

# THE AGRONOMIC POTENTIAL OF A NEW SWEET, NARROW-LEAFED LUPIN CULTIVAR FOR CULTIVATION IN PORTUGAL

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## ABSTRACT

The purpose of this research was to compare the adaptability and seed yield of a new narrow-leaved lupin cultivar 'Giribita' with six commercial Portuguese and Australian cultivars by measuring crop phenology, growth and seed yield, on a haplic podzol soil in Portugal. 'Giribita' is an F<sub>10</sub> derived line from a recurrent selection breeding program with the following selection criteria: high seed yield, seed sweetness, soft seed, non-shattering pods and indeterminate growth habit. The comparative study was performed at the Experimental Agriculture Centre of Pegões, located in the Centre-south of Portugal, under Mediterranean rain-fed conditions, in October 2005 to May 2006, the autumn to spring growing season. The field experiment was a randomised complete block design with 3 replicates. The results indicate that 'Giribita' has good agronomic potential as a new commercial lupin cultivar and as a pulse crop.

## KEYWORDS

*Lupinus angustifolius*, seed yield, germplasm utilisation, domestication, adaptability

## INTRODUCTION

Lupin germplasm biodiversity in the Mediterranean basin and North and Central Africa is an important resource for the development of new crop varieties. Narrow-leaved lupin (*Lupinus angustifolius* L.) grows naturally, mainly in the coastal areas of the countries around the Mediterranean basin, but also in the Iberian Peninsula and North Africa and extends inland to about 1,500 metres altitude (Gladstones, 1974). Since 1980, joint germplasm collecting missions sponsored by our institute, mainly in the Iberian Peninsula, have collected species of the genus *Lupinus* but also other genera. In Portugal, a great wealth of *L. angustifolius* L. germplasm has been collected from a wide range of ecological areas and habitats, extending from northeast, centre, interior centre, southeast and southwest to south coastal regions of the country's mainland (Mota *et al.* 1980, 1981, 1982, 1983).

Lupin cropping is an important means of encouraging biodiversity rich pastures in marginal areas of South, Centre, and Southeast of Portugal. Genetic enhancement and breeding programs have been carried out in our institute for lupin germplasm domestication, in order to breed low alkaloid, non-shattering, soft-seeded genotypes to obtain new varieties and new crops for sustainable agricultural systems (Marques de Almeida 1943, Rebelo *et al.* 1994, Campos Andrada *et al.* 1994, 1999).

Narrow-leaved lupin variety 'Giribita' is obtained from an ancestral cross (PRT81A-50A x 'Danja') made in EAN, Oeiras, Portugal in 1986. Selection criteria of the subsequent recurrent breeding program were increased seed yield, low grain alkaloid levels and adaptation to Mediterranean environmental rainfed conditions.

Agronomic traits and grain quality evaluation were reported in a previously published study (Campos Andrada *et al.* 2007). The variety was submitted for registration to the National Catalogue of Varieties in October 2006 and is currently undergoing the variety assessment scheme trials for 'Distinctness, Uniformity and Stability' and 'Value Cultivation and Use' in the national testing network, over two years.

In order to further assess the agronomic potential and behaviour of 'Giribita', seed yield, 1000 seed weight and phenology of six most commonly used varieties from a range of Portuguese and Australian sweet varieties representing white, yellow and, narrow-leaved lupin, were assessed in a field experiment in a Mediterranean-type rainfed environment in the Centre of Portugal.

## MATERIALS AND METHODS

*L. angustifolius* 'Giribita' was compared with six commonly used sweet lupin cultivars bred in Portugal and Western Australia, namely *L. albus* 'Estoril', two *L. luteus* 'Acos' and 'Wodjil' and three *L. angustifolius* 'Tallerack', 'Tanjil' and 'Wonga'. Australian cultivars were obtained from the Department of Agriculture and Food, Western Australia (DAFWA). Portuguese

cultivars were multiplied for seed production at Pegões, Portugal, during the growing season of autumn 2004 to spring 2005.

The origin and distinguishing characteristics of each cultivar is listed in Table 1. Because of the limited seed availability of the imported cultivars, the experiment was carried out at a single site in Centre of Portugal at Setúbal District Agriculture Centre, located at Pegões, (latitude 38° 40' N, longitude 8° 37' W), at an altitude 93 m above sea-level. The climate of the area is characterised as Mediterranean moderate, with a cold winter and very irregular monthly rainfall (October-May). The trial was sown in 31 October 2005 and harvested in May 2006. The soil was a haplic podzol soil with pH<sub>(H<sub>2</sub>O)</sub> 5.1 (0-10 cm depth). The site was previously under a cereal pasture and was fertilised before sowing with 300 kg ha<sup>-1</sup> of calcium superphosphate and 200 kg ha<sup>-1</sup> of potassium chloride. Plots were hand-sown and were 1 m wide (4 rows, 0.25 m apart) and 5 m long with a density of 20 plants/m<sup>2</sup>. Plots were arranged in a randomised complete block design with 3 replications. 2 t ha<sup>-1</sup> of Bladex (500 g a.i./L of cyanazine) pre-sowing was used to manage weeds. A border was used to protect the trial against rabbits. Chlorpyrifos and lindane (1500 g + 800 g ha<sup>-1</sup>), were incorporated into soil before sowing to control soil-borne insects. Snails and field slugs were controlled when necessary with granular baits based on methiocarb. The site was visited twice per week during flowering, pod setting and ripening. All plots were scored for start of flowering (when 50% of all plants within a plot had at least one flower opened in the main inflorescence) and flower colour. Maturity was recorded when all pods were a golden colour. Harvested seed was dried, cleaned, riddled and sieved to sort seeds according to their shape and size, and a representative sample retained for further testing. Seed was weighed and yield per plot was expressed as a percentage of the yield of the nearest narrow-leafed cultivar control 'Tanjil'. Seed yield and 1000 seed weight were statistically analysed using SPSS 16.0 for Windows (Release 16.0.1; Nov 15, 2007). Means were compared using Duncan's Multiple Rang test after one-way ANOVA.

## RESULTS AND DISCUSSION

Generally speaking, climatic conditions were typical for Mediterranean regions. However, in autumn and winter, minimum monthly temperature values were below the decade average (Fig. 1), and April and May hotter. Rainfall during the growing season was 580.4 mm, lower than the decade average of 601.3 mm (Fig. 1). The monthly rainfall distribution varied considerably from the beginning of growth with heavy rainfall (166.6 mm) in October and no rainfall in May. Monthly average temperatures during podding period were above decade average temperature and water deficit occurred, especially in spring, with only 23.5 mm in April.

Mean temperature; temperature of coldest and warmest month; total rainfall and rainfall during the driest and the wettest month during the growing season at the experimental site were used to create distribution maps, identifying where similar climatic conditions occur, and where 'Girigita' shows high adaptability and agronomic potential (Fig. 2). Flower colour, seed yield (% of 'Tanjil') and first flowering time and maturity time are listed in Table 1. In general Portuguese cultivars were later flowering and maturing than Australia's cultivars. 'Giribita' was slightly later flowering than yellow lupin 'Acos'. White lupin 'Estoril' was latest maturing. Of the Australian cultivars, narrow-leafed lupin 'Tallerack' was the earliest flowering, and yellow lupin 'Wodjil' was the earliest maturing. 'Estoril', 'Girigita' and 'Acos' all produced more seed than 'Tanjil', by up to 58%. Mean seed yield ranged from 2469 kg ha<sup>-1</sup> for white lupin 'Estoril' to 1350 kg ha<sup>-1</sup> for narrow-leafed lupin 'Tallerack'. Mean 1000 seed weight ranged from 373.35 g for white lupine 'Estoril' to 108.49 g for narrow-leafed lupin 'Tanjil'. When only narrow-leafed and yellow lupins were considered, the highest mean seed yield (115% control) and the highest mean 1000 seed weight (142.65 g) were for 'Giribita', higher than yellow lupin 'Acos' (108% and 137.75 g respectively). This indicates that 'Giribita' has good agronomic potential as a pulse crop in environments subject to terminal drought, such as occur in the marginal areas of South, Centre, and Southeast of Portugal.

Improvements in management practices as well as development of genotypes with earlier flowering and ripening are needed to further increase seed yield.

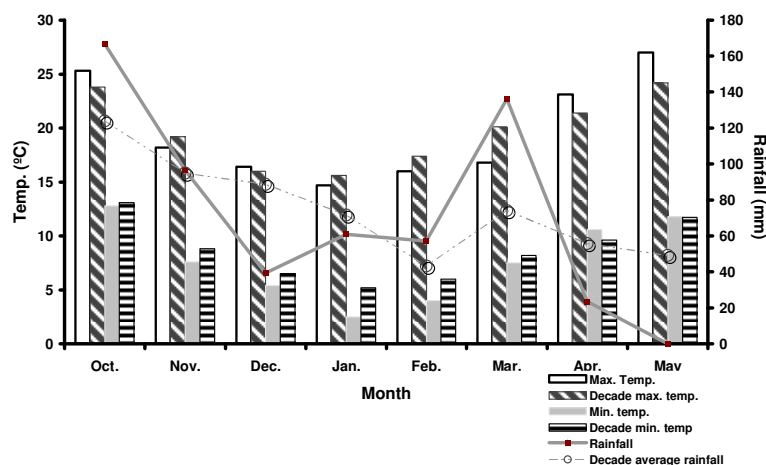
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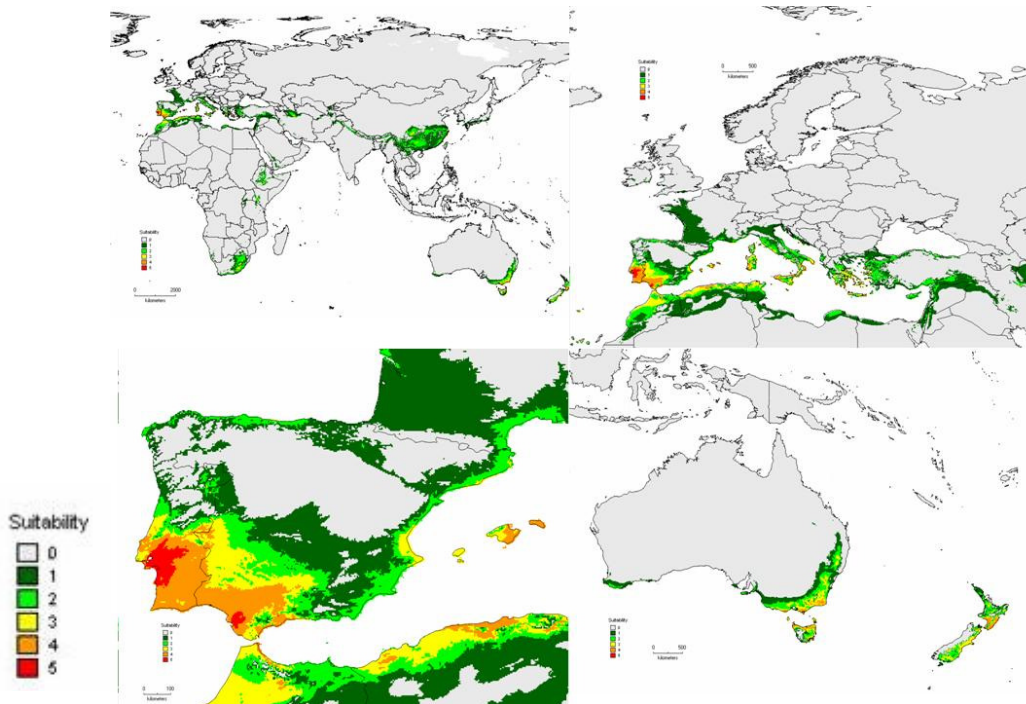
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**Fig. 1.** Monthly average, minimum and maximum temperatures and rainfall distribution, 580.4 mm of rainfall, October 2005-May 2006, Pegões (Portugal, 38° 40'N, 8° 37'W, 93m) and comparison with decade values (601.3 mm average rainfall).



**Fig. 2.** Geographical suitability of the narrow-leaved lupin cultivar 'Giribita'.

**Table 1.** Distinctive characteristics, flower morphology, seed yield (% of 'Tanjil'), time of flowering and time of maturity of narrow-leaved lupin 'Giribita' compared to six commonly used lupin cultivars.

Lupin cultivar	Cultivar identification	Flower colour	Seed yield % of Tanjil	Flowering time <sup>(*)</sup> (DAS)	Maturity time <sup>(*)</sup> (DAS)
<b>Estoril<sup>(1)</sup></b>	Portuguese white lupin released in 1990, adapted to neutral moderate acid soil.	White/slightly blue with age.	158	131.2 (± 3.62)	205.5 (± 5.31)
<b>Acos<sup>(2)</sup></b>	Portuguese yellow lupin released in 1996, adapted to very acid sandy soil and dryness.	Yellow standard <i>and</i> wing.	108	134.4 (± 2.54)	197.0 (± 2.92)
<b>Wodjil<sup>(2)</sup></b>	Rapid maturity yellow lupin cultivar from Australia released in 1996, adapted to very acid soils.	Pale lemon.	92	127.3 (± 1.51)	183.9 (± 1.64)
<b>Giribita<sup>(3)</sup></b>	Portuguese narrow-leaved lupin cultivar registered in 2006, adapted to acid sandy soil and dry conditions.	White/standard <i>and</i> wings slightly purple with age	115	135.4 (± 2.83)	197.8 (± 2.71)
<b>Tallerack<sup>(3)</sup></b>	Restricted branching narrow-leaved lupin cultivar from Australia released in 1998.	Blue/white, wings develops purple with age.	87	125.5 (± 3.56)	188.2 (± 1.94)
<b>Tanjil<sup>(3)</sup></b>	Anthraxnose narrow-leaved lupin cultivar from Australia released in 1997.	Blue/white at opening, wing develops purple with age; older flower on secondary raceme with wing & standard turn purple.	100	128.4 (± 2.87)	187.4 (± 2.34)
<b>Wonga<sup>(3)</sup></b>	Lodging and <i>Phomopsis</i> resistance narrow-leaved lupin cultivar from Australia released in 1997.	Blue/white at opening, wing develops purple with age; purple wing in older flower on secondary raceme.	95	129.1 (± 1.89)	187.9 (± 2.14)

<sup>(\*)</sup> Mean ± standard error in Days After Sowing (DAS); <sup>(1)</sup>*L. albus*, <sup>(2)</sup>*L. luteus*, <sup>(3)</sup>*L. angustifolius*.

**Table 2.** Mean seed yield and 1000 seed weight of narrow-leafed lupin 'Giribita' compared to six commonly used lupin cultivars.

Species/Origin	Cultivar	Seed yield (kg/ha <sup>-1</sup> )	1000 Seed weight (g)
<i>L. albus</i> from Portugal	'Estoril'	2469a	373.35 a
<i>L. luteus</i> from Portugal	'Acos'	1678 bc	137.75 c
<i>L. luteus</i> from Western Australia	'Wodjil'	1430 de	129.25 d
<i>L. angustifolius</i> from Portugal	'Giribita'	1798 b	142.65 b
<i>L. angustifolius</i> from Western Australia	'Tallerack'	1350 e	115.83 e
	'Tanjil'	1559 cd	108.49 g
	'Wonga'	1482 de	113.11 f

Means followed by the same letter are not significantly different at P = 0.05.