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INFLUENCE OF TOPOGRAPHIC ASPECT ON THE DISTRIBUTION OF *NEPETA SEPTEMCRENATA* IN SAINT KATHERINE PROTECTORATE, SOUTH SINAI, EGYPT.

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Abstract

A study was carried out on a wild herb *Nepeta septemcrenata* Benth. (Family: Lamiaceae) in Saint Katherine Protectorate, South Sinai, Egypt to assess the effect of topographic aspect on plant distribution, morphological parameters and soil component. The results show that aspect influence on physical and chemical properties of soil. Water content showed great variation among different aspect directions. Plant traits also affected by these directions. Results found that 26.8% of *N.septemcrenata* populations' recorded at North aspect and no observation for *Nepeta* at South aspect. Soil physical properties showed significant variation among different aspect ranks. Results also showed positive correlation between soil total dissolved solids, electrical conductivity, sodium, potassium and chloride. This component show highest degree at east aspect. Soil pH and calcium carbonate showed the highest value at south west aspect, while calcium and magnesium show highest value at North east aspect.

Key words*:* *Nepeta septemcrenata*, Saint Katherine Protectorate; aspect; topography; spatial variation.

1. Introduction

The genus *Nepeta* (Lamiaceae) comprises approximately 250 species of annual or perennial herbs distributed in temperate Europe, Asia and Africa (Mabberley, 1997). They contain, depending on the species, up to 1% of essential oil as well as nepetalactone, iridoid, bitter principles, tannins and minerals. *Nepeta* essential oil is mainly composed of citral, citronellal, geraniol, carvacol, nepetol, thymol, pulegon, actinidine and monoterpene alkaloid (Nowiński, 1983; Mackú and Krejcá, 1989; Bown, 1999and Senderski, 2004). *Nepeta septemcrenata* is the only species of the genus *Nepeta* in Egypt (Täckholm, 1974). Near endemic found in Stony wadis. Sinai, northwest Saudi Arabia (Boulos, 2002).

The Saint Katherine Protectorate (SKP) is one of Egypt's largest protected areas and includes the country's highest mountains. This arid, mountainous ecosystem supports a surprising biodiversity and a high proportion of plant endemics and rare. The flora of the mountains differs from the other areas, due to its unique geology, morphology and climate aspects (Hatab, 2009).

The high mountains of southern Sinai support mainly Irano-Turanian steppe vegetation. Smooth faced rock outcrops supply sufficient run-off water to permit the survival of the unique flora. St. Katherine Protectorate is one of the most floristically diverse spots in the Middle East and with 44% of Egypt's endemic plant species. To date around 1261 species were recorded in Sinai. 472 plant species have been recorded as surviving and still occurring in SKP (Fayed & Shaltout, 2004) of these 19 species of the surviving flora are endemic and more than115 are with known by medicinal properties used in traditional therapy and remedies.

Topography is the principal controlling factor in vegetation growth and that the type of soils and the amount of rainfalls play secondary roles at the scale of hill slopes (O'Longhlin, 1981; Wood *et al.*, 1988; Dawes and Short, 1994). Elevation, aspect, and slope are the three main topographic factors that control the distribution and patterns of vegetation in mountain areas (Titshall *et al.* 2000). Among these three factors, elevation is most important (Day and Monk, 1974; Busing *et al.,* 1992). Elevation along with aspect and slope in many respects determines the microclimate and thus large-scale spatial distribution and patterns of vegetation (Geiger, 1966; Day and Monk, 1974; Johnson, 1981; Marks and Harcombe, 1981; Allen & Peet, 1990& Busing *et al.,* 1992).

Through its effects on net solar radiation and microclimate, aspect can have an important influence on the formation of soils (Jenny, 1941; Buol *et al.,* 1989; Carter and Ciolkosz, 1991) and plant community structure (Cantlon, 1951; Gilbert and Wolfe, 1959; Whittaker, 1975; Yeaton and Cody, 1979; Hicks and Frank, 1981). This influence occurs in areas as diverse as interior Alaska (Krause *et al.*, 1959). Alberta (Lieffers and Larkin, l987), Israel (Boyko, 1947), Spain (Dariage, 1987), Montana (Goldin and Ninlos, 1976), and the eastern United States (Franzmeier *et al*., 1969; Losche *et al.,* 1970, Hutchins *et al.,* 1976 and Boemer, 1984). Higher level of solar radiation on sun facing slopes result in higher soil temperatures than on slopes facing away from the sun (Franzmeier *et al.,* 1969; Hutchins *et al.,* 1976 and Macyk *et al.,* 1978), lower soil moisture levels (Gilbert and Wolfe, 1959; Stoeckler and Curtis, 1960), and decreased solum development (Cooper, 1969; Gilbert and Wolfe, 1959; Green, 1987 and Carter and Ciolkosz, 1991). Due to its effects on plant cover and soil depth, aspect influences runoff and soil erosion (Branson, *et al.*, 1981; Green, 1987; Agassi *et al.,* 1990 and Marques and Mora, 1992) and resulting levels of soil P (Klemmedson and Wienhold, 1992). Aspect also shows great influence on plant cover, (Branson *et al.,* 1981; Green, 1987; Agassi *et al.,* 1990 and Marques and Mora, 1992).

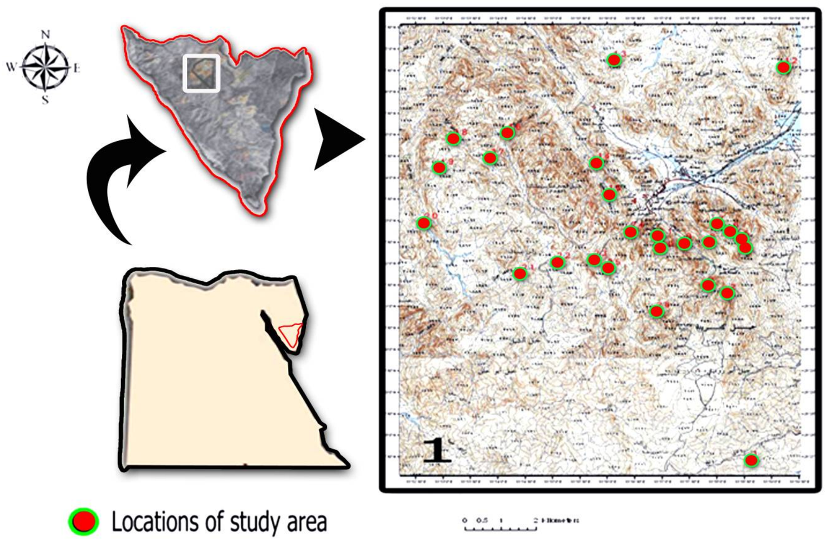
Marked aspect-related differences have been reported for a range of ecosystem properties: soil physical and chemical characteristics (Finney *et al.,* 1962; Franzmeier *et al.,* 1969; Macyk *et al.,* 1978 & Hicks and Frank, 1984): soil genesis (Green, 1987; Carter and Ciolkosz, l99l); stream water chemistry (Sallese *et al.,* 1982);plants species diversity (Boyko, 1947; Pook and Moore, 1966; Whitney, 1991 and Kudel, l992): and forest site properties (Trnnble and Weitzman, 1956; Hurtchins *et al.,* 1976; Hicks *et al.,* 1982; Verbyla and Fisher, 1989; Bale and Charley, 1993 and Mudrick *et al.,* 1994). While the reported magnitudes of the impacts of aspect vary considerably. and may be complicated by variations in other environmental factors, there is sufficient evidence to show that at some steep mid- latitude sites, aspect may exercise a primary control in maintaining ecosystem disjunctions (Bale and Charley 1993).

2. Material and Methods

2.1. Study area

The present study is carried out in 26 main localities of South Sinai, Map 1. represent the study locations from 1 to 26 as following:

Wadi Elrotk, Shak Elgragnia, Shak Mosa, Gabal Mosa, Farsh Ellia, Farsh Ellosa, Farsh Shoeibi, Wadi Elfaraa, Wadi Alarbein, Shak Abo Hamman, Kahf Elghola, Talet Elkalp, Elferee, Wadi Itlah, Wadi Eltalaa, Shak Itlah, Elmaein, Abo Tweita, Farsh Messila, Wadi Eltebk, Abo Waleie, Erheibt Nada, Elzawitin, Elmsirdi, Wadi Elshak and Elgabal Elahmar.



Map 1. Locations of study

The present study was carried out in the period between March to August 2009, Quadrate Transect techniques were used to Study vegetation within 26 locations inside Saint Kathreine Protectorae. 91 stands were studied within 26 locations. Morphological aspects were recorded for all *Nepeta septemcrenata Benth.* individuals by using morphological indices attributed on each parameter as fellow to evaluate the variations that exist among different locations under study (Plant Height (cm) , Shape index of leaf, Number of branches per plant, Internode length (cm), Number of leaves per branch, Leaf area (cm^2), Size index, Plant width (cm)). Soil samples have been collected during the work, from all the ninety one stands for the determination of their physical and chemical characteristics (Soil texture, Water content %, pH, T.D.S PPm, EC μs/ cm, Org.matter %, $CaCO_3$ %m, Ca^{++} meq/L, Mg^{++} meq/L, Na^+ ppm, K^+ ppm, HCO_3^- meq/L, Cl-meq/L, SO_4^{--} meq/l).

Recorded GPS points for each location were imported into GIS software as excel sheet then we add it on TIN map then from 3d analyst tool we choose TIN surface and then chose TIN aspect, manual of topographic maps by Arc GIS are illustrated at ESRI, (2001). All data collected from the field will be classified according to its aspect in order to detect the effect of this factor.

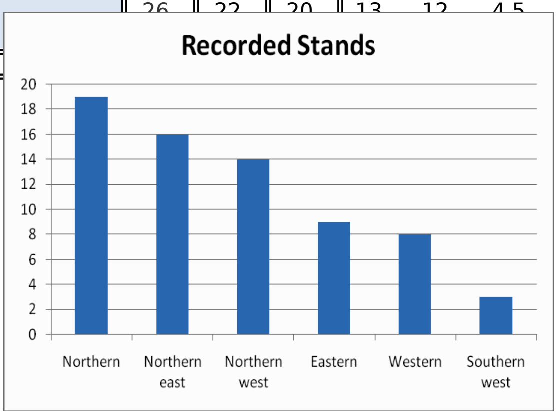
3- Results and discussion

Results showed that *N.septemcrenata* are located at North (26.8%), North East (22.3%), East (13.4%), West (11.9%), North West (20.89%) and South West (4.4%), there was no detection for the plant at the South aspect. This distribution pattern of the populated sites is not significantly different from the division of slope aspects among all survey sites. Table 1 and Figure 1 represent the No. of stands at each aspect categories.

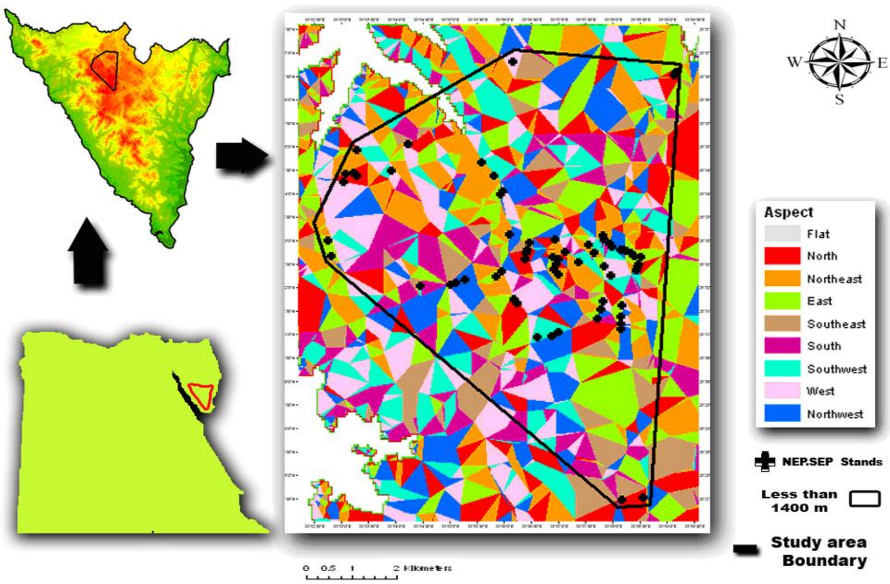
Soil physical properties showed significant variation among different aspect ranks, soil water content showed the highest value at west aspect and the lowest value at east aspect, this results come because the solar radiation is more concentrated in the eastern side that increase the evaporatation of soil water and these results confirmed the results recorded by Franzmeier *et al.* (1969); Hutchins *et al* (1976) and Macyk *et al*. (1978).

Table 1. Aspect categories for the *N.septemcrenata* habitats in SKP.

Aspect	N	NE	NW	E	W	SW
.Stand No	1	23	3	6	4	66
	2	24	8	9	5	86
	12	29	10	14	25	88
	13	31	11	15	26	0
	28	32	17	19	45	0
	30	35	18	20	55	0
	37	36	21	54	57	0
	40	39	22	64	61	0
	41	48	38	65	0	0
	42	50	56	0	0	0
	59	51	69	0	0	0
	60	58	70	0	0	0
	62	75	71	0	0	0
	76	80	87	0	0	0
	77	81	0	0	0	0
	78	14	0	0	0	0
	84	0	0	0	0	0
	85	0	0	0	0	0
	18	0	0	0	0	0
	19	16	14	9	8	3
	26	22	20	13	12	4.5



Results also showed positive correlation between soil total dissolved solids, electrical conductivity, sodium, potassium and chloride. This component show highest degree at easte aspect. Soil pH and calcium carbonate showed the highest value at south west aspect, while calcium and magnesium show highest value at North east aspect. This variation in chemical and physical prosperities of the soil due to the differences in solar radiation ratios (Finney *et al*. 1962; Franzmeier *et al*. 1969; Macyk *et al* 1978 & Hicks and Frank 1981).



Map 2. Aspect ranks within study area.

Results also showed positive correlation between soil total dissolved solids, electrical conductivity, sodium, potassium and chloride. This component show highest degree at easte aspect. Soil pH and calcium carbonate showed the highest value at south west aspect, while calcium and magnesium show highest value at North east aspect. This variation in chemical and physical prosperities of the soil due to the differences in solar radiation ratios (Finney *et al*. 1962; Franzmeier *et al*. 1969; Macyk *et al* 1978 & Hicks and Frank 1981).

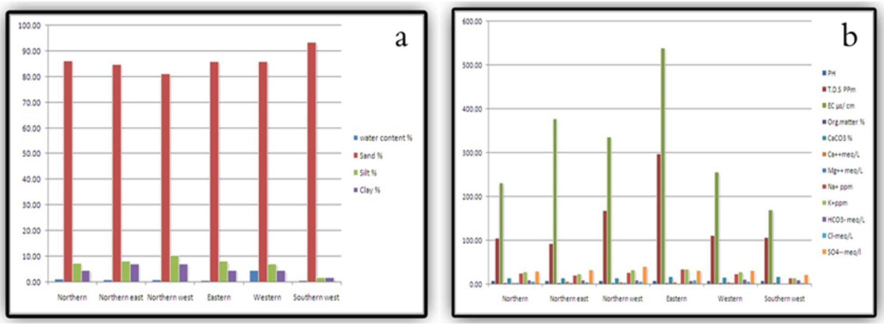
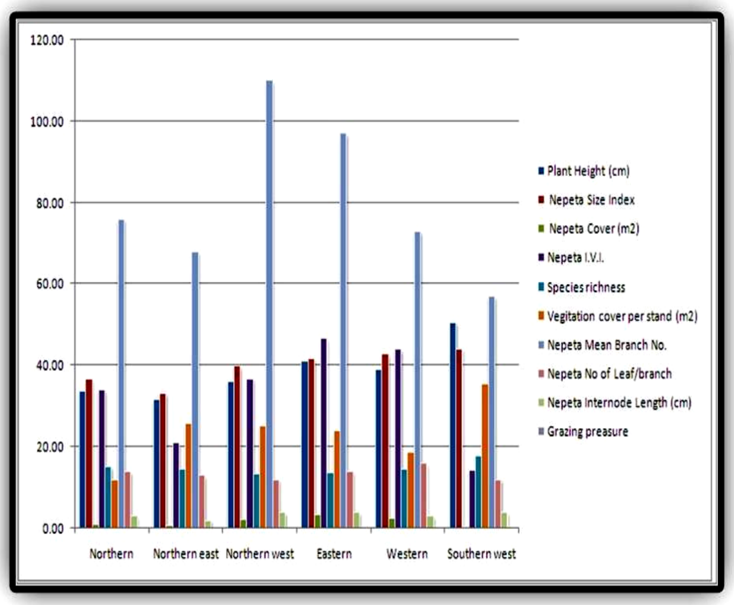


Figure 2. Variation in soil component among different aspect, (a) physical properties, (b) chemical prosperities.

Results recorded great variation in soil components, and plant traits due to the variation in aspect (Table 2).

Table 2. Variation in Soil prosperities and morphological characters of *N.septemcrenata* among different habitat aspects

Aspect	North	Northeast	North west	East	West	Southwest
Soil physical prosperities						
% water content	1.17	1.04	0.84	0.56	4.54	0.74
% Sand	86.32	84.79	81.30	85.96	85.92	93.33
% Silt	7.40	8.20	10.50	8.10	7.10	1.80
% Clay	4.70	7.00	7.10	4.70	4.50	1.80
Soil chemical properties						
pH	8.48	8.46	8.05	8.34	8.48	8.57
T.D.S PPm	105.17	93.00	168.07	297.00	111.25	106.33
EC µs/ cm	231.44	378.00	336.36	539.22	255.88	170.33
% Org.matter	4.25	3.83	3.69	3.54	3.31	3.24
% CaCO3	15.03	15.20	15.00	16.89	15.69	17.83
Ca++meq/L	3.53	6.00	5.64	5.33	5.69	2.33
Mg++ meq/L	2.92	3.33	3.46	2.78	3.44	0.67
Na+ ppm	25.82	20.43	26.75	33.75	23.26	14.52
K+ppm	29.05	23.76	32.29	34.70	28.25	15.07
HCO3- meq/L	9.94	9.13	10.14	8.78	10.81	9.33
Cl-meq/L	6.49	4.95	6.62	10.53	7.44	4.42
SO4-- meq/l	29.19	33.63	40.32	32.00	31.00	21.67
Plant morphological characters						
Plant Width (cm)	39.24	34.85	43.45	42.26	46.60	37.53
Plant Height (cm)	33.87	31.55	36.22	41.24	38.94	50.67
Nepeta Size Index	36.56	33.20	39.84	41.75	42.77	44.10
Nepeta Cover (m2)	0.89	0.79	2.21	3.43	2.46	0.44
.Nepeta I.V.I	34.03	20.96	36.80	46.71	43.97	14.38
Species richness	15	15	14	14	15	18
Vigitation cover per stand (m2)	11.93	25.66	25.22	24.01	18.65	35.41
.Nepeta Mean Branch No	76	68	110	97	73	57
Nepeta No of Leaf/branch	14	13	12	14	16	12
Nepeta Internode Length (cm)	3	2	4	4	3	4



.Figure 3. ***N.septemcrenata*** **morphological characters among different habitat aspects**

Nepeta septemcrenata height, size index, species richness and vegetation cover per stand showed the highest values at south west aspect.

Nepeta septemcrenata cover, I.V.I and No. of branches showed the highest values at east aspect while plant width, No. of leaves per branch and internodes length showed the highest values at west aspect and this is due to the light density.

Aspect also showed great influence on *N.septemcrenata* cover, the highest value was recorded at east side and the lowest value was recorded at south west this effect was recorded also by Branson *et al.* (1981); Green (1987); Agassi *et al*. (1990) & Marques and Mora (1992).

Conclusion

From this study we can detect the great effect of topographic aspect on the vegetation structure and soil composition resulting from variation in solar exposure among different aspect ranks, this variation lead to change in the species demography and morphological characters due to the change in soil temperature and water evaporation.

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