LUPINUS x *HISPANICOLUTEUS* – AN INTERSPECIFIC HYBRID OF OLD WORLD LUPINS

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ABSTRACT

Lupinus species are distributed in two centers of origin: in the Old and New World. In the Old World, 13 lupin species have been recognized hitherto in the Mediterranean basin (mostly with different chromosome numbers and not out-crossing in situ), including three lupin crops, i.e. *L. albus*, *L. angustifolius* and *L. luteus*. Interspecific crossing within this group is interesting from the theoretical as well as practical point of view – for breeding improvement.

Results of crossing of two Old World *Lupinus* species are presented: *L. hispanicus* subsp. *hispanicus* x *L. luteus*. Description and a diagnosis of the synthetic, stable hybrid is presented. The standard and wings from bud to open flower are yellow-violet to violet. The inflorescence is yellow-violet at the top, changing gradually to violet bottom when older. Plant habitus and smooth seed surface as in *L. luteus*. Dark green colour of leaves, not scented flowers and angular edge of compressed seeds as in *L. hispanicus*. The name *L. x hispanicoluteus* is proposed.

KEY WORDS: wide crosses, interspecific hybrid, lupin, *Lupinus x hispanicoluteus*, Old World.

INTRODUCTION

For the genus *Lupinus* two centers of origin and secondary distribution have been accepted: the Mediterranean basin and Africa (the Old World) and the American continents (the New World). In the Old World 13 species have been recognized (Gladstones 1974; Świecicki et al. 1996). The newest among them – *L. anatolicus*, found during a research expedition to south-west Turkey, was distinguished not only on the basis of classical characters but also using biochemical and molecular methods (Przybylska & Przybylska 1995; Świecicki et al. 1996). Old World lupin species differ in many characters, usually including chromosome number and other strong barriers, often making natural out-crossing impossible (Carstairs et al. 1992).

Three crops belong to Old World lupins, i.e. *L. albus* L., *L. angustifolius* L. and *L. luteus* L. N-fixation, high protein content in green mass and seeds as well as adaptation to different soils make lupins important in practical utilisation as green manure, food and animal feed and as an ornamental plant. In their breeding improvement different methods are used, also wide crossing as a source of new variation.

In original research, trials to combine *L. hispanicus* Boiss. and Reut. and *L. luteus* L. genomes were undertaken. Specific distinction between the two taxa is justified on the basis of present genetic and morphological evidence although they are closely related (Gladstones 1974, 1998). Both species are dis-

tributed mainly in the Iberian Peninsula (partly covering the same areas) and have the same chromosome number ($2n = 52$). They differ in flower colour and scent, leaf colour and hairiness, seed shape and tuberculation of seed coat [*L. luteus* (Fig. 1D): flowers – yellow, scented, leaflets light green, hairy, seeds compressed, rounded, seed coat smooth; *L. hispanicus* (Fig. 1A and B): flower light cream to lilac/violet, non-scented, leaflets dark green, glabrous on upper surface, seeds compressed, angular, seed coat tuberculate]. On the basis of differences in distribution ranges, flower colour, growth habit, seed size and colour, *L. hispanicus* is divided into two subspecies: *hispanicus* (Fig. 1B) and *bicolor* (Merino) Gladst. (syn. *L. rothmaleri* Klink) (Fig. 1A). The second one seems to be more close to *L. luteus* (Gladstones 1974, 1998).

L. luteus from the agricultural point of view is distinguished by a high protein content in seeds (about 45%) and low soil requirements but also a relatively low and unstable seed yield. It seems that some characters of *L. hispanicus* (resistance to waterlogging, cold and diseases) could be used for *L. luteus* improvement.

MATERIAL AND METHODS

Parental lines for crosses were selected from the Polish *Lupinus* Gene Bank at Wiatrowo (Świecicki et al. 1984). They represent the following taxa:

Fig. 1. Plants of *L. hispanicus* subsp. *bicolor* (A), *L. hispanicus* subsp. *hispanicus* (B), *L. x hispanicoluteus* (C) and *L. luteus* (D) (W.K. Święcicki).

- *L. hispanicus* subsp. *hispanicus*: catalogue number in the gene bank – Wt 96 383, line name – Badajoz 2,
- *L. luteus*: a high-alkaloid population – Wt 96 839 and two low-alkaloid cultivars – cv. Topaz, Wt 98 066 and cv. Ventus, Wt 98 067.

The following crossings were conducted:

- [1] – *L. hispanicus* subsp. *hispanicus* x *L. luteus*,
- [2] – F₁ [1] x (*L. luteus* x *L. hispanicus* subsp. *hispanicus*),
- [3] – F₁ [1] x *L. luteus*,
- [4] – (F₁ [1] x *L. luteus*) x (*L. luteus*).

Based on the holotype of hybrid plants, the diagnosis of a new taxon was elaborated. The herbarium specimen is deposited at the Department of Plant Taxonomy, Institute of Biology, A. Mickiewicz University, Poznań, Poland.

For pollen viability estimation microscopic preparations were made using the acetocarmin method.

RESULTS AND DISCUSSION

Crossings of *L. luteus* x *L. hispanicus* have already been described in literature (Kazimierski & Kazimierska 1965, 1982; Maysuryan & Atabyekova 1974). A high degree of difficulties was experienced depending on crossing direction, and the obtained hybrid plants were similar to one of the parents in most characters. The combination *L. luteus* x *L. hispanicus* is easy technically and a fertile offspring can be obtained. Hybrid plants are very similar to *L. luteus*. The hybrid origin is revealed by some seed characters and a high alkaloid content, as in *L. hispanicus*. The offspring was obtained also from a reciprocal cross *L. hispanicus* x *L. luteus* but only when subsp. *bicolor* was used, with much sterility in the hybrids (Kazimierski & Kazimierska 1965; Gladstones 1974). F₂ hybrid plants were similar to one or the other parental species.

In the original work *L. hispanicus* subsp. *hispanicus* x *L. luteus* [1] were crossed because no successful experimental crossings between these taxa have been reported so far (Gladstones 1974, 1998). Hybrid seeds were obtained. F₁ plants developed correctly – with plant habitus similar to *L. luteus* and an outstanding, mixed flower colour – but were sterile. The same was observed by Jambrina and Crespo (1982). Similarly Kazimierski & Kazimierska (1982) reported F₁ sterility after crossing the two taxa. Fertile hybrid plants were obtained only after more complex crosses [2-4], always when F₁ plants of the [1] combination were used as a mother. They were presented for the first time at the forum of the International Lupin Association (Święcicki 1984). No influence of the genotype of the second parental species was observed (in the crosses two low-alkaloid cvs. Ventus and Topaz and a high-alkaloid line were used). Among the segregating plants of the F₂ generation, recombinations of characters of parental species were found, e.g. for flower colour, shape and size of seeds as well as plant habitus. What is characteristic for wide crossings, no correct Mendelian segregation was found. An additional reason could be the small number of plants in segregating F₂ generations.

The most outstanding hybrid plants, with characters of both parents, were selected from the [2] combination followed by [3] and [4]. The most characteristic in comparison to parental species was the flower colour – as if a mixture of yellow (*L. luteus*) with violet (*L. hispanicus* subsp. *hispanicus*). The developed inflorescence has violet colour at the bottom, gradually turning yellow at the top (Fig. 1C). The

Fig. 2. Pollen grains of *L. x hispanicoluteus* (B. Naganowska).

plant habit and smooth seed coat is similar to *L. luteus*, whereas not scented flowers, dark green leaflet colour and angular seed edge is like *L. hispanicus*. Seed size and colour vary. From each cross combination [2, 3, 4] one plant was selected from which three lines were multiplied:

- from the [2] cross combination – line Wt 98301 (seeds large, beige-brown),
- from the [3] cross combination – line Wt 98 302 (seeds small, white with a brown sickle),
- from the [4] cross combination – line Wt 98 306 (seeds small, white).

An analysis of pollen viability showed that these lines are fully fertile (Fig. 2).

An additional confirmation of the hybrid nature of the above-mentioned lines are results of an analysis of isozymic variation (Wolko & Święcicki 1988). For example, their electrophoretic phenotypes for LAP, ACP, PRX and EST are different from both parental species (Fig. 3). For ME and MDH systems they are identical to *L. hispanicus* subsp. *hispanicus*.

The above data show that a synthetic, stable, interspecific lupin hybrid was obtained for which the name *Lupinus x hispanicoluteus* is proposed.

Fig. 3. The ACP-electrophoretic phenotypes of *L. x hispanicoluteus* in comparison to parental *L. hispanicus* subsp. *hispanicus* and *L. luteus*.

Lupinus x hispanicoluteus W. Świącicki & W.K. Świącicki sp. hybrida nova

Flores juveniles luteo-violacei, flores deflorescentes violacei. Plantarum habitus et testa leavis *Lupini lutei*. Folia astro-iridia et seminum margo acutus *Lupini hispanici*.

Annual, up to 40 cm high. Stems and petioles scarcely pilose. Hairs white, about 0.5-1 mm long. Stipules linear, ca. 15 x 3 mm. Leaflets 9-11, oblanceolate, light green, pilose on both sides, hairs on the lower surface longer. Inflorescence racemose on a fairly long peduncle. Pedicels half as long as calyx. Flowers not scented, verticillate, medium large 10 x 16 mm. Upper lip distinctly 2-partite, lower lip entire. Standard and wings yellow in bud stage, violet when opened and older. Keel pointed, light yellow with a brown tip. Pods pilose 5.0-6.6 x 0.8-1.0 cm, with 4-6 seeds. Seeds from small to large, somewhat flattened, angular, 5-11 x 4-10 x 3-5 mm, beige-brown, white, white with a brown sickle, marbled. Seed coat smooth.

Holotypus: Plant Breeding Station, Wiatrowo, Poland, August 1997. W. Świącicki. Plants obtained from F₄ hybrid generation seeds. Deposited at the Herbarium, Dept. of Plant Taxonomy, Institute of Biology, A. Mickiewicz University, Al. Niepodległości 14, 61-713 Poznań, Poland (POZ).

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LUPINUS X HISPANICOLUTEUS

– MIESZANIEC MIĘDZYGATUNKOWY ŁUBINÓW STAREGO ŚWIATA

STRESZCZENIE

Gatunki z rodzaju *Lupinus* występują w dwu centrach pochodzenia: w Starym i Nowym Świecie. W Starym Świecie, w basenie Morza Śródziemnego rozpoznano dotychczas 13 gatunków (w większości o różnej liczbie chromosomów i niekrzyżujące się w stanie naturalnym) w tym 3 gatunki uprawne, tj. *L. albus*, *L. angustifolius* i *L. luteus*. Krzyżowanie międzygatunkowe w tej grupie jest interesujące nie tylko z teoretycznego, ale także praktycznego punktu widzenia – dla hodowlanego ulepszania.

W pracy przedstawiono wyniki krzyżowań dwu gatunków Starego Świata z rodzaju *Lupinus*: *L. hispanicus* subsp. *hispanicus* x *L. luteus*. Przedstawiono opis i diagnozę syntetycznego, ustabilizowanego mieszańca. Żagielek i skrzydełka od stadium pąka do otwartego kwiatu są żółto-fioletowe do fioletowych. Kwiatostan ma barwę żółto-fioletową u góry, stopniowo przechodzącą w miarę starzenia w fioletową u dołu. Pokrój roślin i gładka okrywa nasion jak u *L. luteus*. Ciemnozielona barwa liści i ostra krawędź spłaszczonego nasion oraz niepachnące kwiaty jak u *L. hispanicus*. Zaproponowano nazwę *L. x hispanicoluteus*.

SŁOWA KLUCZOWE: krzyżowania oddalone, *Lupinus x hispanicoluteus*, łubin, mieszaniec międzygatunkowy, Stary Świat.