

Photosynthetic photon flux density during seed development of narrowleaf birdsfoot trefoil (*Lotus glaber*) influences seed production and subsequent dormancy and germination

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Introduction

Lotus glaber grows from spring to autumn and flowers from November to March. Plants of *Lotus glaber* are generally less vigorous than alfalfa and red clover and stands may be lost due to competition from other companion species and weeds with a similar growth cycle (Chevrette *et al.*, 1960) due to a strong competition for mineral nutrients, water and light, specially.

It is known that growth habit of *Lotus glaber* shoots is influenced by photosynthetic photon flux density in addition to sucrose and endogenous levels of gibberellins A1 and photosynthetic photon flux density during flowering and ripening of pods in seeds production and subsequent dormancy and germination.

In order to *Lotus glaber* quality forage, it is important, in a ecophysiological point of view, the study of several factors that conditioning *Lotus glaber* competition with weeds and others companion species in permanent pastures, with the purpose of enhance its productivity, being one of this mentioned factors the persistence capacity on vegetable communities trough natural reseeding.

The objective of this study was to test the hypothesis that the light environment during seed development and maturation affects seeds production and degree of hard-seededness in *Lotus glaber* by changing seed coat properties, conditioning water uptake through seed coat, and subsequently affecting dormancy, germination and speed of germination.

Materials and methods

Seeds of *Lotus glaber* obtained from a naturalized population of Saladillo, Buenos Aires Province, were disinfected with Ca hypochlorite, washed thoroughly and sown in 250 cc pots filled with culture soil. Pots were placed under natural conditions in the field and

watered daily. One plant per pot was selected 30 days after sowing and transplanted to 4 kg pots filled with same substrate 60 days after sowing.

Twenty plants were used for each treatment in a complete randomized experimental design. The trial was initiated at the beginning of flowering and treatments imposed consisted of *Lotus glaber* plants with different artificial shade conditions simulating natural shade, previously measured in a permanent pasture of *Lotus glaber*, shading by others companion species. Treatments were: (a) full sunlight (FS; 2400 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ photosynthetic photon flux density or PPF; R:FR ratio = 1.2); (b) artificial shade with 70 % of full sunlight reduction (AS 70; 720 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ PPF) and (c) artificial shade with 50 % of full sunlight reduction (AS 50; 1200 $\mu\text{mol}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ PPF). Shadow was obtained by covering the plants with 4 and 2 layers of commercial grey plastic net for AS 70 and AS 50 treatments, respectively, which diminished irradiance by ca 70% and 50%, respectively, but did not change the spectral quality (R:FR ratio = 1.2). These irradiance levels were maintained constants during all trial.

During all flowering period pods of plants were manually collected at complete pod ripening before the spontaneous dehiscence of them, determining for each treatment number of total pods, number of pods per plant, number of total seeds, number of seeds per pod and 1,000 seeds weight.

Immediately after harvest, seeds were stored in the dark in natural conditions of pressure, temperature and relative humidity. Treatments were evaluated for germination at 21° C in darkness in batches of 200 seeds per Petri dish every month for 12 months, starting from 1 May 2005, to determine changes in dormancy through time. The number of imbibed, non-imbibed and germinated seeds was recorded every 24 hours for 15 days and the accumulated rate was calculated. Final germination rate, estimated according to Pollock and Roos (1972), was evaluated after 150 days. Speed of germination was expressed as the time elapsed (h) since the beginning of the test until half of the final germination rate was reached (T_{50}). The imbibed seeds were recognized by their greater volume and bright teguments, and seed was considered germinated when radicle length reached 2 mm. The design was a complete randomized block experiment with 4 replicates.

Data were analyzed statistically by ANOVA and differences between means were tested for significance using the least significance difference test according to Snedecor and Cochran (1980).

Results

Artificial shade treatments, AS 50 y AS 70 showed a significant reduction of total pods, with a 9.8% and 8.5%, respectively, of FS treatment values for number of total pods. Likewise FS treatment showed a significantly higher number of pods per plant compared with artificial shade treatments, without significant differences between them. In consequence, treatments showed differences for number of total seeds and number of seeds per pod too. Shade treatments, AS 50 and AS 70 showed 5.8% and 5.4%, respectively, of number of total seeds compared with FS treatment (Table 1).

FS treatment showed a significantly higher number of seeds per pod compared with both AS 50 and AS 70 which did not show significant differences between them. 1000 seeds weight was significantly smaller for AS treatments comparing with FS treatment though without differences between them (Table 1).

Table 1. Number of total pods, number of pods per plant, number of total seeds, number of seeds per pod and 1000 seeds weight (g) of *Lotus glaber* plants subjected to Full sunlight (FS) and Artificial shade treatments, (AS 50 and AS 70).

Treatment	N° total pods	N° pods/ Plant	N° total seeds	N° seeds/pod	1000 seeds weight
FS	1121 a	56.0 a	11990 a	10.7 a	1.0614 a
AS 50	110 b	5.50 b	698 b	6.6 b	0.9671 b
AS 70	95 b	4.75 b	647 b	6.8 b	0.9669 b

(*) values with different letters within the same column are significantly different (P>0.05)

FS treatment seeds had a significantly greater germination rate compared with AS 50 and AS 70, without differences between them. The FS treatment seeds germinated faster than the AS 50 and AS 70 treatments seeds, without differences between them (Table 2).

Table 2. Germination rate (%) and average speed of germination (T₅₀, hours for a germination rate of 0.50) for *Lotus glaber* seeds harvested from plants subjected to Full sunlight (FS) and Artificial shade treatments (AS 50 and AS 70).

Treatment	Germination rate (%)	Average speed of germination
FS	27.5 a	65.6 b
AS 50	10.1 b	76.8 a
AS 70	9.8 b	81.2 a

(*) values with different letters within the same column are significantly different (P>0.05)

Discussion

Photosynthetic photon flux density variations can produce several effects as photosynthetic rate modifications and photomorphogenical changes. In first phloem photoassimilates translocation capacity can be diminished and affects sugars partition among sinks as flowers and fruits during reproductive stages.

Respect to photomorphogenical changes, they are consequence of non tolerant shade plants strategies with the purpose of avoiding shade environments with low irradiances rates. Low photosynthetic photon flux density induced an ortotropic growth of *Lotus glaber* shoots with

an enhanced of internodes and shoots length and a higher whole plant height with a significant reduction of shoot base growth. The changes that modify plant architecture consist on plants with less and longer shoots (Clúa *et. al.*, 1996).

Increment of cell elongation and architectural plant changes imply sucrose consumption for vegetative growth, reducing carbohydrates translocation resources for important sinks as flowers and pods during reproductive stages (Clúa *et. al.*, 1996). In consequence, the number of pods, number and seeds rates germination can be affected by a combination of two effects: reduction of shoots and carbohydrates resources.

The present results showed a strong incidence of light environment over *Lotus glaber* seeds production and germination and consequently its persistence in a permanent pasture. This persistence can be drastically affected by a low natural seed production, compromising natural reseeding and future plants stands in high light competition conditions between *Lotus glaber* and companion species.

In conclusion, the presents results show that *Lotus glaber* light competition responses are very important for its management, for to obtain a successful competition trough sowing density, fertilization, frequency and height of grazing, companion species election, etc., with the purpose to reach an optimal plant stands, in natural and artificial pastures.

References.

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