Seed Production and Germination of the Endangered Species *Astragalus gines-lopezii*

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Introduction

Astragalus gines-lopezii Talavera *et al.* (*Fabaceae*) is an endemic species from southwest Spain with a very limited area of distribution. There are only two known populations of this species, totaling less than 1000 individuals. This species was included on the Red List of Threatened Spanish Vascular Flora in 2008 in the category Endangered (EN) (Moreno 2008). The restricted area of distribution, limited number of individuals and their population structure could represent a high risk for survival of this species. Therefore, in order to detect potential threats, we have studied some key aspects of its reproductive biology. Fructification success and seed production were evaluated, and morphological and physiological seed variability were also studied.

Methods

From each one of the two known populations of *A. gines-lopezii*, 50 individuals were randomly selected. For each plant, both the number of inflorescences and the number of flowers were recorded and then ripe fruits were collected and the number of ripe seeds per fruit was counted. For each population, the length, width and weight of seeds belonging to different individuals were determined. Seeds belonging to different individuals to be used for germination kept separately. To study the germination response of each population, seeds of several individuals per population were bulked. In all germination trials, seeds were incubated at alternating temperatures of 25/15ºC under a 16/8 h light/dark photoperiod. Mechanical scarification by sandpaper was used as presowing treatment applied for enhancing seed germination.

Results and Conclusions

The average number of inflorescences and flowers per individual was 8.5 and 34, respectively. Plants converted the 42% of flowers into fruit and the mean number of ripe seeds per fruit was 12. For each population, great variability in seed weight, length and width were found among seeds belonging to different individuals (intrapopulation variability; Table 1). However, no significant differences were found between mean morphometric features of the two populations (interpopulation variability; Table 1). The germination percentages of control seeds (unscarified) ranged from 0% to 80% depending on the individual plant and the germination mean values of the two populations were 22% and 60% (Table 2). For each population, the scarified seeds reached higher final germination percentages (from 60 to 100%) and the mean values were very similar (97% and 99%) (Table 2). Therefore, as occurs in many *Fabaceae* taxa (see e.g. Baskin and Baskin 1998), the hard and impermeable seed coat seems to be the cause of the physical dormancy present in *A. gines-lopezii* seeds. Under natural conditions, the progressive erosion of the seed coat allows germination of the seeds of this species gradually. This species produces seeds with different degrees of physical dormancy and the degree of dormancy varies among individuals. Therefore, seeds are released from dormancy at different times and germinate intermittently over a determinate period. In conclusion, *A. gines-lopezii* seeds present a great intrapopulation morphological variablity as well as a high intra and interpopulation physiological variability. These results highlight that the source (origin) of seed samples should always be taken into account when defining models of germination behaviour, especially in wild species with a high degree of morphological and physiological variability. The results obtained in this study will be used in the development of a conservation programme for this species.

References

Baskin CC and Baskin JM (1998) *Seed. Ecology, biogeography, and evolution of dormancy and germination*. Academic Press, San Diego, USA.

Moreno JC, coord. (2008) *Lista Roja 2008 de la flora vascular española*. Dirección General de Medio Natural y Política Forestal (Ministerio de Medio Ambiente, y Medio Rural y Marino, y Sociedad Española de Biología de la Conservación de Plantas), Madrid, Spain.

Table 1. Length, width and weight of *A. gines-lopezii* seeds belonging to different individuals of the two populations (A and B). For each parameter, mean values followed by the same letter are not significantly different ($P>0.05$).

Population and number of individual plant	Seed length ± SE (mm) (n = 10)	Seed width ± SE (mm) (n = 10)	Ratio of length to width ± SE	Seed weight ± SE (mg) (n = 2)
A1	2.88 ± 0.12	2.08 ± 0.07	1.40 ± 0.07	7.15 ± 0.00
A2	2.67 ± 0.05	2.18 ± 0.11	1.29 ± 0.06	7.67 ± 0.19
A3	2.76 ± 0.07	2.23 ± 0.05	1.22 ± 0.03	7.32 ± 0.00
A4	3.27 ± 0.08	2.52 ± 0.05	1.31 ± 0.05	8.50 ± 0.52
A5	3.25 ± 0.10	2.58 ± 0.08	1.27 ± 0.05	9.64 ± 0.00
A6	3.19 ± 0.10	2.39 ± 0.06	1.34 ± 0.05	8.27 ± 0.05
A7	2.95 ± 0.08	2.26 ± 0.08	1.31 ± 0.04	—
A8	2.80 ± 0.05	2.26 ± 0.08	1.26 ± 0.06	—
A9	2.91 ± 0.07	2.42 ± 0.05	1.21 ± 0.04	8.23 ± 0.24
A10	3.00 ± 0.09	2.30 ± 0.09	1.32 ± 0.06	7.99 ± 0.04
A11	3.15 ± 0.05	2.63 ± 0.07	1.21 ± 0.05	9.54 ± 0.36
A12	3.26 ± 0.07	2.51 ± 0.04	1.30 ± 0.04	10.47 ± 0.18
A13	3.16 ± 0.14	2.40 ± 0.09	1.32 ± 0.05	---
A14	3.12 ± 0.14	2.32 ± 0.08	1.42 ± 0.08	9.18 ± 0.00
A15	3.22 ± 0.11	2.40 ± 0.04	1.35 ± 0.05	8.35 ± 0.16
A16	2.93 ± 0.08	2.41 ± 0.06	1.22 ± 0.05	6.83 ± 0.00
A17	3.05 ± 0.10	2.51 ± 0.07	1.23 ± 0.06	8.54 ± 0.00
A18	2.95 ± 0.07	2.38 ± 0.08	1.25 ± 0.06	7.98 ± 0.04
A19	2.95 ± 0.06	2.38 ± 0.06	1.25 ± 0.04	7.86 ± 0.07
A20	3.28 ± 0.12	2.51 ± 0.09	1.32 ± 0.06	8.20 ± 0.02
A21	3.11 ± 0.07	2.49 ± 0.08	1.26 ± 0.06	9.56 ± 0.10
A22	2.90 ± 0.07	2.28 ± 0.06	1.28 ± 0.04	7.39 ± 0.17
A23	3.07 ± 0.10	2.52 ± 0.09	1.23 ± 0.07	8.48 ± 0.26
A24	3.04 ± 0.07	2.44 ± 0.06	1.26 ± 0.05	8.84 ± 0.30
P	<0.000	<0.000	0.456	<0.000
Mean values of the population A	3.036 ± 0.003 a	2.392 ± 0.027 a	1.284 ± 0.011 a	8.380 ± 0.195 a
B1	3.05 ± 0.07	2.46 ± 0.06	1.25 ± 0.06	8.78 ± 0.14
B2	2.85 ± 0.06	2.52 ± 0.04	1.14 ± 0.03	7.38 ± 0.39
B3	3.36 ± 0.17	2.62 ± 0.07	1.28 ± 0.06	9.79 ± 0.27
B4	3.20 ± 0.07	2.30 ± 0.06	1.40 ± 0.04	9.15 ± 0.01
B5	3.32 ± 0.15	2.33 ± 0.05	1.44 ± 0.10	7.53 ± 0.04
B6	2.83 ± 0.08	2.24 ± 0.08	1.22 ± 0.07	7.08 ± 0.17
B7	3.39 ± 0.09	2.51 ± 0.04	1.35 ± 0.04	---
B8	3.11 ± 0.09	2.39 ± 0.08	1.31 ± 0.04	7.32 ± 0.28
B9	2.91 ± 0.09	2.39 ± 0.07	1.22 ± 0.05	8.20 ± 0.07
B10	2.85 ± 0.08	2.36 ± 0.07	1.22 ± 0.05	7.80 ± 0.08
P	<0.000	0.036	0.011	<0.000
Mean values of the population B	3.089 ± 0.067 a	2.412 ± 0.003 a	1.283 ± 0.028 a	8.114 ± 0.294 a

Table 2. Final germination percentages of untreated seeds (control) and mechanically scarified seeds from the two *A. gines-lopezii* populations (A and B). Results after 35 days of incubation at 25/15°C under a 16-h light photoperiod. Mean values followed by different letters within columns are significantly different ($P<0.05$).

Population	Germination (% ± SE)		S[1]
	Control	Mechanical scarification	
A	60 ± 3.16 b	97 ± 1.66 a	***
B	22 ± 2.24 a	99 ± 0.87 a	***

ANOVE table	df	MS	F	*P*
Treatment (T)	1	8362.19	249.98	<0.000
Population (P)	1	355.51	10.63	0.007
T x P	1	732.78	21.91	0.001
Error	12	33.45		

[1] S, significance level: ***$P<0.001$