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Comparing *Artemisia sieberi* Besser and *Artemisia scoparia* Waldst and Kit. Elemental Content Grown on Crusted and Uncrusted Soils

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Abstract: Biological soil crusts occur as assemblage of lichens, mosses, liverworts, and cyanobacteria. Lichens and mosses are the two important components of biological soil crusts, especially in arid and semiarid rangeland environments, where vascular plants vegetation is poor. Biological soil crusts contribute to a variety of ecological functions. The current study was carried out to compare two native shrubs elemental content. For this purpose, aerial parts of two native annual and perennial shrubs, *Artemisia scoparia* and *A. sieberi*, were collected from crusted and uncrusted soils in Qara Qir rangelands, next to Iran - Turkmenistan border line. N, P, K, Zn and Fe of the samples were measured. Factorial experiment based on Completely Randomized Design (CRD) was used for data analysis. Results showed that N, Fe and Zn content of samples collected from crusted and uncrusted sites were significantly different. Different treatments showed different behavior for each of mentioned elements. *A. scoparia* related to crusted and uncrusted soils contained the highest and lowest nitrogen percent, respectively. Zinc of *A. sieberi* and *A. scoparia* both collected from crusted site showed the greatest and lowest amount, respectively. This status was true for Fe changes in understudy treatments, too.

Key words: *Artemisia sieberi*, *Artemisia scoparia*, biocrust, lichen, moss, nutrient, Qara Qir, Iran

Introduction

Biological soil crusts, complex communities composed of cyanobacteria, lichens, green or brown algae, mosses, microfungi and their byproducts, are a common surface feature of arid and semiarid lands throughout the world (West, 1990). Available information indicates that biological soil crusts contribute to a variety of ecological functions, including soil stabilization, nitrogen fixation, nutrient availability, and vascular plant establishment (Williams *et al*., 1995; Harper and Marble, 1998; Belnap *et al.*, 2001). Some studies demonstrate that alterations in surface soil chemistry due to biocrust presence are correlated with changes in the content of bioessential elements in the tissue of associated seed plants (Belnap and Harper, 1994; Pendleton and Warren, 1995; Harper and Belnap, 2001; Pendleton *et al.*, 2003). The intent of this paper is to report new data from Iran bearing on the influence of biological soil crusts on mineral nutrition of associated vascular plants in Qara Qir rangelands, northern Iran.

Materials and Methods

Two species, an annual native shrub, *Artemisia scoparia* Waldst and Kit., and the perennial shrub, *Artemisia sieberi* Besser, were chosen for this research. The aerial parts of abovementioned species were collected for experiment. For this purpose, two adjacent sites in Qara Qir ranges (loess hills) one including crusted soils and the other one without biocrust (lichens and mosses), were considered as sample collecting sites. Qara Qir is located in Turkmen Steppe, northern Iran, in Golestan province. Annual mean precipitation and evapotranspiration for this area is estimated about 200 and 170 mm, respectively. Absolute maximum and minimum temperature of Qara Qir is 42.8 and -5.36°C. Plant tissue of *A. scoparia* and *A. sieberi* were collected in four replications from crusted and uncrusted sites (Table 1). Samples of aerial tissues were stored in packages until analyzed. Analysis was done by the Soil - Plant Analysis Laboratory, Natural Resources Faculty of Tehran University. To analyze, samples were washed with distilled water, ovendryed at 70°C for 24 hours and milled. Nitrogen, Phosphorus, and Potassium content of tissues was determined using micro - Kjeldhal (Sparks, 1996), Ascorbic Acid (Olsen and Sommers, 1982) and Flame photometery (Walinga *et al.,* 1989) procedures, respectively. Concentration of micronutrients including Zinc and Iron was determined using atomic absorption procedure. Factorial experiment based on Completely

Table 1: The general plan of sample collection from crusted and no - crusted sites

Sample collection site		Species
No-cr††	Cr†	*Artemisia sieberi*
No-cr	Cr	
No-cr	Cr	
No-cr	Cr	
No-cr	Cr	*Artemisia scoparia*
No-cr	Cr	
No-cr	Cr	
No-cr	Cr	

Cr†:Crusted soil No – cr††: No – crusted soil

Table 2: ANOVA of different elements in *A. sieberi* and *A. scoparia* samples collected from crusted and uncrusted soils

Zn	Fe	P	K	N	df	Source of Variation
0.003***	2.382***	0.106	0.052***	0.0001	1	Species
0.001051	0.207	0.016	0.007***	0.247***	1	Biocrust
0.001***	0.414*	0.001	0.9025	0.006**	1	Biocrust × Species
0.04507	0.114	0.083	0.00001	0.01	12	Error
-	-	-	-	-	16	Total

***P<0.01 ** P<0.05 * P<0.1

Randomized Design (CRD) was used for data analysis.

Results

Table 2 shows the result of ANOVA of understudy variables in *A. scoparia* and *A. sieberi* grown on crusted and uncrusted soils. According to the Table 2, there is significant difference between species in term of their K, Fe, and Zn concentration, that is, without biocrust influence, content of these elements significantly differs in mentioned species. Also, Table 2 indicates that presence of biocrusts leads to an increase in N, K, and Mn content in associated vascular species. Interaction of biocrust by vascular species shows significant difference in N, Zn, and Fe concentration.

Comparison of elements content in vascular plants samples collected from crusted and uncrusted sites is presented in Fig. 1 and 2. As it is shown in Fig. 1, *A. scoparia* related to crusted site, has the highest %N, while *A. scoparia* collected from non – crusted site presents the lowest %N.

Among species, Zn concentration is highest in *A. sieberi* grown on crusted soil, followed by *A. sieberi* from non – crusted soil. *A. scoparia* of crusted soil differs significantly in Zn level compared with other treatments, including the lowest Zn content (Fig. 1).

Fe changes of species is approximately close to Zn (*A.sieberi* related to crusted site, has the greatest level of Fe, while among treatments, *A. scoparia* from uncrusted site lies in fourth position), but there is no significant difference between *A. sieberi* samples gathered from crusted and no-crusted site. Also Fe of *A. sieberi* and *A. scoparia* both related to non-crusted site is not significantly different.

According to the Table 2 and Fig. 2 there are no significant differences among treatments in view point of their P, and K level. However, mentioned elements concentration is higher in samples collected from crusted soils.

Discussion

Increase of nitrogen in vascular plants tissues collected from crusted sites could be related to soil nitrogen increment due to biocrust presence. Comparison of N content in crusted and uncrusted soils of study area (Jafari *et al.*, 2004) shows that nitrogen level in crusted soils averaging about twice those of uncrusted one (0.9 versus 0.5 mg g^{-1}). This indicates that nitrogen of soil and consequently vascular plants grown on this kind of soils is strongly influenced by biological crusts, specially when biocrust comprises of nitrogen fixation species like *Collema*. In Qara Qir rangelands, *Collema tenax* (Sw.) is one of the dominant lichen species. Atmospheric nitrogen fixed by microbiotic crusts has been well documented (Belnap, 1996; Barger, 2003).

Ebrahim Zadeh (1990) states that increase of a given element concentration in the environment either directly leads to increase of its level in the plant or affects other element content in the plant. It seems that increase of N level in the soil due to biocrust existence resulted in increase of %N in the associated vascular plants. Although P of crusted and no-crusted soils showed a difference (0.017 versus 0.013 meq l^{-1}), but no differences were observed between plant samples collected from these soils. It was expected to have greater amount of P level in those samples collected from encrusted soil. Black (1968) suggest that P and plant - available Fe are often in short supply in the calcareous, sandy soils common to many deserts. Since Qara Qir is located in an arid area in Turkmen Steppe, adjacency of Turkmenistan deserts, so the negative or little effect of biocrusts on the associated vascular plants P and Fe content may be related to competition between the soil crust organisms and the roots of seed plants for mentioned elements due to their short supply in the study area. The competitive effect for Fe is especially true about *A. scoparia,* an annual plant, that its surface roots are influenced by the biological soil crust organisms.

Salardidni (1985) states that soil Zn and P have a negative interaction. Increase of soil P causes increase of insoluble phosphates which consequently limits the availability of Zn to root cells. Since zinc phosphate should be soluble enough to supply adequate Zn, the problem may be inside the plant or in interaction not clearly understood (Miller and Donahue, 1990). Therefore, according to P enhancement at 0-5 cm depth due to biocrust influence (Jafari *et al.*, 2004), one may conclude that Zn decline in samples of annual shrub (*A. scoparia*) with surface roots collected from crusted site is affected by phosphorus increase. On the other hand, it might be related to dilution effect due to higher growth rate in annual plant.

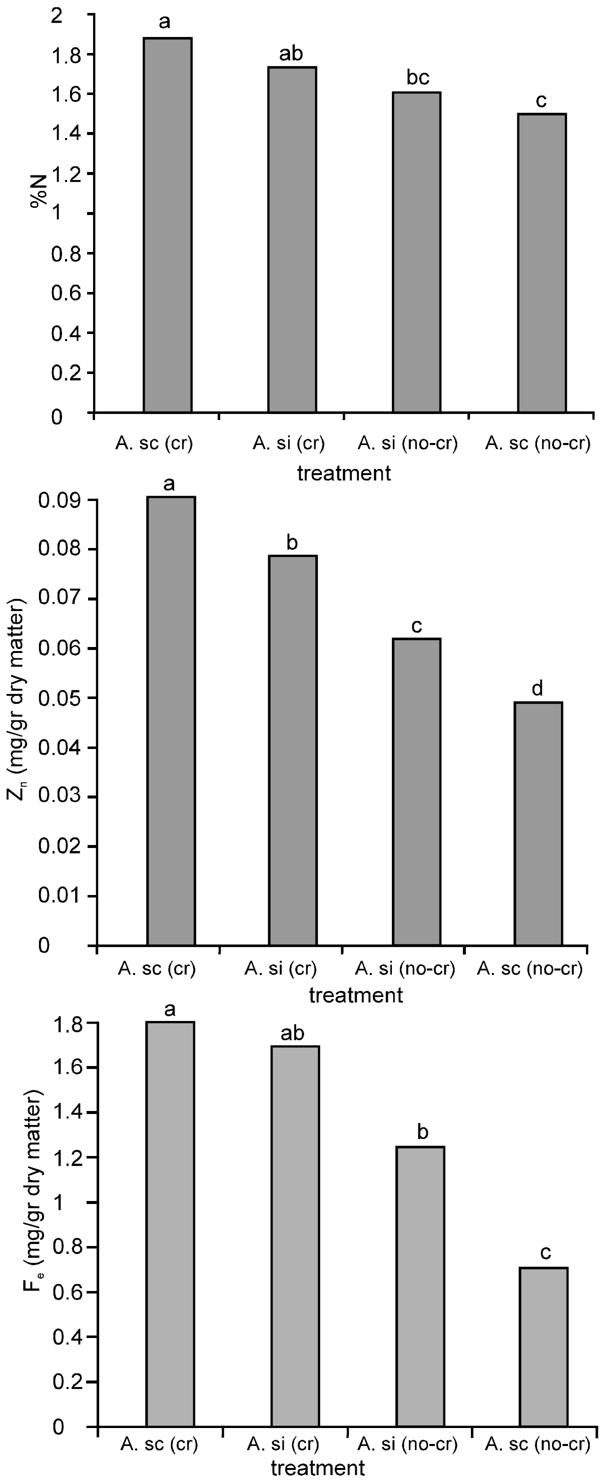

Fig. 1: N, Fe and Zn content of samples collected from crusted and no-crusted soils

Comparing K content of crusted and uncrusted soils in Qara Qir at depths of 0-5 and 5-20 cm showed that there was no significant difference between mentioned soils, but totally K possesses higher levels at 5-20 cm in

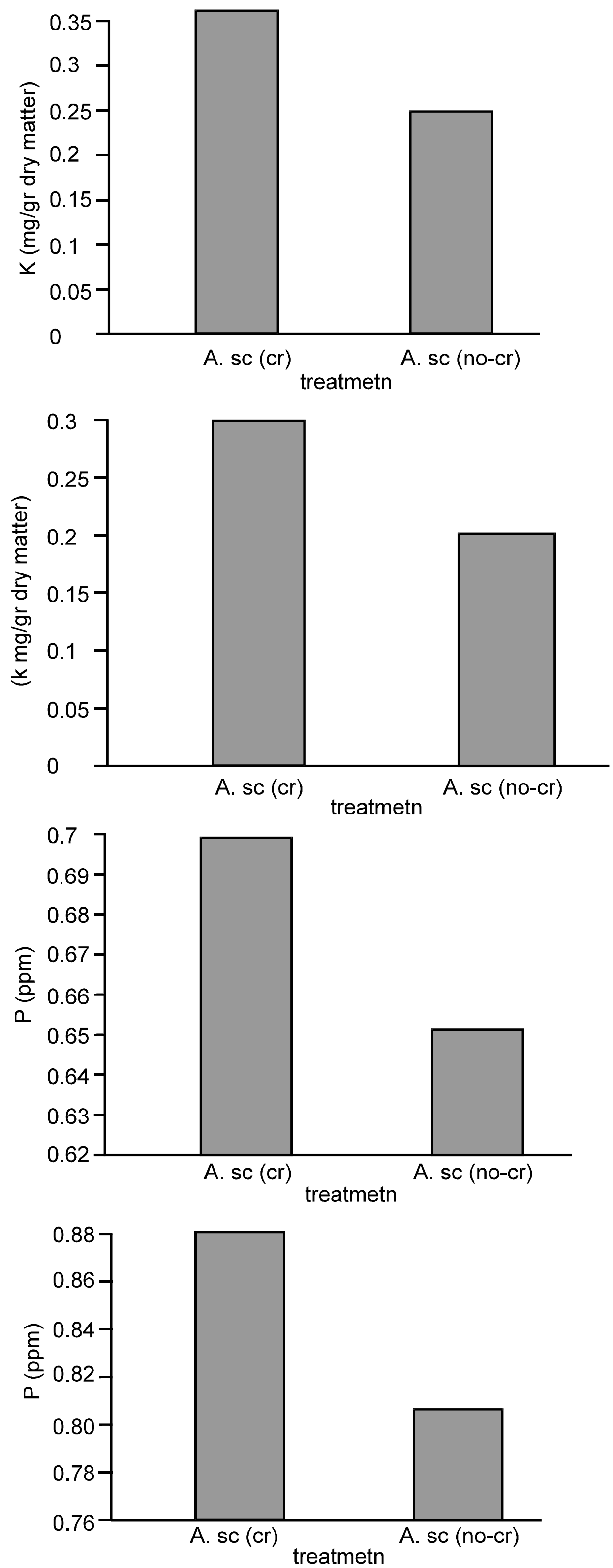

Fig. 2: K and P content of samples collected from crusted and no-crusted soils

crusted soil. Hence, it is expected to have higher level of K in samples of *A. sieberi* (perennial species) which its roots are deeply distributed in soil. Comparison of K in tissues of *A. sieberi* and *A. scoparia* (Fig. 2) dedicates that although these species are not significantly different but annual species includes higher content of K. Since K absorption by plant roots mainly depends on active absorption mechanism of plant (Ahmadi, 1984), it could be suggested that active absorption mechanism of *A. scoparia* is more considerable than *A. sieberi.*

Since legums and other vascular plants that form symbiotic, nitrogen - fixing associations with bacteria are uncommon in the study area, hence biocrusts importance as sources of biologically available nitrogen is considerable in Qara Qir ranges.

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