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Vegetative development, blooming and chemical composition of some Algerian populations of sulla

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Abstract. As part of the assessment of plant genetic resources of fodder and pastoral interest in Algeria, ten populations of sulla (*Hedysarum coronarium* L.) were taken into account. The vegetative development, the blooming and the chemical composition corresponding to the second year of the growth of this biennial plant, were studied. Several parameters (vegetative development, blooming, green matter, mineral matter, organic matter, crude fiber, fat, total nitrogen, calcium, phosphorus, neutral detergent fiber, acid detergent fiber, lignin, hemicellulose) were analyzed. Two ecological factors (altitude, rainfall) of the natural habitat of the populations were also considered. For two variables (total nitrogen, NDF), the analysis of variance showed a significant variation within the populations of sulla. Many significant relations were also found, especially between the variables linked to the chemical composition of the plant. The populations characterized by a weak vegetative development came from the high altitude areas. The cluster analysis highlighted the established variation and its interest in a future selection program.

Keywords. Chemical composition – Fodder legume – *Hedysarum coronarium* – Nutrient contents – Sulla.

Développement végétatif, floraison et composition chimique de quelques populations algériennes de sulla

Résumé. *Dans le cadre de l'évaluation des ressources phytogénétiques d'intérêt fourrager et pastoral en Algérie, dix populations de sulla (*Hedysarum coronarium *L.) ont été considérées. Le développement végétatif, la floraison et la composition chimique relatifs à la seconde année de croissance de cette plante bisannuelle, ont été étudiés. Plusieurs paramètres (développement végétatif, floraison, matière verte, matière minérale, matière organique, cellulose brute, matière grasse, azote total, calcium, phosphore, NDF, ADF, lignine, hemicellulose) ont été analysés. Deux facteurs écologiques (altitude, pluviométrie) de l'habitat naturel des différentes populations ont été pris en compte. Pour deux variables (azote total, NDF), l'analyse de variance a montré une variation significative chez les populations de sulla. Plusieurs relations significatives ont été indiquées, notamment entre les variables relatives à la composition chimique de la plante. Les populations caractérisées par un développement végétatif faible, proviennent des régions de forte altitude. L'analyse hiérarchique a mis en relief la variation établie et son intérêt dans un futur programme de sélection.*

Mots-clés. *Composition chimique* – Hedysarum coronarium – *Légumineuse fourragère – Sulla – Teneur en nutriments.*

I – Introduction

Hedysarum coronarium L., commonly called sulla, is a forage legume in some Mediterranean countries. Through the North East of Algeria, this plant was encountered at variable altitudes and relatively variable rainfall (Issolah *et al*., 2012). It is also an interesting plant for the fight against erosion of steep slopes on which this species is frequently observed. This work enters in the framework of the characterization of plant genetic resources of fodder and pastoral interest in Algeria. It completes the study carried-out on the same populations of sulla, during the first year of the growth of this biennial plant (Issolah *et al.,* 2014).

II – Material and methods

Following a study conducted on some Algerian populations of sulla during the first year of the growth (Issolah *et al*., 2014), ten Algerian populations were subjected to a trial on the vegetative development, blooming and chemical composition during the second year of the growth of the plants. A randomized complete block design with four replicates was used. The texture of the soil was silty clay. The pH was alkaline (8.17). The annual rainfall was 818.2 mm (2011/2012) and average temperatures of the year were 22.34°C (average maximum) and 13.83°C (average minimum), respectively. The plots did not receive N-P-K fertilization before sowing. We surveyed the following parameters: maximum height (MH in cm), maximum width (WM in cm), date of appearance of the first inflorescence (1F, number of days after sowing). Following the cut at blooming stage (cutting date: CD, number of days after the sowing), several analyses were performed: weight of green matter (GM, g/m^2), mineral matter (MM), organic matter (OM), crude fiber (CF), fat (F), phosphorus (P), calcium (Ca), total nitrogen (N), acid detergent fiber (ADF), neutral detergent fiber (NDF), lignin (ADL) and the hemicellulose (Hcell). All the results related to chemical composition are expressed in percent of dry matter (DM) (ISO, 2009). The data obtained (40 for each variable) were analyzed using Anova, Pearson correlation, and cluster analysis. For the two last analyses, two variables describing the ecological conditions of natural habitats of the populations were added (altitude, rainfall). Statistical analyses were performed using the software Minitab (2003).

III – Results and discussion

The analysis of variance indicated that two variables (N and NDF) were significantly different among populations (Table 1). Correlation highlighted also several significant relations between the different variables, especially those linked to chemical composition (Table 2). Concerning the links with the ecological factors, we noted that the populations characterized by a weak vegetative development came from high altitude areas ($P<0.001$***). It also seems, at this stage, that the others variables and the ecological factors were not linked. Through the cluster analysis applied on all variables (vegetative development, blooming, chemical composition, ecological factors), the variation is clearly established at 70% of similarity (ten different groups of populations). Six groups were obtained at about 40% of similarity. All populations seem to have about 30% of similarity only, which is relatively weak (Fig. 1). Thus, the existing variations among populations could be used for a future selection program. Overall, the results showed significant differences within the populations of sulla during the second year of the growth (cut at blooming). The results obtained during the first year of the growth (cut at the beginning of the blooming) indicated that the differences were more pronounced at that period (first year) for several parameters (Issolah *et al*., 2014). Moreover, nitrogen (N) was negatively correlated to the maximum height of plants (Issolah *et al*., 2014) whereas, it was linked only with crude fiber (CF) in the case of the present study (second year). We noted also that the content of N was relatively higher during the first year of the growth of Sulla (Issolah *et al*., 2014) as compared to the second year of the development of this biennial plant.

Table 1. Analysis of variance (ANOVA) of parameters linked to the vegetative development, blooming, and chemical composition (second year of growth)

Parameters	Min	Max	Mean	F observed	*P*
MW (cm)	77.2	166.4	131.5	1.64	0.153
MH (cm)	16.3	42.8	29.05	1.02	0.448
1F (days)	491.8	506	499.32	1.23	0.319
CD (days)	503.3	521.8	512.55	1.26	0.303
GM (g/m^2)	706.7	4974.8	2438.54	1.23	0.317
MM (% DM)	10.5	15.6	12.76	1.68	0.142
OM (% DM)	84.4	89.5	87.24	1.68	0.142
N (% DM)	5.5	11.1	6.77	3.82	**0.003****
CF (% DM)	11.4	15.5	13.75	0.76	0.655
F (% DM)	1	1.5	1.26	0.91	0.530
Ca (% DM)	0.8	1.9	1.44	1.39	0.239
ADF (% DM)	21.4	24.1	22.63	1.54	0.183
NDF (% DM)	30.6	35.6	33.33	2.46	**0.034***
ADL (% DM)	11.5	14.4	12.56	1.49	0.201
Hcell (% DM)	7.6	13.8	10.69	2.09	0.067

Min: mean minimum of populations; Max: mean maximum of populations; Mean: mean of the populations. Probability: *P<0.05, **P<0.01. MH : maximum height ; MW: maximum width ; 1F: date of appearance of the first inflorescences ; CD: cut date ; GM: weight of green matter/m^2 ; MM: mineral matter ; OM: organic matter ; CF: crude fiber ; F: fat ; Ca: calcium ; N: total nitrogen ; ADF : acid detergent fiber ; NDF : neutral detergent fiber ; ADL: lignin ; Hcell : hemicellulose.

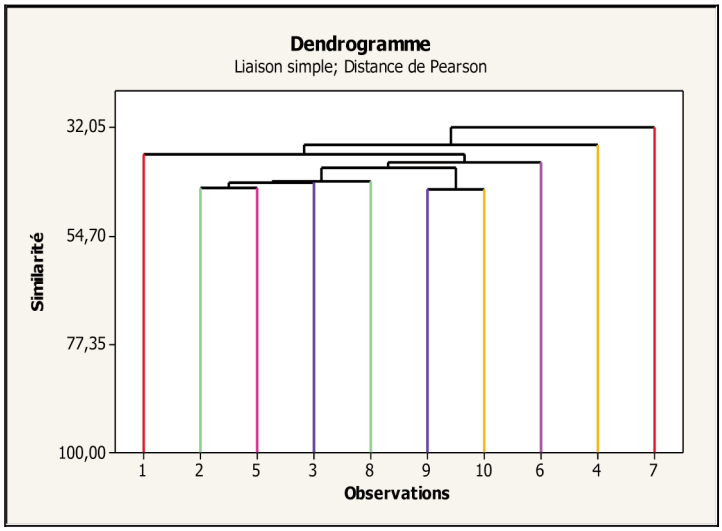

Fig. 1. Cluster analysis of ten Algerian populations (observations) of sulla based on the vegetative development, blooming, chemical composition, and ecological factors (second year of growth).

Table 2. Correlations between the parameters linked to the vegetative development, blooming, chemical composition and ecological factors (second year of the growth)

Parameters	MH	1F	MM	OM	TN	CF	F	NDF
CD	NS	0.840**	NS	NS	NS	NS	NS	NS
OM	NS	NS	-1.000***	–	NS	NS	NS	NS
Ca	NS	NS	0.814***	-0.814**	NS	NS	NS	NS
N	NS	NS	NS	NS	–	-0.641*	NS	NS
ADL	NS	NS	NS	NS	NS	NS	0.806**	NS
Hcell	NS	NS	NS	NS	NS	NS	NS	0.875***
R	NS	NS	NS	NS	NS	NS	NS	NS
ALT	-0.882***	NS	NS	NS	NS	NS	NS	NS

Values of r are reported in the cells only when significant. Probability: *P<0.05, **P<0.01, ***P<0.001 ; NS: not significant.

MH: maximum height ; 1F: date of appearance of the first inflorescences ; CD: cut date ; MM: mineral matter ; OM: organic matter ; CF: crude fiber ; F: fat ; Ca: calcium ; N: total nitrogen ; NDF: neutral detergent fiber ; ADL: lignin ; Hcell: hemicellulose ; R: rainfall ; ALT: altitude.

IV – Conclusion

The study of the vegetative development, blooming and chemical composition of some Algerian populations of Sulla permitted to note a variation in certain parameters during the second year of growth. Except the relationship established between vegetative development and altitude, it seems that the chemical composition and the ecological factors of the different populations were linked. Further investigations on a larger number of populations, at different phenological stages, would improve the knowledge on the nature of the variability within the features of this biennial or short perennial plant.

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