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Phenological variation within several Algerian populations of sulla (*Hedysarum coronarium* L., Fabaceae)

R. Issolah and S. Yahiaoui
INRAA, CRP Mehdi Boualem, Lab. des Ressources Phytogénétiques, BP 37, Baraki, Alger, Algeria

SUMMARY – As part of the characterization and the valorization of plant genetic resources of fodder and pastoral interest in Algeria, twenty natural populations of *Hedysarum coronarium* L. were subject to a phenological study for two consecutive years. Eighteen characteristics linked to the vegetative development, bloom and fruiting heads were studied. The ecological factors (rainfall, altitude) of the original environment of the populations were taken into account during this study. Certain variability was noticed. The results indicated that the plant is characterized by an interesting vegetative development, particularly during the second year of growth. Relations seem to exist between some phenological characteristics and factors of the populations' original environment. *Hedysarum coronarium* L. should be developed, particularly in isolated and disadvantaged areas, to which it could adapt.

Keywords: Ecological factors, *Hedysarum coronarium*, morphology, phenology, sulla, variation.

RESUME – *"Variation phénologique chez plusieurs populations algériennes de sulla (*Hedysarum coronarium *L., fabaceae)". Dans le cadre de l'évaluation et de la valorisation des ressources phytogénétiques d'intérêt fourrager et pastoral en Algérie, vingt populations naturelles de l'espèce* Hedysarum coronarium *L. ont fait l'objet d'une étude phénologique sur deux années consécutives. Dix-huit variables relatives au développement végétatif, à la floraison et aux gousses ont été considérées. Les facteurs écologiques du milieu d'origine (altitude, pluviométrie) des populations ont également été pris en compte lors de cette étude. Une certaine variabilité a été mise en relief. Les résultats obtenus indiquent que la plante se caractérise par un développement végétatif appréciable, particulièrement au cours de sa seconde année de croissance. Des relations semblent exister entre quelques caractères phénologiques et les facteurs écologiques du milieu d'origine des populations.* Hedysarum coronarium *L. mérite d'être valorisée, particulièrement dans les régions déshéritées et isolées où l'apport d'engrais n'est pas économiquement recommandable.*

Mots-clés : *Facteurs écologiques,* Hedysarum coronarium*, morphologie, phénologie, sulla, variation.*

Introduction

Hedysarum coronarium L. (sulla, French honey-suckle, Spanish sainfoin, Spanish esparcet) is a member of the *Leguminosae* family originating and growing in the mediterranean basin, where it has been established as a forage crop in several countries (Benguedouar *et al*., 1997). This species is suitable for soil conservation work because it fixes nitrogen, grows satisfactorily over a wide range of soil conditions and tolerates drought and coastal conditions (Douglas, 1984).

Several authors throughout the world indicated that *H. coronarium* is characterized by a stable chromosome number (2n = 16) whereas two chromosome numbers (2n = 16 and 2n = 18) were encountred in Algerian populations of this species (Issolah *et al*., 2006).

The objective of this study is to understand the heriditary mechanism of *Hedysarum coronarium* and to quantify the phenotypic variation available within Algerian populations using a number of phenological characteristics. This work follows previous studies conducted on fodder legume species in Algeria (Issolah *et al*., 2001; Issolah *et al*., 2006; Issolah and Khalfallah, 2007).

Materials and methods

Collect missions were undertaken by the National Institute of Agronomic Research (INRAA) in 1998 throughout the North-East of Algeria (Issolah *et al*., 2001). Several populations of *Hedysarum*

coronarium were collected. Twenty were subjected to a trial over a consecutive two years period (1999/2000 and 2000/2001).

The study was carried out in the experimental station of Mehdi Boualem in Baraki (INRAA) at an 18.5 m altitude, in a subhumid zone. The soil was clayey-mudy with a 7.9 pH. The temperature was ranging from 10.9℃ (m1) to 21.7℃ (M1) for the fi rst year (99/00) and from 11.7℃ (m2) to 22.9℃ (M2) for the second year (00/01). The annual rainfall was, respectively, about 412 mm (99/00) and 408.1 mm (00/01). The populations were sown (08/11/1999) (200 seeds/line) on 3 m long lines separated by 1.50 m. We used a randomized complete block design with two replications. Eighteen characteristics were considered: H1 (17/05/00), H2 (20/03/01): Maximum height (cm) of vegetation at the line; W1 (17/05/00), W2 (20/03/01), W3 (30/04/01): Maximum width (cm) of vegetation at the line; BB1 and BB2: Beginning of bloom during the first and the second year (one inflorescence / plant on the line); FB1 and FB2: Full bloom during the first and the second year ; EB1 and EB2: End of the bloom during the first and the second year; DB: Duration of the bloom (time separating the appearance of the first inflorescence and the end of the bloom during the first year); FFH1 and FFH2: Appearance of the first fruiting heads on the line during the first and the second year; BFH1 and BFH2: Beginning of the fruiting heads during the first and the second year (1 fruiting head / plant on the line); FH1 and FH2: Full formation of fruiting heads during the first and the second year.

The observations concerning the vegetative development were made periodically, at precise dates during the two years (99/00 and 00/01). The observations concerning the bloom and the fruiting heads were made by regular passages (2-3 days), during the two years. In this case, the indicated values are recorded in terms of days following the sowing. The considered characteristics were subject to statistic treatments (variance analysis, matrix of correlations). The rainfall (ANRH, 1993) and the altitude of the natural habitat have been considered (Table 1).

Table 1. Ecological characteristics of the original environment of twenty natural populations of *H. coronarium* in Algeria (Source: Issolah *et al.,* 2006 completed; Issolah and Khalfallah, 2007)

Population number	Origin	Altitude (m)	Rainfall (mm)
03/98	Bejaia	3	900
04/98	Bejaia	3	800
05/98	Bejaia	12	800
06/98	Bejaia	250	800
07/98	Bejaia	650	900
08/98	Setif	740	564
09/98	Setif	765	564
13/98	Setif	1030	600
14/98	Skikda	10	622
15/98	Guelma	980	600
16/98	Guelma	120	700
18/98	Guelma	250	800
20/98	Guelma	400	558
21/98	Guelma	400	600
22/98	Guelma	500	600
23/98	Guelma	1060	600
24/98	Skikda	270	600
25/98	Souk Ahras	680	800
26/98	Souk Ahras	840	700
27/98	Souk Ahras	480	700

Results and discussion

The populations turned to be interesting in terms of vegetative development attained by the species in the first year of the growth (Table 2). During the second year, the vegetative development

is more important, particularly the width (recovering of soil) which attains 256 cm for certain populations (Table 3). This would be explained by the different types of stand (erected, prostrate) observed in the populations of *H. coronarium*.

Table 2. Results of analysis of variance within twenty Algerian populations of *H. coronarium* during the first year of growth (Source: Issolah *et al*., 2001)

Characteristics	Min*	Max*	Mean**	Standard deviation	Variation coefficient
H1 (cm)	12.50	47.75	27.96	10.68	37.92
W1 (cm)	81.03	209.25	154.90	26.37	16.43

*Min = Mean of the population.
**Mean = Mean of the species.

Table 3. Results of variance analysis within twenty Algerian populations of *H. coronarium* during the second year of growth

Characteristics	Min*	Max**	Mean***	Fobs	Prob
H2 (cm)	45	93	60.53	2.39	0.0327*
W2 (cm)	120.5	229.5	190.63	0.91	0.5814
W3 (cm)	153	256	211	1.69	0.1304
BB2 (days)	499	527	512.70	1.88	0.0888
FB2 (days)	516	534	525.45	0.89	0.5988
EB2 (days)	553	566	559.92	0.78	0.7008
FFH2 (days)	497	536	515.3	0.66	0.8171
BFH2 (days)	488	543.5	532.03	1	0.4977
FH2 (days)	502	566	556.95	1.01	0.4879

*Min = Mean of the population.
**Max = Mean of the population.
***Mean = Mean of the species.

The analysis of variance indicates that one variable (H2) is significant at the second year of growth within *H. coronarium* (Table 3). Relations are established between some phenological characteristics and two ecological factors of the environment of origin (altitude and raifall). The populations coming from higher altitude areas show the weakest development in height (H1). The populations coming from relatively most watered areas are characterized by an early end of the bloom and full formation of fruiting heads (Table 4).

Table 4. Relations of some phenological characteristics with ecological factors of the originating environment in *H. coronarium* (Source: Issolah *et al*., 2001)

Charact. Ecol. factors	H1	W1	BB1	FB1	EB1	DB	FFH1	BFH1	FH1
Altitude	-0.452*	-0.291	-0.080	-0.017	0.197	0.021	0.147	0.145	0.061
Rainfall	0.113	0.072	-0.078	-0.078	-0.480*	-0.349	-0.296	-0.258	-0.548**

d.f. = 18
Significance = * 5%; **1%.

In Italy, Sarno *et al*. (1978) have also shown the influence of high elevation on the diversification of morphological types within *H. coronarium*. In Algeria, Abdelguerfi (2001) indicated that in *Hedysarum*

coronarium, the stand type and the development of the orthotropic axis seem to be influenced by high elevation (Abdelguerfi, 2001).

According to Issolah and Khalfallah (2007), the Algerian populations which present the highest thousand seed weight are originating from the high altitude areas. An interesting study conducted on fourteen Algerian populations showed that the altitude would be the most important ecological factor for its influence on the morpho-physiological variation within *H. coronarium* (Issolah and Khalfallah, 2007). The principal component analysis highlights the existence of great morpho-physiological variation between the populations coming from the same area, particularly from Setif in *Hedysarum coronarium* (Issolah and Khalfallah, 2007).

A previous cytogenetic study conducted on some Algerian populations of *H. coronarium* revealed a chromosomic variation (n = x = 8 and n = x = 9) which was noticed for the first time in this species (Issolah *et al*., 2006). Through the length of the chromosomes and the diversity of heterochromatic bands, the Algerian populations would be richer in heterochromatin than Italian ones (Issolah *et al*., 2006). The environment of the origin of the populations would have an influence on the distribution of the heterochromatin in *Hedysarum coronarium* (Issolah *et al*., 2006).

Conclusions

This study shows the variation existing within several Algerian populations of *Hedysarum coronarium*. Relations seem to exist between some phenological characteristics and certain factors (altitude, rainfall) of the environment of origin of the populations. More investigations must be done to understand the nature of variation within and between several natural populations of *H. coronarium* originating from different areas of the mediterranean basin. Because of its economical and environmental interest, this fodder legume should be valorized and developed, particularly in the isolated and disinherited areas, where it could adapt itself bringing those advantages.

References

Abdelguerfi, A. (2001). *Ressources génétiques d'intérêt pastoral et/ou fourrager: Distribution et variabilité chez les légumineuses spontanées* (Medicago, Trifolium, Scorpiurus, Hedysarum *et* Onobrychis*) en Algérie.* Thèse Doc. D'Etat, Institut National Agronomique, Alger.

ANRH, (1993). *Cartes pluviométriques de l'Algérie du Nord*. *Moyennes annuelles ramenées à la période 1922/1960 – 1969/1989. Echelle 1/500 000*. Cartes dressées par l'ANRH avec la collaboration scientifique de Jean – Pierre Laborde (U.R.A 1476 DU CNRS).

Benguedouar, A., Corich, V., Giacomini, A., Squartini A. and Nuti, M.P. (1997). Characterisation of symbiotic bacteria from the Mediterranean legume crop *Hedysarum coronarium* (sulla) by multilocus enzyme electrophoresis. *Agr. Med*., 127: 173-177.

Douglas, G.B. (1984). Seed production of sulla. A plant for soil conservation. *Proc. of the New Zealand Grassland Association*, 45: 239-242.

Issolah, R., Benhizia, H. and Khalfallah, N. (2006). Karyotype Variation within Some Natural Populations of Sulla (*Hedysarum coronarium* L., Fabaceae) in Algeria. *Genet. Res. and Crop Evol*., 53, 8: 1653-1664.

Issolah, R. and Khalfallah, N. (2007). Analysis of the morpho-physiological variation within some Algerian populations of Sulla (*Hedysarum coronarium* L.; Fabaceae). *J. Biol. Sciences.,* 7(7): 1082-1091.

Issolah, R., Yahiaoui, S., Beloued, A., Kerkouche, R., Makhlouf, A., Kherraz, R., Terki, N., Mansour, B. and Hamdaoui, A. (2001). Comportement de vingt populations spontanées de sulla (*Hedysarum coronarium* L.) en Algérie. *Actes des 3ème journées de l'INRAA*, Bejaia (Tunisia), 2001, INRAA (ed), pp. 209-222.

Sarno, R., Stringi, L. and D'Alessandro, F. (1978). Relazione tra il comportamente morfobiologico e produttivo e la quota di provenienza di alcune popolazioni di sulla (*Hedysarum coronarium* L.). *Quaderni di Agronomia*, 9: 141-167.