Bulletin of Pure and Applied Sciences.
Botany, Vol.41 B, No.2.
July-December 2022: P.139-147
Original Research Article

Print version ISSN 0970 4612
Online version ISSN 2320 3196
DOI: 10.5958/2320-3196.2022.00017.9
Available online at www.bpasjournals.com

Soil-Vegetation Relations in Some Stations of the Kabylia Region (North Algeria)

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Received on 15.09.2022
Revised on 20.11.2022
Accepted on 30.11.2022
Published on 15.12.2022

Keywords:
Inventory,
Flora,
Soil,
Ecological analysis,
kabylie.

Abstract
In order to characterize the soil-vegetation relationship in Kabylia, a qualitative inventory of plant species was carried out in the stations of Sidi Ali Bounab, Redjaouna and Mizrana (Tizi-Ouzou) during the spring season 2022 as well as physico-chemical analyzes of the soil (texture, total limestone CaCO3, pH, electrical conductivity as well as organic matter). The inventory of the flora collected made it possible to draw up a systematic list of 54 species, of which 26 species are listed at the level of the Redjaouna station, which is the more diversified, 23 species at the station of Sidi Ali Bounab and only 15 species at the station of Mizrana. The latter belong to 25 botanical families, 22 orders, 4 classes (Liliopsida, Equidopsida, Magnoliopsida and Flicopsida), and 5 divisions of the kingdom Planteae. The Fabaceae family dominates in the Redjaouna and Sidi Ali Bounab stations, so much said that at the Mizrana station it is the Asteraceae family that dominates. The analysis of the quality of the soils by determining their physical and chemical properties reveals that it is favorable to the installation and the diversification of the flora thanks to their loamy-sandy texture rich in organic matter and their neutral pH as well as their electrical conductivity, which is confirmed by the ecological analysis (equitability which tends towards 1) as well as statistical analysis by ACP and CAH.

How to cite this article: Lembrouk L., Guerrmah D., Lakabi L, Medjdoub-Bensaad F. (2022). Soil-Vegetation Relations in Some Stations of the Kabylia Region (North Algeria). *Bulletin of Pure and Applied Sciences-Botany,* 41B(2), 139-147

INTRODUCTION

The vegetation is far from being the same in all regions, especially since its diversification impresses the appearance of the regions where it often presents a striking character with a fairly variable distribution on the surface of the globe (Jodra, 2015). The Algerian flora is diversified and rich in Mediterranean and Saharan botanical species belonging to the field of

African flora. The latter is the result of a Mediterranean climate in the North and a Saharan climate in the South. The same is true for Kabylia, which is centered in the north of Algeria, occupying an important place for its specific richness in plant species, some of which are endemic, as well as the fertility of its soils (Vela, 2017). The soil is an environment to be discovered in order to better build the future of the plant and allow its development, its diversification and its renewal on the surface of the continents, especially since the plants are in strong interaction with their environment (Ruellan, 2010). Therefore, our study main objective focused on the soil-vegetation relationship in order to characterize the distribution of plant species according to the quality of the soil in Kabylia after the perception of its physico-chemical qualities in three different sampling stations (Sidi Ali Bounab, Redjaouna and Mizrana).

MATERIAL AND METHODS

The study region is located in northern Algeria, in the Tizi-Ouzou department (located 100 km east of Algiers), in greater Kabylia and in the heart of the Djurdjura massif, 36°42' North latitude and 4°13' East longitude. It extends within its current limits over an area of 2958 km2 dominated by mountainous areas where the Mediterranean climate is essential with a mild and rainy winter and a hot and humid summer given the proximity of the Taksebt dam. The vegetation is classified in the thermo-Mediterranean stage, dominated by olive trees (Olea europaea).We were interested in the soil-vegetation interaction in order to characterize the distribution of plant species according to the quality of the soil in Kabylia. For this, we carried out a qualitative inventory of the flora collected at random, sampled in three different stations (Sidi Ali Bounab, Redjaouna and Mizrana, table 1andfigure 1) during the spring season 2022, after determining the physico-chemical qualities of the soil. (particle size, pH, CaCo3, electrical conductivity: CE and MO).

Table 1: Geographical coordinates of study stations

Stations	Geographical coordinates	Altitude
SidiAliBounab	36,44° N, 3,57°E	700 m
Redjaouna	36,43° N, 4,33°E	650 m
Mizrana	36,44° N, 4,9°E	299 m

Figure 1: Geographical location of the Sidi Ali Bounab, Redjaouna and Mizrana study stations (GoogleEarth, 2022).

RESULTS AND DISCUSSION

Substrate analysis

The results of the physico-chemical analyzes obtained are illustrated in Table 2, which is interpreted according to international standards.

Table 2: Results of the physico-chemical analyzes of the soils of the stations studied.

Ground of Stations	Physical analyzes					Chemical analyzes				Texture
	A%	LF%	LG%	SF%	SG%	pH	CACO3 Total	C.E ds/cm	M.O %	
SidiAliBounab	17.37	40.06	1.53	18.04	23	6.3	5.63	111.1	8	SL
Redjaouna	16.18	27.36	22.34	11.68	22.44	6.5	13.75	244	7.46	SL
Mizrana	9.08	19.26	33.97	11.56	16.13	7	1.88	541	8.15	SL

The physico-chemical characterization of the soils of the study stations allowed us to distinguish a sandy-loamy texture, a neutral pH, a high electrical conductivity and a low rate of organic matter and limestone with the exception of the Redjaouna station which is moderately calcareous.

Flora analysis

Table 3 represents all the floristic groups inventoried according to the quality of the soil of the different sampling stations (Sidi Ali Bounab, Redjaouna and Mizrana) during the spring season of the year 2022.

Table 3: All the floristic groups identified in the stations studied

Stations	Orders	Families	Species
SidiAliBounab	16	19	23
Redjaouna	13	14	26
Mizrana	7	5	15
Total	22	25	54

A total of 54 speciesbelonging to 4 classes (Magnoliopsida, Liliopsida, Pteridophyta and Equisetopsida) spread over 22 orders (Cyperales, Lamiales, Apiales, Fabales, Poales, Asterales, Ranunculales, Arales, Gentianales, Caryophyllales, Rosales, Geraniales, Campanulales, Boraginales, Capparales, Rhamnales, Ericales, Polygonales, Mytrales, Urticales, Liliales and Polypodiales) and 25 families were collected.

Ecological study

Relative abundance

During our sampling of the flora at the three stations studied (Sidi Ali Bounab, Redjaouna and Mizrana), we collected a total of 54 species (Fig. 2).

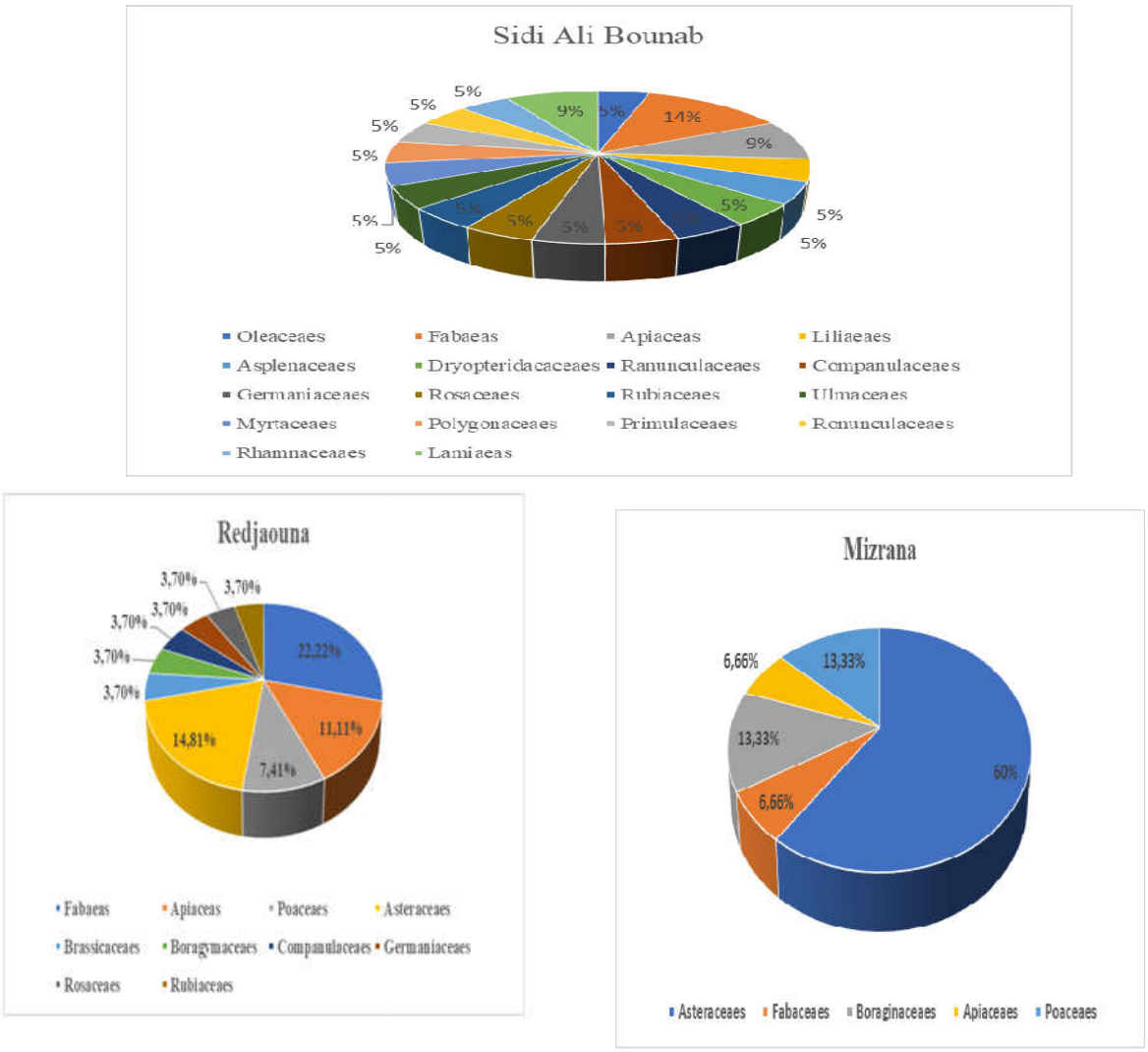

Figure 2: Relative abundance of families of plant species recorded in the study stations.

The flora of the study area includes several spontaneous plant species. It is marked by the dominance of Asteraceae (60%) in Mizrana as well as Fabaceae in Rédjaouna (22.22%) and Sidi Ali Bounab (14%).

Species richness

The results of the specific richness of the plant species harvested in the study stations are illustrated in Figure 3.

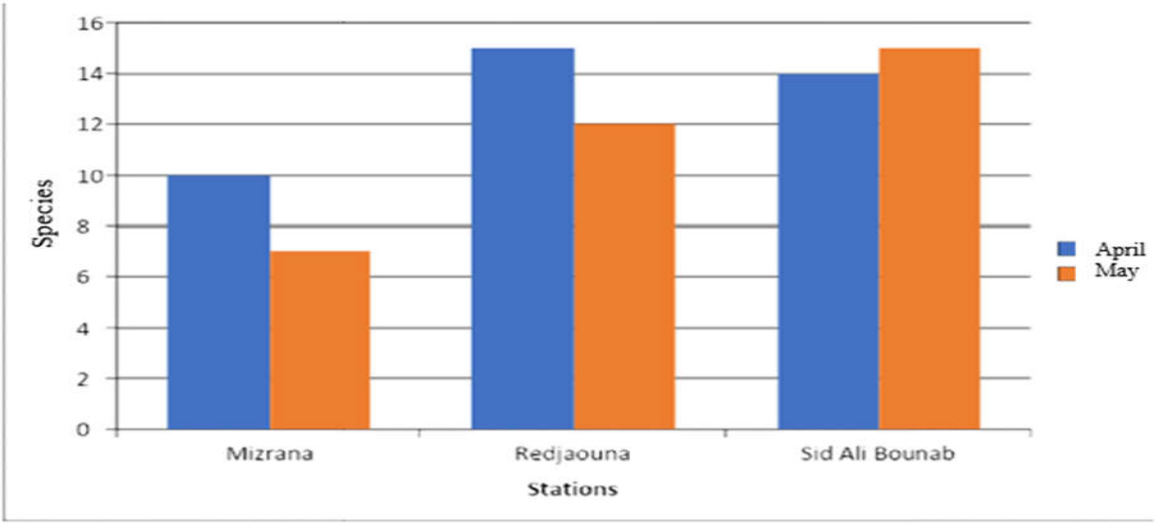

Figure 3: Monthly specific richness recorded in the study stations.

The sampling carried out reveals a total of 54 plant species identified in the various stations studied Sidi Ali Bounab, Redjaouna and Mizrana. Figure 3 shows that the specific richness is higher in the Redjaouna and Sidi Ali Bounab stations respectively with 15 and 14 species.

Fairness

The equitability or the diversity index is calculated for the three study stations (Sidi Ali Bounab, Redjaouna and Mizrana) where the results are shown in Figure 4.

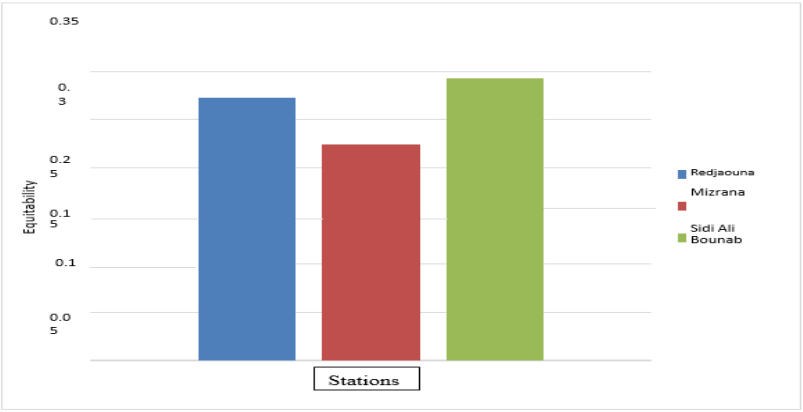

Figure 4: Equitable distribution of plant species at study stations.

In general, evenness increases with the number of species, i.e. low evenness is only the consequence of a low number of taxa and/or the dominance of a few species. , which is explained by Figure 4, which reflects an equitability of less than 1 for the three stations with a maximum peak of 0.29 at Sidi Ali Bounab and a minimum of 0.22 at Mizrana due to a low number of species.

Statistical analysis

Principal Component Analysis (PCA)

The study carried out on the stations: Sidi Ali Bounab, Redjaouna and Mizrana allows the use of principal component analysis (PCA) in order to obtain a perspective approach (Figure 5).

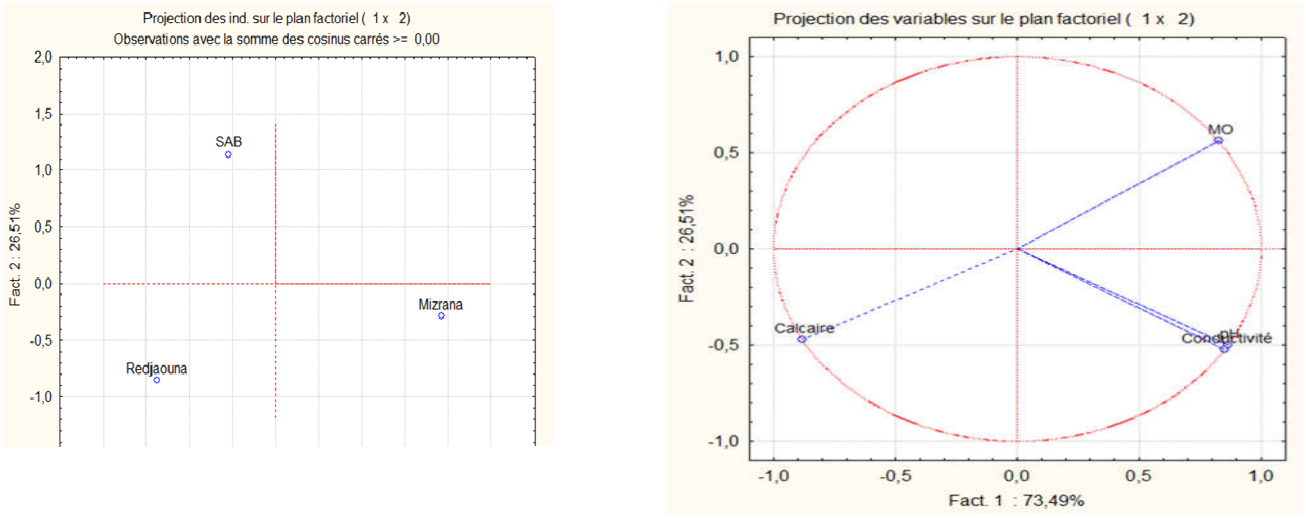

Figure 5: PCA representative of the distribution of study stations according to soil characteristics.

The PCA of Figure 5 shows in space on the two axes (F1: 73.49% and F2: 26.51%) the relationship between vegetation and the physico-chemical quality of the soil (organic matter, pH, limestone (CaCO3) and electrical conductivity). This analysis is completed by dendrograms (figure 6) and ascending hierarchical classification (figure 7).

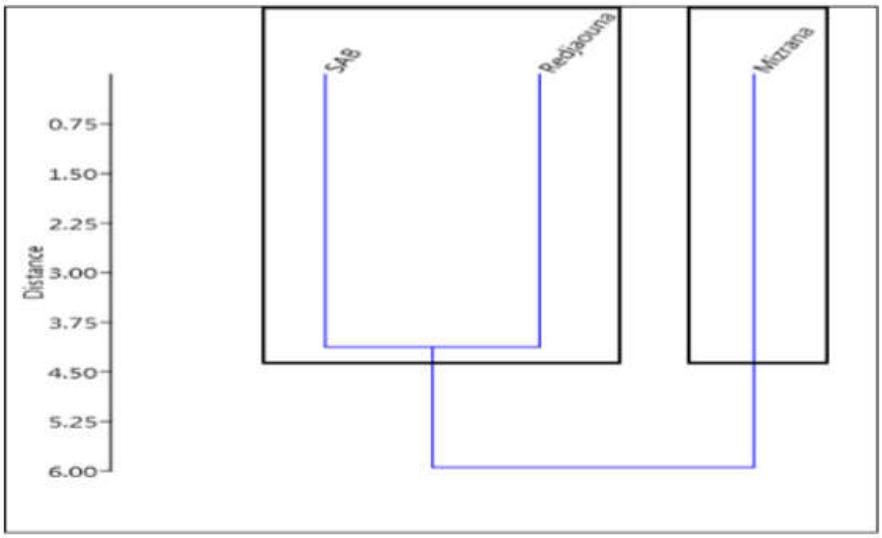

Figure 6: Dendrogram visualizing the relationships between the study stations.

Figure 6 highlights the relationship of altitudinal similarity of the Sidi Ali Bounab and Redjaouna stations since they are medium altitude stations, as well as the physico-chemical characteristics of their soils, which gives rise to a similar flora, unlike the Mizrana station which is totally different due to its coastal location exposed to sea air currents.

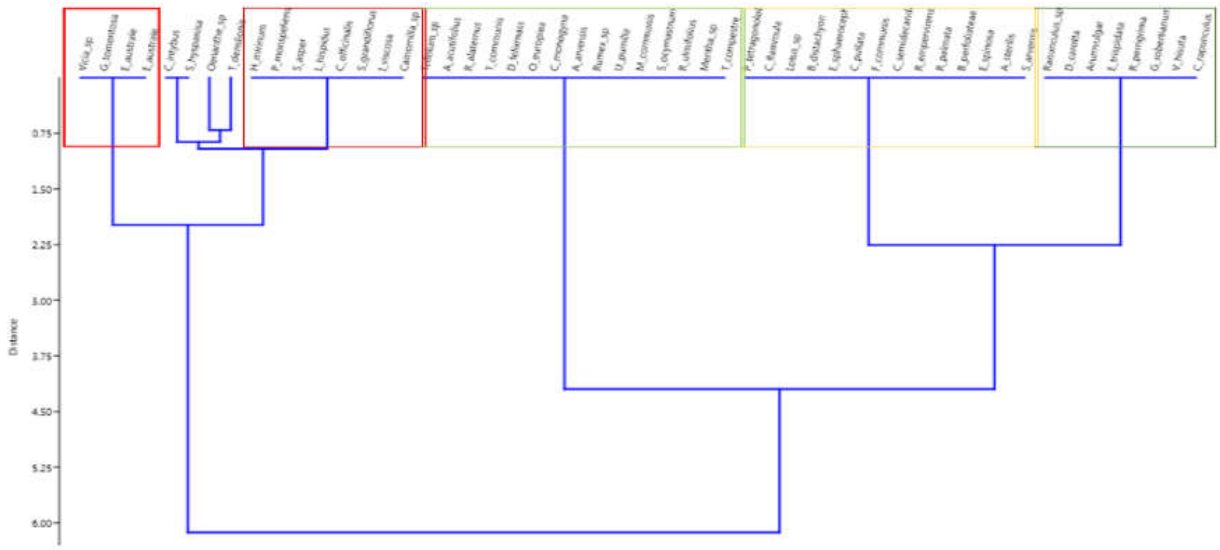

Figure 7: Ascending Hierarchical Classification (AHC) of groups of plant species in the three study stations.

Figure 7 distributes the plant species inventoried according to their appearance in the stations studied, which highlights eight homogeneous groups:

Group 1: *Vicia* sp, *Galactitestomentosa, Echiumaustrale, Trifolium repense* and *Asplenium adiantum,* where the species of this group are most abundant.
Group 2: *Cichorium intybus*, *Scholymushyspanica*
Group 3: *Oenanthe* sp.
Group 4: *Taraxacumdenslionis.*
Group5: *Hordeummirinum*, *Polypogonmonspeliensis*, *Sonchusasper*, *Leotodonhispidus*, *Cynoglossumofficinalis*, *Scolymusgrandiflorus*, *Inulaviscova*, *Camomilla* sp.
Group 6: *Trifoliumsp*, *Asparagusacutifolius*, *Rhamnusalaternus*, *Ferumlacommunis*, *Dryopterisfelixmass*, *Oleaeuropaea*, *Trifoliumrepens*, *Craetegusmonogyna*, *Anagallisarvensis*, *Rumex* sp, *Ulmuspumila*, *Stachysocymastrum*, *Mentha* sp, *Trifoliumcompestre.*
Group7: *Synapisarvensis*, *Avenasterilis*, *Echinopsspinosa*, *Blackstoniaperfoliateae*, *Ranunculus palmata, Rosas emperviens*, *Cerastiumflammula*, *Psophcarpustetragonolobus*, *Lotus* sp, B*rachypodiumdistachium*, *Echinopssphaerocephalus.*

Group 8*: Ranunculussp, Daucuscarotta, Arumvulgare, Eryngiumtrispidata, Rubiaperrigrina, Geraniumrobertianum,Vicia hirsute, Companularopunculus.*

DISCUSSION

The flora of a geographical area is the most important biotic component (Ozenda, 1982) which expresses the ecological conditions (climatic, geological, historical, geomorphological and edaphic) which prevail there (Loisel, 1978) especially since it is far from be the same in all countries (Jodra, 2015). Thus various authors point out that the Mediterranean region is one of the great world centers of plant diversity whose current flora corresponds to various heterogeneous groups linked to the region's paleo-history (Quezel in 1978, 1985; Quezel et *al*., 1980; Myers, 1990; Medail and Quezel, 2003). Algeria, one of the rare biogeographical countries, having an exceptional ecological entity in the biosphere, by its extended surface constituted by various ecosystems. Its plant cover is a very important ecological factor, especially in Kabylia, by its topographic heterogeneity and the anthropic action which have printed a plant landscape with a very fragmented character which appears in the form of rather complex mosaics. The flora

of our study stations (SidiAliBounab, Redjaouna and Mizrana) is inventoried during the spring season of the year 2022, where we have identified 54 species belonging to 25 botanical families, 22 orders, 4 classes (Liliopsida, Equidopsida, Magnoliopsida and Flicopsida), and 5 divisions of kingdom Planteae. The Redjaouna station is the most diversified of all the stations with 26 species, characterized by the predominance of the Fabaceae family. Our results are similar to the results obtained by Rebbas et al. (2010) at the Gouraya massif, which is one of the hotspots of plant biodiversity in Kabylia, as well as Lembrouk and Sadoudi (2022). Plant communities are in direct interaction with their soil throughout their existence, they are involved in the genesis, spatial organization and functioning of soils (Freshet et al., 2018). For this we conducted a study based on the relationship of vegetation and the physico-chemical quality of its soil. In fact, the statistical analysis (ACP and CAH) of the inventoried flora reveals a direct link with its soil which is of loamy-sandy texture, rich in organic matter and limestone, with a neutral pH. These results are confirmed by Chapin et al. (2011) who specify that many edaphic factors influence vegetation; these may be physical and chemical factors or the availability of nutrient resources. According to the Ascending Hierarchical Classification (CAH), the Sidi Ali Bounab, Redjaouna and Mizrana stations are similar from the point of view of mountainous relief located respectively at altitudes of 650m and 700m, presenting soils with common physico-chemical characteristics, as well as their floristic composition. While the Mizrana station is totally different from these first two by its coastal geographical position and its high electrical conductivity (541cm/m) in its soil resulting from the salinity of the coastal environment and its saturation in sodium and chlorine (Gardner et *al.*, 1999). This classification brought out 8 homogeneous groups of which the species of group 1 are the most abundant while those of group 3 and 4 are the least abundant. The distribution and association of these species in the stations studied is essentially dependent on the geomorphology and the altitude of the environment, the physico-chemical characteristics of the soil as well as the availability of water and minerals. Dahmani (1996) points out that the analysis of the floristic richness of the different groups, of their biological and chronological characteristics would make it possible to highlight their floristic originality, their state of conservation and, consequently, their heritage value.

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