1	
Cu	0.502	0.235	0.362	-0.675*	-0.682*	0.542	0.692*	-0.821**	1

* = $p<0.05$ ** = $p<0.01$ *** = $p<0.001$

التغيرات الموسميه فى تركيز العناصر المعدنية لنبات أيكاينبس أسبينوسيسيمس (كدار)

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يتضمن البحث دراسة التغيرات الموسمية فى تركيز العناصر المعدنية ومعدل أمتصاصها فى نبات أيكاينيس أسبينوسيسيمس وعلاقة ذلك بما تحتويه التربه من هذه العناصر·

أوضحت الدراسة أن عنصر النتروجين كان أعلى العناصر تركيزا فى أعضاء النبات (الورقة - الساق - الجذر) وتبع عنصر النتروجين فى الأوراق عناصر الماغنسيوم ، الفوسفور ، الصوديوم على التوالى ، بينما فى السيقان والجذور تلى النتروجين عناصر الصوديوم والبوتاسيوم · أظهرت النتائج أن تركيز العناصر الأساسية فى الأوراق والجذور أعلى منه فى حالة السيقان ، وأن قيمة معامل التغير فى تركيز هذه العناصر كان منخفضا بالمقارنه بالعناصر الغير أساسية·

أشارت النتائج الى أن أعلى معدل امتصاص عناصر النتروجين والفوسفور والزنك كانت خلال الفترة من مارس حتى يوليو وارتبط ذلك بمرحلتى الأزهار والاثمار للنبات ، وظهرت علاقات أرتباطيه معنويه بين أمتصاص عناصر النتروجين والماغنسيوم وكذا بين أمتصاص الكالسيوم والماغنسيوم وأمتصاص البوتاسيوم ، ولم تظهر علاقات ارتباطيه معنوية بين معدل الامتصاص للعنصر وتركيزه فى التربه·