Tenth International Lupin Conference

Wild and Cultivated Lupins from the Tropics to the Poles

Laugarvatn, Iceland

19–24 June 2002

10th International Lupin Conference

Wild and Cultivated Lupins from the Tropics to the Poles

19 – 24 June 2002
Laugarvatn, Iceland

Organizing committee

Dr. Borgþór Magnússon, Chairman – *Icelandic Institute of Natural History*
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Conference organizer

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Editor Program and Abstract book

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Sponsors

The organizers wish to acknowledge:

The International Lupin Association
Ministry of Agriculture, Iceland
Agricultural Research Institute
Iceland Forest Service
Soil Conservation Service
Icelandic Institute of Natural History

for sponsorship of the 10th International Lupin Conference.

10th International Lupin Conference

Wild and Cultivated Lupins from the Tropics to the Poles

Program

Wednesday, June 19, 2002

		Arrival in Iceland
18.00		Bus tour to Laugarvatn
19.30		Dinner
20.30		Registration and welcoming Reception

Thursday, June 20, 2002

08.00 – 09.00	Registration	
09.00 – 09.15	B. Magnússon, Chairman of organizing committee	Conference opening
	Th. Tómasson, Director Agricultural Research Institute	Welcome address

Session 1: Ecology, land rehabilitation, plant introductions

Chairman: A. Arnalds

09.15 - 10.00	R. del Moral (invited speaker)	How *Lupinus lepidus* affects primary succession on Mount St. Helens
10.00 - 10.45	E. Fremstad (invited speaker)	Perennial lupins in Fennoscandia
10.45 – 11.15	COFFEE	
11.15 – 12.00	A. Pickart (invited speaker)	Ecological impacts of non-native lupin introduction in California, USA
12.00 – 12.30	B. Magnússon	Plant succession in areas colonized by introduced Nootka lupin in Iceland
12.30 – 13.00	Á.L. Aradóttir	Does introduced Nootka lupin facilitate or impede colonization and growth of native birch in Iceland?
13.00 – 14.00	LUNCH	

Session 2: Plant protection

Chairman: E. von Baer

14.00 – 14.30	P. Talhinhas	Molecular, morphologic and pathogenic diversity of lupin anthracnose pathogen, *Colletotrichum acutatum*
14.30 – 15.00	P. Römer	Control of anthracnose (*Colletotrichum spp.*) in white lupins (*Lupinus albus*) in organic farming systems
15.00 – 15.30	O. Golovchenko	The new forms of white lupin resistant to *Colletotrichum gloeosporoides*
15.30 – 16.00	COFFEE	
16.00 – 19.00		**Poster session 1**
19.00 – 20.30	DINNER	
20.30 -	**Workshop I**	Anthracnose – revisited (organized by: J. Neves-Martins)
20.30 -	**Workshop II**	Lupin products, uses and users (organized by: Tom Acamovic)

Friday, June 21, 2002

Field trip

08.30	Departure from Laugarvatn
20.00	Dinner at Laugarvatn

Saturday, June 22, 2002

Session 3: N-fixation and roots

Chairman: J.L. Christiansen

08.30 – 09.15	J.I. Sprent (invited speaker)	*Lupinus*: diversity of nutrient acquisition systems
09.15 – 10.00	K.R. Skene (invited speaker)	Evolution and physiology of cluster roots in the genus *Lupinus*
10.00 – 10.30	C. Vance	Genomic analysis of proteiod root formation in white lupin
10.30 – 11.00	COFFEE	

Session 4: Genetics and breeding

Chairman: P. Römer

11.00 – 11.30	B. Jørnsgaard	Adaptation of lupins for maritime Northern European growing conditions
11.30 – 12.00	E. Sawicka-Sienkiewicz	Genetic studies of Andean lupin
12.00 – 12.30	J.C. Clements	Research on proportion of seed hull and pod wall for lupin improvement
12.30 – 14.00	LUNCH	

Session 5: Biochemistry and physiology

Chairman: J. Neves-Martins

14.00 – 14.30	C. Atkins	Regulation of podset and seed development in lupin
14.30 – 15.00	T. Rogers	Approaches to marker analysis in white lupin (*Lupinus albus* L.)
15.00 – 15.30	F. Santana	Biodegradation of Lupanine by soil bacterial isolates: kinetics and intermediate metabolites
15.30 – 16.00	COFFEE	
16.00 – 17.00		**ILA General Assembly**
17.00 – 19.00		**Poster Session 2**
19.00 – 20.30	DINNER	
20.30 -	**Workshop III**	Molecular breeding (organized by: P. Caligari)
20.30 -	**Workshop IV**	N-fixation and roots (organized by: J. I. Sprent & K.R.Skene)

Sunday, June 23, 2002

Session 6: Agronomy

Chairman: Á. Helgadóttir

08.30 – 09.00	G.D. Hill	The effect of narrow-leaf lupin incorporation on soil physical and chemical properties compared with other grain legumes and barley
09.00 – 09.30	T. Eckardt	Importance of growth habit, sowing time and sowing density of *Lupinus angustifolius* in conventional and organic farming systems
09.30 – 10.00	J. Palta	Genotypic response in lupin to terminal drought
10.00 – 10.30	G.J. Dean	The effect of planting density on yield and seed size of bitter albus lupins.
10.30 – 11.00	COFFEE	

Session 7: Animal and human nutrition

Chairman: G.D. Hill

11.00 – 11.30	E. von Baer	Requirement of lupin protein as salmon food
11.30 – 12.00	T. Acamovic	Nutritional studies of lupins for poultry
12.00 – 12.30	A. Scarafoni	Lupin seeds as a source of nutraceuticals
12.30 – 13.00	D.A. Roth-Meier	Blue and yellow lupin seeds in the feeding of pigs
13.00 – 14.00	LUNCH	
14.00 – 15.30	Á. Helgadóttir	**Summary round table** and conference closure
15.30 – 16.00	COFFEE	
16.00 – 19.00		**A short field trip to Gullfoss and Geysir**
20.00 -		Conference Dinner

Monday, June 24, 2002

05.00	Early morning departure direct to Keflavik Airport
09.00 -	Check out and departure to Reykjavik

Poster Presentations

Ecology, land rehabilitation, plant introductions PS-1 Room 1

First author	Title
Arnalds, A.	The role of Nootka lupine (*Lupinus nootkatensis*) for revegetaton in Iceland
Friend, A.P.	Seed recruitment and loss of Russell lupin in a Canterbury Riverbed
Óskarsson, H.	Effects of fertilization on tree seedling establishment and growth in a lupin field in southern Iceland
Riege, D.R.	The use of *Lupinus nootkatensis* in a revegetation and afforestation program in Southwest Iceland.
Santa-Cruz, E.	Distribution and abundance of *Lupinus stipulatus* J. Agardh (Leguminosae) at Nevado De Colima, Jalisco, Mexico
Sigurdardóttir, H.	Earthworm activity in a lupin patch in Heidmörk, Southern Iceland
Sigurdsson, B.D.	Seed ecology of Nootka lupine (*Lupinus nootkatensis*) in Iceland
Svavarsdóttir, K.	Distribution dynamics of exotic Nootka lupin (*Lupinus nootkatensis*) on a braided river plain in Skaftafell National Park, Iceland

N-fixation and roots PS-1 Room 1

First author	Title
Merbach, W.	Influence of P-deficiency on white lupin N_2 fixation
Pálmason, F.	Symbiotic nitrogen fixation estimated by use of 15N dilution method in annual blue lupin and perennial Nootka lupin in Iceland
Sator, C.	Impact of nitrogen and sulphur nutrition on the N-fixation potential of lupins

Biochemistry and physiology PS-1 Room 2

First author	Title
Adhikari, K.	Extending photoperiod and increasing illuminance hastens flowering of narrow-leafed lupin (*Lupinus angustifolius* L.)
Benítez Martínez, S.	Optimization of the expression of a *Lupinus campestris* conglutin gamma gene fragment rich in essential aminoacids
Christiansen, J. L.	Vernalization and day length control of flowering in narrow leafed lupin
Gulewicz, K.	Biological activity of alpha galactosides from lupin seeds
Gutte, R.	Characterisation of the fibre-rich fraction of *Lupinus amiga* L.; functional properties and polysaccharide structure

Lagunes, L.	Diallele analysis of pod wall proportion
Louro Martins, L.	Effect of different forms of nitrogen supply on the protein content and mineral composition of lupin leaves
Obermayer, R.	Variation of nuclear DNA content in *Lupinus luteus*, its wild progenitor *L. hispanicus* and the hybrid *L. x hispanicoluteus*
Piotrowicz-Cieślak, A.	Occurrence of galactosyl cyclitols in *Lupinus elegans* seeds
Santa Cruz R, M.E.	Micropropagation and regeneration of *Lupinus stipulatus* J. Agardh (Leguminosae)
Sánchez, M.C	Changes of alkaloids during germination of lupin seeds

Agronomy PS-1 Corridor

First author	Title
Alami, I.T.	Collection of the *Lupinus* genus in Morocco
Ayaz, S.	Harvest index stability in narrow-leafed lupin compared with other grain legumes
Björnsson, H.	Yield potential of the Nootka lupin
Fausto, G. S.	Cultivation of *Pleurotus* spp. on *Lupinus montanus* and *Lupinus rotundiflorus* stubble
Fort, J.L.	Development of the white lupin crop in Poitou-Charentes (France)
Frick, C.	Grain yields of white and narrow-leafed lupins (*Lupinus albus, Lupinus angustifolius*) in Switzerland and Southern-Germany
Gataulina, G.	Photosynthetic Characteristics and Seed Yield Of Lupin Species and Cultivars Under Conditions Of Moscow Region
Harzic, N.	Dwarf autumn-sown white lupin: present status and future prospects in France
Helgadottir, A.	Annual lupins grown for green fodder in Iceland
Hill, G.D.	The effect of water stress and nitrogen on the nodulation and dry matter partitioning of *Lupinus angustifolius* compared with *Pisum sativum*
Kitessa, S.M.	The acceptability and harvestable yield of Russell lupins for sheep
Prine, G.M.	Why so little lupin is grown in Florida at the beginning of the 21st century
Saiko, V.	The lines and prospects of white sweet lupin breeding in the Ukraine
Zubetz, M. V.	Evaluation of lupine energy-saving role in today land management and its cultivation future in connection with ecological, feed and nutritional protein problems

Plant protection — PS-2 Room 2

First author	Title
Frencel, Irena M.	Lessons of seven years' experience and investigations on *Lupin anthracnose* in Poland
García, A.A.	Inhibition in the *Fusarium* growth by a new Lupania Thionoanáloge, (+)-2-Thionosparteine and (+) Lupanine
Kuptsov, N.	Greenhouse screening for fusarium wilt resistance in lupin
Ruiz-Moreno, J.J.	Insectistatic activity of *Lupinus* spp. (Fabaceae) aqueous extract against fall armyworm *Spodoptera frugiperda* (Lepidoptera: Noctuidae)
Valente, A.	Evaluation of lupin germplasm to anthracnose resistance
Zamora, N.J.F.	In vitro antifungal activity of *Lupinus montanus* extract and lupanine on *Fusarium oxysporum* f.sp *melonis*

Genetics and breeding — PS-2 Room 3

First author	Title
Campos-Andrada, M.P.	DSC analysis as a tool to evaluate lupine breeding lines and their ancestral progenitors
Clements, J.C.	A high chlorophyll genotype in *Lupinus angustifolius* L.
Fartushnjak, A.	Result of lupin breeding in Ukraine
Galek, R.	Evaluation of different lupin species in low Silesia region of Poland in regard with some morphological characters
Gataulina, G.	Breeding Of *Lupinus albus* Cultivars with Different Plant Architecture and Characteristics of their Development Pattern as a Photosynthetic System
Golovchenko, O.	The nature of some morphological characters inheritance in the white lupin
Harcha, C.	Genotypic and environmental effects on pod walls of cultivars and breeding lines of *Lupinus angustifolius*
Huyghe,C.	RILS in white lupin *(Lupinus albus* L.)
Joernsgaard, B.	Genetic control of flower color in *L. angustifolius*
Kuptsov, N.	Non- allelic gene recombination and its use in the breeding of *Lupinus angustifolius*
Kurlovich, B.	Possibility of selection and cultivation of narrow-leafed lupin in Finland
Lema Marquez, M.	Evaluation of natural lupin populations from the northwest of Iberian Peninsula
Papineau,J.	Variation in pod wall proportion during pod development at different inflorescence levels

Talhinhas, Pedro	Inter- and intra-specific genetic diversity in *Lupinus* evaluated with AFLP, ISSR and RAPD markers
Vishnyakova, M.	Strategy of preservation of world Lupin genofond in Vavilov institute of plant industry
von Baer, Erik	Potential of the crossing *L. polyphyllus* x *L. mutabilis*

Animal and human nutrition — PS-2 — Corridor

First author	Title
Adomas, B.	The characteristic of protein quality in yellow lupin seeds treated different desiccants
Bogdanov, G.	Technological aspects of efficient use of lupine grain and products of its complex processing on the basis of profound evaluation of their nutritional characteristic
Bunger, A.	Development and sensory evaluation of cakes and pastry filling with lupin protein isolate
Castañeda S.J.	Protein Quality Evaluation of four Mexican Wild Lupins
Cowieson, A.J.	The effects of enzyme supplementation and lupin cultivar on the performance and endogenous losses of broiler chicks
Cowieson, A.J.	The digestibility of amino acids in *Lupinus albus* seeds grown in the UK, for poultry
Cowieson, A.J.	The effects of enzyme supplementation on the nutritional value of lupins seeds, grown in the UK, for broiler chicks
Dávila Ortíz, Gloria	Evaluation of debittered for aqueous, acid and alkaline thermal treatment and protein quality of *Lupinus campestris* seeds
Fychan, R.	Evaluation of two narrow-leafed lupin varieties for silage and grain production
Haddad, Joseph	Impact of the controlled instantaneous pressure drop (DIC) on lupin quality
Haddad, Joseph	Effect of the controlled instantaneous pressure drop (DIC) on lupin alkaloids
Hauksdóttir, H.	Variation in seed size, seed coat proportion and protein content in *L. angustifolius*
Isaac V.L.,	Feeding trial in pigs and broilers used *Lupinus albus* seeds cultivated in Mexico
Kadlec, P.	a-Galactooligosaccharides, starch and proteins changes in germinating lupin seeds
Kochapakdee, S.	Evaluation of white lupin (*Lupinus albus* L.), temperate corn (*Zea mays* L.), tropical corn (*Zea mays* L.), or hybrid pearl millet (*Pennisetum glaucum* [L] R. BR.) silage for lactating cows

Kurlovich, B.	Breeding of fodder perennial forms of multifoliate lupin (*Lupinus polyphyllus* Lindl.)
Medina, E.	Functional properties of protein isolates from two mexican lupin species and their enzymatic modification
Mohamed, A.	Thermal and Rheological Properties of *Lupinus albus* Flour Meal
Roth-Maier, D.A.	Blue and Yellow Lupin Seed (*Lupinus angustifolius* L. and *Lupinus luteus* L.) in the Feeding of Broiler Chicks
Roth-Maier, D.A.	Nutritional Values of Blue Lupin (*Lupinus angustifolius* L.) and Yellow Lupin (*Lupinus luteus* L.) for Ruminants
Sator, Christine	Influence of sulfur nutrition on yield and dietary quality of lupin seeds
Sator, Christine	May lupins be used as feed after growth on cadmium contaminated soils?
Wittic de Penna, E.	Development of lupin food products for the elderly
Wróblewska, M.	Influence of extracts of oligosaccharides from pea and lupin seeds on caecal fermentation and nitrogen excretion patterns in rats

Abstracts submitted with presentation to be arranged

First author	Title
Ageeva, P.	Genotype diversity of collection of narrow-leaved lupin breeding lines
Anokina, V.	The Action of Genetic Systems of Nucleus and Cytoplasm on the Features Phenotypic Manifistation of Lupins Plants
Cruz de Carvalho, M.H.	Dehydrins in water stressed lupin
Domash, V.	Proteolytic enzymes and their inhibitors in various lupine species growing in Belarus
Francisco, R.M.B.	How does UV radiation affect lupin intercellular proteins?
Golodna A.V.,	The peculiarities of determinant and semideterminat white Lupin cultivation in Ukraine
Kandelinskaya, O.	*Lupinus angustifolius*: growthregulating and adapting action of 24-epybrassinolide
Kononov, A.	Nitrogen-Fixing Activity of Nodule and Nitrobacteria Microorganisms´ in Lupin and Grass Agro-Coenosis
Kononov, A.	Intercropping as a productive approach to stability increase of lupin seed yield
Kononov, A.	Herbicides in lupin cultivation
Kuptsov, N.	Periodic system of narrow-leafed lupine taxons and its using in ecological breeding
Kuptsov, V.	Evaluation of antifungal activity of bacteria-antagonists towards lupine pathogens
Lukashevich, M.	*Lupinus albus* breeding objectives in Russia
Mironova, T.	Possibilities of non-traditional using of alkalioidness in the breeding on narrow-leafed lupine (*Lupinus angustifolius* L.)
Mujica Sanchez, A.	Andean lupin (*Lupinus mutabilis* Sweet.) – forty years research in Peru
Noffsinger, S.L.	Why do determinate types of *Lupinus albus* L. yield less than indeterminate types in the Southeastern USA
Pinheiro, C.	Lupin stem proteins involved in drought responses
Perissé, P.	Determination of water pathway during imbibition in two lupin species
Planchuelo, A.M.	Potential uses of wild lupins as ornamental and garden plants

Podleśny, J.	The effect of seeds laser biostimulation of white lupine (*Lupinus albus* L.) growth in differentiated temperature conditions
Ravelo, A.C.	Agroecological zoning for crop production of white lupin (*Lupinus albus* L.) in Argentina
Shutov, G.	Main problems of ILA
Timoshenko, M.	Using of the Gametophit Selection in the Estimation of the Lupines Resistance to *Fusarium* sp.
van Santen, E.	Evaluation of the NPGS *Lupinus* germplasm collection for resistance to *Colletotrichum*
van Santen, E.	Indirect effects of selection for grain yield in *Lupinus albus* L. in the Southeastern USA
van Santen, E.	The value of *Lupinus albus* L. cv. AU Homer as a winter cover crop for cotton
van Santen, E.	Development of *Lupinus albus* L. forage cultivars for the Southeastern USA
Vilarino, M.P.	Tolerance to herbivory in *Lupinus angustifolius* was not related to alkaloid concentration
Vilarino, M.P.	Inductive responses in white lupin (*Lupinus albus* L.) submitted to defoliation were greater in a sweet variety
Yagovenko, T.	Legumes tripcine inhibitors effect on activity of *C. gloesporioides* extracellular proteases

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10th International Lupin Conference

Abstracts

(in alphabetical order of first author)

An update on the nutritive value of lupin seeds for poultry.

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Ground lupin seeds are potentially nutritionally valuable as a protein source in the diets of pigs and poultry. This is increasingly important in poultry diets where there is escalating public concern about the use of soyabean meal that cannot be guaranteed as genetically 'normal', as well as the controversy associated with the use of meat and bone meal. These polemics are particularly acute in Europe where the use of meat and bone meal in farmed animal diets has been banned since 1996 and some major producers and retailers of poultry avoid the use and sale of genetically modified dietary ingredients. Historically, lupin seeds have been regarded as containing high concentrations (>200 mg kg^{-1}) of quinolizidine alkaloids that are toxic and may cause reduced feed intake by conferring a bitter taste to the diet. However, modern low-alkaloid cultivars produce seeds that are essentially non-toxic and are generally nutritious. The major compounds present in lupin seeds that reduce their nutritive value are the non-starch polysaccharides (NSPs), refactory and antigenic proteins, and also the relatively low concentration of sulphur amino acids within the protein. However, many of these adverse attributes are present in other leguminous seeds, thus lupin seeds need not be considered as being particularly unique in this respect. The major antinutritional components of lupin seeds are the carbohydrates. These are essentially devoid of starch and consist mainly of NSPs such as galactomannans and cellulose that poultry cannot digest. These compounds strongly influence the transit of feed, the transfer of nutrients and also the microflora and the morphology of the gastro intestinal tract. They also influence water intake and reduce the quality of the litter. One of the major factors that can ameliorate the adverse effects of the NSPs is the inclusion of exogenous enzymes in poultry diets that contain lupin seeds. This paper will review aspects of the above where lupin seeds have considerable potential in diets for poultry.

Extending photoperiod and increasing illuminance hastens flowering of narrow-leafed lupin (*Lupinus angustifolius* L.)

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Narrow-leafed lupin (*Lupinus angustifolius* L.) is now established as one of Australia's most important grain crops and is the focus of an active breeding programme. The breeding process in this species is limited by generation time, particularly in early generations. This study examined whether flowering in narrow-leafed lupin could be hastened by extension of the photoperiod, using a range of levels of illuminance. Genotypes with a range of natural flowering times were grown with and without extension of the photoperiod to 16 or 20 h in a phytotron, and in a field experiment in which photoperiod extension to 20 h was applied along a gradient of illuminance, the maximum value of which (30 μmole/m^2/sec) did not provide an effective level of photosynthetically active radiation. Late flowering genotypes were generally more responsive to extended photoperiod, flowering up to 16 days earlier, whereas early-flowering genotypes flowered only 1-3 days earlier. Extension of photoperiod substituted for part of the plant's vernalisation requirement, and vernalised plants flowered earlier when exposed to extended photoperiod. There was also high sensitivity to illuminance, indicating that narrow-leafed lupin has a high saturation level of illuminance for photoperiod responses as compared to other crop species.

The characteristic of protein quality in yellow lupin seeds treated different desiccants

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Field experiment with yellow lupin cultivars i.e. Markiz and Teo was conducted in 1999 at the vicinity of Olsztyn, Poland.

The aim of the research work was to determine the effect of desiccants used with adjuvant on the notritiouseness of yellow lupin seeds protein.
The following desiccants were used at 30 day after lupin flowering:

1. Roundup Ultra 360 SL (glyphosate) at dose of 3.0 dm^3 ha^{-1} – as desiccant
2. Roundup Ultra 360 SL (glyphosate) at dose of 3.0 dm^3 ha^{-1} in mixture with Trend 90 EC (isodecyl alcohol) at dose of 1.5 dm^3 ha^1 – as an adjuvant
3. Reglone Turbo (diquat) at dose of 2.0 dm^3 ha^{-1} - desiccant

The content of total protein in seeds from untreated plots was not dependent on lupin variety. These values were 43.61% for Teo cultivar and 43.27% for Markiz. It was found that all applied desiccants irrespective of used adjuvant didn't modificate results obtained. The share of amino acids was not differed under effect of pesticides too. The lowest value among them, i.e. 0.97g/16gN was obtained in the case of methionine. Essential Aminoacid Index was 69.65 for Teo cultivar and 67.95 for Markiz. Chemical Score Mitchel & Block was 48.7 and 48.1 respectively.

Analyses of the results showed a lack of differentiation in protein and amino acids content under effect of applied desiccants and adjuvant.

Genotype diversity of collection narrow-leafed lupin breeding lines

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Narrow-leafed lupin (L. angustifolius) is notable for ecotype diversity. It allows its cultivation in zones with extreme different soil and climatic conditions. During the last years narrow-leafed lupin gene bank has been enriched significantly due to breeding work. Collection is genotypic diverse on morphotypes, alkaloid and protein content level, vegetation period duration, 1 000 seeds weight, plant height, attraction ability, micro-assignment coefficient and on other characters. The last mentioned characters are less studied in the case of narrow-leafed lupin. The fulfilled analyses show their significant diversity. Attraction ability index (AI) varies from 1.2 to 2.6. The varieties Ladny and Snezhet have the highest one (2.6 and 2.4 respectively). Pods and seeds weight is two times higher in comparison to stem weight of vars. Bryansky 1299, Pershatsvet and Uzkolistny 42. Micro-assignment coefficient (MC) varies from 1.4 to 2.9. Vars. Bryansky L-3, Attractive, Bryansky 883 and Aschadny have high level of micro-assignment.

New sources of high protein content in seeds are studied in the collection. These sources have stable high indexes (39–40%) in years with contrast weather conditions. The most valuable among them are Vb-Rz-Bsur448 and FL-Vb-362. Their protein content level varies from 39.9 to 41.9%. This index of the standard var. Crystal is 36.0 – 36.3%.

Var. Perschatsvet has the same alkaloid level of 0.02–0.030% both under usual climate conditions and under stress situation. Low seed alkaloid level is typical for new varieties Svetanik, Raduzhny, Uzkolistny 89 and Yaroslavna.

Narrow-leafed lupin plants differ on their morphotypes and plant height. The total stem height is 35.2 – 121.5 cm. Spike type var. Ladny k-2648 has the lowest index and the new breeding line 714-00 has the highest one. Var. Crystal k-3589 as well as vars. Bryansky L-3 k-2887, Mutant 1 k-2803, Danko k-2949, Mitan, Snezhet and Vonga belong to the group with middle plant height. Vars. Dikar k-374, Belozerny 110 k-3634 and Lad 88 have the total plant height more than 80cm.

Using different genotype collection material allows develop initial breeding material with recombinant characters.

Collection of the Lupinus genus in Morocco

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Two collections of the *lupinus* species were carried out in Morocco in 1998 and 1999. Their purpose was to collect lupin seed samples and to document collection sites and grain uses within the framework of preserving Morrocos genetics resources. Indeed, the overgrazing and the long periods of drought induced the decline of numerous landraces and of spontaneous populations.

We collected spontaneous populations and traditionally cultivated species : yellow lupin (*L. luteus*), blue lupin (*L. angustifolius*) and white lupin (*L.albus*). On each site, soil sample was collected to assess pH and isolate *Bradyrhizobium* strains. We bought seeds on traditional Moroccos markets to assess the use of foreign sweet varietes

In 1998 we prospected the rainfall Intermediary Atlantic area. Twenty-six samples of soils were taken (pH ranging between 4.2 and 7.9) and 44 seed samples of 3 species : *L. cosentinii, L. lutéus* and *L. albus,* were collected.

In 1999 we prospected the northern zone of the country (Rif) as well as the High and the Middle Atlas. We collected 49 samples of 5 species: *L. cosentinii, L. atlanticus, L. luteus, L. angustifolius* and *L. albus*. We took 8 samples of soils covering a range of pH going from 4.9 to 7.5. The accessions were studied in Morocco and France to describe their main traits. They will be used in breeding programmes to create varieties adapted to the Moroccan pedo-climatic conditions.

The Action of Genetic Systems of Nucleus and Cytoplasm on the Features Phenotypic Manifistation of Lupins Plants

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The creation of varieties with the desired features and characteristics to a great extent depends on wether the role of nuclear and cytoplasmic cell structure in the formation of features and their phenotypic manifestation is known. However the problem of interaction of nuclear and organelle genome within higher plants is not studied sufficiantly enough and the information regarding the role of cytoplasmic systems in the manifestation of biologically important features of leguminous plants is not available.

We have studied the role of cytoplasm in the expression of nuclear genes that controle the plants breeding features of yellow and blue lupine in the series of reciprocal hybrids received from interbreeding of samples with different cytoplasms.

When analysing the first generation hybrids a number of genetic rules in the inheritance of the economically valuable features has been revealed. F1 hybrids have shown domination and superdomination, the domination effect has been mostly connected with the direction of interbreeding, although the domination extent has been specific in the relation to single interbreeding combinations. The greater extent of heterosis effect has been observed when genetically different parents have been interbred. The revealed reciprocal effect has been positive in the majority of the analysed interbreeding combinations in regard to the studied elements of plant productivity, although there has been difference in its manifestation in the relation to some features. The cytoplasm effect and its interaction with the nuclear genes has obviously been specific not only for certain interbreeding combinations but also for certain elements of plant productivity. The deviations of certain features from Mendelian splitting in the posterity of the studied hybrids have been probably connected with their genetic controle of cytoplasmic genomes. It has been experementally proved that by means of the components selection and the interbreeding direction the value of features phenotypic manifestation can be significantly changed. Consequently in the process of hybridization taking into account the plasmon and nuclear genome form characteristics it is possible to make the range of feature variations wider at the expence of new recombinations of two genetic systems and at the same time to increase the genetic variety of the cultivated lupine species.

In the result of study of inharitance nature of economically valuable features we have revealed the reciprocal effect and samples the cytoplasm of which provides the maximum features phenotypic manifestation in hybrids. We have isolated the interbreeding combinations in which the heterosis effect for studied features has been manifested. .

Does introduced Nootka lupin facilitate or impede colonization and growth of native birch in Iceland?

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Restoration of native birch (*Betula pubescens* Ehrh.) woodlands is among the long-term objectives in reclamation of severely degraded areas in Iceland. It is important to know whether introduced Nootka lupin (*Lupinus nootkatensis* Donn ex. Sims) used for reclamation is likely to facilitate or impede the colonization and growth of birch on degraded and sparsely vegetated soils. A study was initiated in 1995 to test the hypotheses that (1) the probability of birch establishment in lupin stands is affected by density of the lupin mat, which is a function of site conditions and maturity of the lupin at that particular point; and (2) birch establishment in lupin mats can be enhanced by artificially opening the lupin mats. The study was based on identical experiments at four sites representing a range of precipitation and soils that affect the growing conditions for lupin. At each site, plots were established inside mature lupin stands (L), at the stand edges (E) where the lupin density was low and on sparsely vegetated soils outside the lupin stands (O). The lupin was cut in late June–early July 1995 in half of the L and E plots at each site, and birch was seeded or planted in the plots in late autumn same year. Seedling emergence and survival of birch in seeded plots and survival and growth of planted birch seedlings were monitored for three growing seasons. Birch establishment from direct seeding was overall greater in the E-plots than in the O- and L-plots but the establishment pattern varied between sites. Direct seeding of birch in L-plots was only successful where the lupin mats were not too dense and LAI was less than 2.5. Survival of planted birch seedlings was inversely correlated to LAI and birch survival and growth was higher in cut than undisturbed L-plots. Frost heaving of birch seedlings was common on sparsely vegetated soils outside the lupin stands (O-plots), but uncommon in the L-plots, where a sward layer, mostly of litter and mosses, covered the soil. The results showed facilitation of birch establishment in open lupin stands compared to degraded soils with little vegetation cover, but severe inhibition of birch survival and growth in dense lupin stands. Their implication for reclamation is that Nootka lupin should not be used in projects aimed at restoring birch woodlands, if the site conditions favour formation of dense lupin mats.

The role of Nootka lupine (*Lupinus nootkatensis*) for revegetaton in Iceland

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The nootka lupine has an important role for reclamation of severely degraded areas in Iceland. However, Iceland has vast areas of eroded land where the lupine can potentially spread by self seeding. It therefore has to be used with care for reclamation and other purposes, especially with regard to issues of biological diversity.

Soil conservation and revegetation of eroded land is an important issue in Iceland. Since settlement of the island in 874 about 60% of the original vegetation may have been lost. Remaining vegetation is extensively degraded. About 96% of the tree cover have been lost, and poor land condition and continued soil erosion are considered to be the most severe environmental problems in Iceland. More than 37,000 km2 af the country is barren land and in addition large areas have damaged vegeation with open spots and limited plant production.

When the nootka lupine was introduced from Alaska in 1945, only about spoonful of seed was brought to Iceland, along with some root segments with nodules for carrying the rhizobia. Consequently its spread was slow during the first few decades in a new country. Around 1975 its high yield and ability to colonize damaged land in Iceland had been recognized, and research began with the objective to develop methods for using the lupine for reclamation and agriculture. In 1989 the first seed fields were harvested, and although no selection has been done with regard to seed production, the seed harvest averages about 4 tons per year.

The nitrogen fixation associated with the lupine is high, and in reclamation and the first few years of harvesting there is no fertilization by phosphorus or other nutrients. In many areas it also has a great ability to spread from established plants, even under difficult conditions. Hence, it is an economic option for establishing plant cover and increasing fertilty of eroded land, f.x. for prepare eroded land for plant production and tree planting.

The Soil conservation service uses the lupine to revegetate about 1600 hectares annually, mostly by drillseeding, at a low cost compared to traditional methods. It is used by the institute on some sites that have been fenced for protection from grazing. In addition several other sectors of society use the lupine for reclamation, mostly without documentation. As a consequense the lupine now grows in some areas where this introduced plant is undesireable, for instance in areas of biological or natural importance.

When decided to use the Nootka lupine for reclamation in Iceland it was believed that it would behave as a pioneer plant, i.e. disappear after improving growing conditions for other plants. It should not affect landscape appearance nor limit other land use options for an unacceptable length of time. Research indicated that in many areas the lupine starts disappearing and native plants invading about 20-40 years after a dense stand has developed. However, research has also shown that this is not be case under all conditions. To meet objectives such as with regard to biological diversity and nature conservation, rules for the use of lupine in Iceland are under development.

Regulation of Podset and Seed Development in Lupin

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Abortion of fertilized flowers is a significant limitation to yield potential in narrow-leafed (*Lupinus angustifolius* L.) and white lupins (*Lupinus albus* L.). In field and controlled environment conditions abortion can be reduced significantly by application of cytokinin (CK) to the base of flowers just prior to or following fertilization. If CK is applied to each flower on a raceme at anthesis 100% podset can be achieved and very low levels (0.3 nmol applied / flower) of both naturally occurring and synthetic CK (BAP) are effective. Developing florets and young fertilized ovaries within a few days of anthesis are supplied CK in both xylem and phloem. The CK delivered by translocation and which accumulate in the flowers are primarily in the form of *cis*-isomers. The proportion of *cis*-isomers remains high in flowers that are destined to abort while *trans*-isomers increase within a few days of fertilization in flowers that are destined to set pods. While these data indicate a role for *cis/trans* isomerization in determining podset we have not been able to show the inhibitory effects of *cis*-CK applied externally, nor have we been able to detect an enzyme that might catalyse the isomerization.

Despite increased podset following CK application yields are not increased and many seeds fail to fill. Increasing N supply to CK-treated lupins during reproductive development, by supplementing N_2 fixation with soil applied urea, does not enhance seed filling. Even though the N content of the vegetation is more than doubled the 'extra' N is not translocated to seeds. The site(s) that limit translocation have not been identified but appear to be at or close to the developing seed. To genetically manipulate N translocation we have cloned an asparaginase and two seed amino acid transporters from developing *L. angustifolius* seed. Constructs from these genes coupled to a seed specific promoter are being used to generate transgenic over-expression and anti-sense lines in *cv.* Merritt.

Harvest index stability in narrow-leafed lupin compared with other grain legumes

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Peas (*Pisum sativum*) and lentils (*Lens culinaris*) are common commercial grain legume crops in Canterbury, New Zealand. However, in seeking more productive and stable grain legume crops, two other species; narrow-leafed lupins (*Lupinus angustifolius*) and *desi* chickpeas (*Cicer arietinum*) which are not currently grown commercially in Canterbury and peas and lentils were grown in two successive seasons in 1998/99 and 1999/2000.

This study was an extensive analysis of the effects of plant population, sowing depth; legume species and micro-variation on the stability of yield and harvest index (HI) in the four grain legume species. The study aimed at understanding the phenomenon of high yield stability in narrow-leafed lupin compared with the other three legumes in Canterbury.

In these trials, seed yield depended on the interaction between species and plant populations, and species and sowing depth at harvest maturity. The highest potential seed yield was > 6.5 t/ha in chickpeas and narrow-leafed lupins. Yield was more stable in the latter species.

The increase in seed yield in response to increased population was a function of greater total dry matter (TDM) production, harvest index and the number of pods/m^2. Yield stability in narrow-leafed lupin was due mainly to the stability of its radiation use efficiency across plant population and sowing depth.

Potential of the crossing *L. polyphyllus* x *L. mutabilis*

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All New World lupins, distributed between Alaska and Fireland, show the same number of chromosomes. In 1990 I presented the first results (H5) of the crossing between both species (F3).

Now we have the first lines and the information about the inheritance of different properties. Dominant are for instance: spring habit, shattering, bitterness, color, etc.

The present challenge is to achieve early varieties that are sweet, have high protein (up to 50%) and/or oil (up to 25%) content, are of an appropriate grain size and justify their mass production. We would like to inform you about our achievements, but are far yet from the goal.

As expected, there is a negative correlation between protein and oil content, added to a considerable variation in carbohydrates. In order to increase the yield the selection is centered on grain size and shape. During the next season the first yield trials are expected to be made.

From the agronomic point of view this material shows an extended vegetative cycle. This aspect will be improved through crossing with determined growth mutants, but means a further delay for entering into mass production.

Requirement of Lupin Protein as Salmon Food

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Presently in a globalized world, facing problems like BSE, Foot and Mouth Disease, contamination and transgenics, not only many windows are being closed, but also others open. So it was possible for us to enter in the difficult market of salmon and trout food, replacing transgenic soy and meat flour.

During 2001 the total cost of salmon and trout food at world level was US$ 1.700 million. In Chile approximately US$ 550.000.- were sold for this purpose. The food cost represents approximately 50% of the total production cost. The average conversion rate of food into Kg of salmon is 1,4.

Chilean nutrition research on sweet lupin flour of *Lupinus albus* is carried out since 1980. Recent results allowed the inclusion of 2600 ton of lupin flour into salmon food during 2001, amount to be hopefully doubled during 2002 and to be considerably increased in the future. The present inclusion in the diet varies from 4 to 10%.

The present flour production is based mainly on the *L. albus* variety TYP TOP, which yields flour with a content of 0,02% alcaloids, 42 % protein and a significant contribution of energy and other components.

Yield potential of the Nootka lupin

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The perennial Nootka lupin (*L. nootkatensis*) can produce substantial amount of biomass without added fertilizer. However, its potential to sustain harvest over years is crucial for its use in agriculture. The sustainability of lupin fields is being investigated in two series of experiments. Natural or seeded lupin fields are not well suited for experimental purposes as the stand is usually uneven with openings in the lupin cover. Uniform experimental fields were obtained by planting pot-grown plants at 33 cm spacing. In the first series micro-plots were harvested at two weeks interval in 1999, beginning 7 July, and less frequently in 2000. The effect of cutting on the regrowth potential was found as follows: In certain plots roots were dug out at the time of harvest and in others regrowth was measured and the roots dug out in autumn or in the following year. Preliminary measurements were done on single plants in nine replicates four times in 1998 and regrowth measured in June 1999. In the other series, begun in 2000, the intention is to measure the potential for repeated harvesting at different harvest dates.

The above ground biomass is increasing untill late summer and the seasonal maximum increases with the age of the plants. The root mass increases throughout the summer and from year to year. In spring the root reserves are partly used for the initiation of new growth and the root mass is at a lower level in spring than in the previous autumn. Intact lupin plants were thus building up increasing biomass throughout the period of these experiments. The number of stems per plant is a simple measure of the effect of harvest on the lupin.

Survival was poor, 60% or less, on plots harvested 8 August or earlier. The experimental field is fertile. Grass and other herbs invade and replace the lupin. The competitive ability of the lupin is weak and more than half of the surviving plants disappeared from spring to autumn 2000 on plots harvested early in 1999.

The results confirm earlier findings that the Nootka lupin is very sensitive to early harvest. The experiments will be continued in order to evaluate the capacity of the lupin to sustain harvest over a number of years. The development of different yield qualities in the potential harvest season must be known in order to evaluate the suitability of the lupin for different industrial purposes.

Technological aspects of efficient use of lupine grain and products of its complex processing on the basis of profound evaluation of their nutritional characteristic

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Expanding of lupine areas in Ukraine is accompanied by working out of technologies for complex processing of lupine grain for its more efficient utilization in modern animal feeding systems and for food purposes. It is envisaged to obtain food protein products: non-fat flour, protein concentrates, lupine oil, as well as various feeds. Recipes of new foods with lupine additives – concentrates, cakes, pasta, sweets – were developed.

Through establishing biochemical parameters in special studies there were determined criteria for evaluation of nutritional values of lupine grain and its products, or its preparation for feeding as an additional source of protein, essential amino acids, energy, fat, individual fatty acids, and bioactive substances. Carried out experiments have proven the methods of lupine's efficient use for feeding of animals with the strictest requirements to full-value nutrition: broiler chickens, calves, lambs while intensive growing on milk substitutes, pregnant and suckling sows). There were developed and approved recipes for compound feeds, feed additives and milk substitutes with natural, hulled and extruded Lupinus albus and L luteus, technologies of their production and usage guidelines.

There are given results of biological evaluation and veterinary-sanitary expertise of animal products obtained from livestock raised on lupine feeds.

Development and sensory evaluation of cakes and pastry filling with lupin protein isolate

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The aim of this study was the development of individual cakes and pastry filling with lupin protein isolate (LPI). Optimisation was carried out according to an experimental design based on response surface methodology (RSM), choosing as response variable a texture profile analysis (hardness, cohesiveness, adhesiveness, springiness). Targets for both products were texture of market products without replacement. LPI was used to substitute milk protein in commercial pastry filling and to substitute egg protein in yellow cakes.

The pastry filling was optimised with 1.53% carrageenan and 2% LPI, with additional 50% substitution of sucrose by a sweetener blend aspartame/acesulfameK. The cake was optimised with 2.8% LPI and 7% mono- and diglycerides, with total replacement of egg by LPI.

Both developed products, as well as commercial cakes and pastry fillings available in Chile, were assessed by descriptive sensory analysis with a trained panel. The LPI pastry filling showed higher adhesiveness and yellow colour intensity than the market products, and the LPI cake presented high denseness and adhesiveness compared with market cakes. Acceptability of the products with LPI, conducted with 50 consumers, showed high acceptance, similar to market products available in Chile.

DSC analysis as a tool to evaluate lupine breeding lines and their ancestral progenitors

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The evaluation of thermal properties of macromolecules is a helpful tool to evaluate both structure and functionality. In lupines the most important macromolecules are proteins. The most important phase transition that occurs in proteins is denaturation that may be considered to be an irreversible phase transition.

In previous works a first attempt to use Differential Scanning Calorimetry (DSC) as a tool to identify affinities among different lupine species was done.

In the present work the same methodology was applied to evaluate and characterise some genotypes of different genetic origins (semi-domesticated, sweet breeding lines and varieties and their ancestral progenitors) of *Lupinus luteus, L angustifolius* and *L. consentinii.*

Principal component analysis and cluster analysis was applied to results in order to establish assemblies among the tested samples.

Protein quality evaluation of four Mexican wild lupins

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Protein efficiency ratio (PER) and *in vivo* digestibility in rats to subject a diets of lupins debitter seeds with boil and wash in water, unsupplemented and supplemented with 0.2% methionine were evaluated. Five groups of six 21-28 days-old male albino rats, with weight of 55-65 g were utilized, a control group was fed with casein and five groups each were fed with meal of debittered seeds of *Lupinus exaltatus, L. rotundiflorus, L. montanus* and *L. elegans,* as protein source. All diets were isocaloric and isonitrogenous. Body weight and intake were recorded for 28 days and the feces were collected for nitrogen determination. PER and protein digestibility in unsupplemented diets were low compared to casein diet (3.5), but in supplemented diets, the PER increased in *L. rotundiflorus* from 1.47 to 2.37 and in *L. elegans* 0.08 to 1.33; however, in *L. exaltatus* and *L. montanus* decreased from 1.65 to 0.91 and 0.9 to 0.3 respectively. Likewise, the digestibility in *L. elegans* (79.6%) and *L. montanus* (80.03%) was lower in supplemented diets as compared to casein (86.6%). PER results are hard to interpret, due to the negative effect in supplemented diets of two lupin species, this might be interpreted by the presence of residual alkaloids or other antinutritional substances present in *L. exaltatus* and *L. montanus*. The Mexican lupins could be take into consideration for future researches and could represent an important source of protein, once the alkaloids are fully removed and the protein adequately supplemented.

Vernalization and day length control of flowering in narrow leafed lupin

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To adapt narrow leafed lupin to northern temperate conditions the influence of vernalization and day length on flower initiation was investigated.

Six genotypes representing a wide variation of germplasm were investigated under controlled conditions. Seed were either vernalized at 3°C for 5 weeks or sown directly at 18°C. Plants were grown at 18°C at 10 h and 24 h day length respectively.

The effect of vernalization and day length was measured as number of leaves on the main stem.

Seed vernalization always resulted in the lowest number of main stem leaves varying from 20 to 35 leaves in the six varieties. The three varieties with lowest leaf number only formed slightly fewer leaves after vernalization as compared to direct sowing at 18°C, and these varieties reacted only little to day length.

The three vernalization sensitive varieties formed from 46 to 49 leaves at 24 h day length without vernalization. At 10 h day length one variety flowered with 53 leaves. However, the remaining two varieties formed up to 100 leaves without flower initiation.

In order to determine the sensitive period for flower initiation by long day one vernalization sensitive variety was moved between long and short day length regimes. Results indicates the presence of a juvenile phase not sensitive to day length and that some genotypes, in the absence of a low temperature stimulus, may have an absolute requirement for long days to initiate flowers.

A high chlorophyll genotype in Lupinus angustifolius L.1 – Comparison with parent genotype in terms of carbon economy of fruits, yield and water use efficiency

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An EMS-induced dwarf mutant of lupin is described which has elevated concentrations of chlorophyll in its vegetative and reproductive tissue, particularly in stem and pod wall. Photosynthetic rates during the day were up to four times higher in attached intact fruits of the mutant than in the parental wild-type cv. Merrit, but fruits of the two genotypes responded closely in terms of dark respiration rates. The reduced plant height of the mutant was completely restored to that of its parent by application of GA, without appreciable dilution of its high stem chlorophyll content. Stomatal frequencies on pod wall surfaces were slightly elevated in the mutant than with similarly sized fruits of the parent, but leaf stomatal densities were closely similar between genotypes. Higher chlorophyll contents of pod wall tissues reduced the level of light transmission to developing seeds of the mutant in comparison to its parent. The increased rates of photosynthesis in pods is discussed in relation to other species and with respect to potential productivity gains.

Research on proportion of seed hull and pod wall for lupin improvement: variation in germplasm and mutant populations and G×E effects.

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Crop improvement in narrow-leafed lupins has more recently been concerned with seed quality aspects. *L. angustifolius* has a high percent of seed weight in the hull relative to other grain legumes and contributes to their high content of indigestible fibre. The proportion of seed hull is about 24% in *L. angustifolius* domesticated lines compared to only 7% in soybean and 9% in field pea. Lupins also inefficiently transfer dry matter out of the vegetative parts, including pod walls into the grain. A substantial collection of wild and domesticated lupins and mutation populations have been screened to search for genotypes with lower hull and pod wall proportion for incorporation into breeding programs and the potential benefits of these traits. Additionally, environmental and genetic effects on hull and podwall proportions in lupin were examined by analysing data from 125 advanced genotypes at 17 year × site combinations in Western Australia. Genotypes have been selected with up to 25% less seed coat and 20% less pod wall than the current major cultivar, Tanjil. In *Lupinus angustifolius* the effect of genotype dominated the variance for seed hull and pod wall percentage and weight per seed, indicating strong heritability for these traits. Hull percentage was found to decrease with increase in seed weight and hull thickness was found to correlate positively with site seasonal rainfall. There was no significant correlation between genotype means for hull percentage and pod wall percentage indicating that selection for one will have little effect on the other. A low but significant correlation was identified between decreasing hull percentage and increasing protein percentage and protein + oil percentage.

The digestibility of amino acids in *Lupinus albus* seeds grown in the UK, for poultry

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Since the EU ban on the inclusion of meat and bone meal in farmed animal diets in 1996 there has been increasing interest in vegetable protein sources such as lupins, oilseeds, peas and soybean in poultry diets. However, many vegetable protein sources contain anti-nutritional compounds such as phytate, non-starch polysaccharides (NSP), alkaloids and trypsin inhibitors, which reduce their nutritive value. A study was undertaken to evaluate the digestibility of amino acids in two cultivars of *Lupinus albus*, grown in the UK, for broilers. Milled seeds from *L. albus* (cv. Lunivers and Lucille) were tube-fed to each of sixteen female Ross broilers (8 birds per treatment) with a mean weight of approximately 3kg. Amino acid composition of the seed meal and the excreta was measured by HPLC and digestibility coefficients calculated. The predominant amino acids in both cultivars were arginine, leucine and glutamic acid, accounting for over 400g kg^{-1} of the total amino acid content. Histidine was present at less than 30g kg^{-1} of total amino acids in both lupins. The digestibility coefficients of amino acids were similar for both cultivars with the exception of glutamic acid and alanine, which were significantly higher in Lucille than in Lunivers ($P<0.05$). A higher content of digestible amino acids were found in Lucille compared to Lunivers ($P<0.01$) which could be explained by the similar digestibility coefficients but higher amino acid content of Lucille. Differences in the NSP composition of Lunivers compared to Lucille may explain the lower amino acid digestibility coefficients in Lunivers since NSPs can interfere with amino acid metabolism and increase endogenous losses. The data demonstrate that the digestibility coefficients of amino acids in both Lunivers and Lucille are similarly high for broilers but that Lucille has a superior digestible amino acid content.

The effects of enzyme supplementation and lupin cultivar on the performance and endogenous losses of broiler chicks

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The nutritional potential of lupin seeds is high, but their use as a protein source in the diets of broilers is limited by a high concentration of non-starch polysaccharides (NSPs). Supplementation of diets containing lupin seed meal with exogenous enzymes may improve their nutritional value. Seeds from two cultivars of *L. albus* and one of *L. luteus* were milled and included at 300g kg^{-1} in a wheat-based diet for broiler chicks. Each diet was provided with and without an enzyme cocktail of pectinase, α-galactosidase and protease. The diets were fed *ad libitum* from day old for a period of 21 days to a total of 160 broiler chicks (8 treatments, 5 replicates of 4 chicks per cage). Body weight gain and feed conversion were monitored weekly and the gross morphology of the gastro intestinal tract (GIT) and the excretion of sialic acid (as an index of mucoprotein production) were obtained on day 21. Inclusion of lupin seed meal reduced weight gain, feed intake, and the efficiency of feed conversion compared to birds fed a wheat/soybean meal-based diet ($P<0.05$). An increase in the relative length and weight of portions of the distal GIT and an increase in mucoprotein production were also associated with the inclusion of lupin seed meal. The addition of exogenous enzymes partially ameliorated the negative effects of lupin inclusion but not to the level of birds fed the control diet. The reduction in weight gain associated with lupin inclusion was mainly due to the depression in feed intake of birds fed lupin-based diets. This may be due to the NSP content of those diets. The increase in the relative mass of the distal GIT and the apparent increase in the secretion of endogenous material may be due to an increase in the relative numbers of microbes in the lower GIT caused by increased substrate availability. The increased endogenous losses may also be attributed to irritation of the GIT by lupin seed meal. The nutritional potential of lupins is likely to be improved if the NSP fraction can be effectively targeted through polygenic methods or enzyme biotechnology.

The effects of enzyme supplementation on the nutritional value of lupins seeds, grown in the UK, for broiler chicks

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Seeds from *Lupinus* species typically contain between 350–450 g kg^{-1} crude protein, and thus they have a potentially high nutritive value for poultry. However, the consumption of diets containing lupin seed meal at concentrations above 200g kg^{-1} often results in a decrease in chick performance. Their relatively high concentration of non-starch polysaccharides (NSPs) has been implicated in the reduced performance. Seeds from two cultivars of *L. albus* and one of *L. luteus* were milled and included at 300g kg^{-1} in a wheat-based diet for broiler chicks while a wheat/soybean meal control diet was fed for comparison. Each diet was provided with and without an enzyme cocktail of pectinase, α-galactosidase and protease, in an attempt to reduce antinutritive effects. The diets were fed *ad libitum* from day old for a period of 21 days to a total of 160 broiler chicks (8 treatments, 5 replicates of 4 chicks per cage). Excreta were collected during the final week of the experiment and nutrient digestibility and metabolisable energy were calculated. The inclusion of lupin seed meal from all three cultivars reduced the apparent coefficient of dry matter digestibility, nitrogen retention and also the metabolisable energy of the diets compared to birds fed the control wheat/soybean meal ration ($P<0.05$). Supplementation of the diets with exogenous enzymes failed to improve nutrient digestibility coefficients or dietary metabolisable energy ($P>0.05$). The reduction in the nutritive value of the diets associated with lupin seed meal inclusion is likely to be due to the higher NSP concentration of those diets. The reason for the poor response to enzyme addition is not clear; however, it may be due to a use of inappropriate enzymes at the wrong concentrations, a negative synergy between enzymes, or an enzyme-linked increase in the flow of endogenous material from the GI tract. Although lupin seeds have a high nutritive potential for poultry their use in the diets of broilers is limited but may be improved by the judicial use of supplementary enzymes.

Dehydrins in water stressed lupin

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Dehydrins are a subgroup of LEA proteins (late embryogenesis abundant), which have been assumed to assist cells in tolerating dehydration. The pattern of dehydrin expression in white lupin has been investigated and attempts were made to relate this with the ability of the plant to withstand and recover periods of severe water shortage. Preliminary studies on protein blot analysis have shown different patterns in dehydrin accumulation regarding drought intensity and tissue specificity. By the use of degenerate primers, designed from the highly conserved regions on dehydrin sequences, several partial cDNA clones coding for putative lupin dehydrins have been isolated. The specific (spatial and temporal) location of dehydrin transcripts during an imposed water deficit and following rewatering, has been investigated by RT-PCR. Differences were found between the dehydrins expressed in leaves from those expressed in the stem. These results should provide means to further elucidate the dehydrin involvement in the drought response of white lupin.

How does UV radiation affect lupin intercellular proteins?

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Ultraviolet (UV) radiation is harmful to all organisms and numerous studies have demonstrated the detrimental effects of UV radiation on plant growth, development and physiology. The study of the intercellular space (apoplast) is particularly interesting since this is the compartment of immediate impact under stress conditions. Our purpose is to identify and characterise the soluble proteins present in the intercellular fluid (IF) of *Lupinus albus* leaves and evaluate the alteration on the protein expression pattern due to UV exposure, using two-dimensional gel electrophoresis, immunoblotting and mass spectrometry. Preliminary results have shown that the major soluble proteins present in IF are acidic and have molecular mass lower than 50 kDa. We have been able to identify some proteins, which show similarity with pathogenesis-related proteins. These results suggest that these proteins may be involved in white lupin defence against the imposed stress.

Metabolism of bitter yellow lupin alkaloids (*Lupinus luteus* L.) in sheep ruminal fluid and milk

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In vitro action of ovine ruminal fluid on yellow lupin alkaloids was studied. Lupin seed was incubated and alkaloid concentrations at 0, 24 and 48 h of fermentation were mesured. Lupinine, the main alkaloid in yellow lupin, was not affected by rumen microbs. However concentrations of the other alkaloids have changed . Sparteine concentration siginificatively decreased ($P<0,05$) and gramine practically disapeared at the end of the incubations ($P<0,001$). Total concentration of alkaloids was not affected ($P>0,05$). Quinolizidine alkaloids were poorly degraded by rumen microbes but gramine, an indolic alkaloid, was apparently metabolized.

The effect of diets containing 0, 15 and 30% BYL on milk production and its chemical composition, DM intake and live weight (LW) variation was studied in a 2nd experiment with "Serra da Estrela" ewes. The only parameter affected by diet was quinolizidinic alkaloids presence in milk. This parameter was null in 0%-BYL animals and reached 1.9 mg/Kg and 5.6 mg/Kg in 15% and 30%-BYL animals, respectively ($P<0.01$).

The effect of planting density on yield and seed size of bitter albus lupins

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Bitter albus lupins (lupinis) are used for human consumption and large seed commands high prices. Undersize seed, however, is commonly rejected by markets and the high alkaloid content renders it unsuitable for use as stock-feed. It is therefore necessary that improvements in yield are not accompanied by a reduction in seed size. Field trials were conducted in northern Tasmania to determine the response of grain yield to plant density (10, 20, 35, 45 and 60 plants/m^2) and the impact on seed size. In 1998-99 and 2000-01 trials were rain-fed but with widescale adoption of irrigation in commercial crops a trial in 2001-02 was irrigated. Yield from the irrigated trial in 2001-02 was significantly higher than the dryland trials largely due to increases in the number of seeds/m^2, mean seed weight and the number of seeds per pod but response to plant density was the same. There was a large decrease in yield per plant, number of pods and number of seeds per plant with increasing plant density. Mean grain yield increased significantly from 2.7 to 3.7 t/ha with increase in density and this same pattern was reflected in the number of pods and seeds/m^2. The percentage of large seed declined significantly with increasing inflorescence level and at the higher densities a greater proportion of yield was derived from the main stem inflorescence. This resulted in a significant increase in the percentage of seed greater than 13mm (industry standard). Higher commercial sowing rates, up to an economic limit, will have the dual effect of directly increasing seed size as well as increasing the quantity of large seed through improved yields.

How *Lupinus lepidus* affects primary succession on Mount St. Helens

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I examined how a native lupin affected community structure following the 1980 eruption of this volcano. Does *Lupinus lepidus* hasten succession, alter species composition, or facilitate the invasion of exotic species? Answers to such questions may inform rehabilitation programs involving lupin species. I explored how lupins affected structure in both small and large permanent plots. I contrasted species composition in young, dense lupin patches, older, open ones, and adjacent barren sites. The effects of increasing lupin density in "potholes" were compared.

L. lepidus is short lived, but can form dense patches. It can both facilitate and inhibit vegetation. Permanent plots were sparse until 2000 when the lupin population exploded. This resulted in an inhibition of common species. Dense lupine patches that developed where barren vegetation already existed increased cover and diversity of other species compared to adjacent barrens, but did not alter species composition. Sparse lupine patches established initially on barren sites and had experienced three population cycles. These patches promoted substantial cover increases and greater equitability of associated species when compared to adjacent sites, and the species composition differed considerably. Lupin density varies greatly among potholes, a phenomenon that only developed in 2000. Dense lupins reduced cover of other species and altered species composition significantly. In grids, higher cover lupine plots had more species and greater cover (of other species) than did plots with little lupin, and species composition shifts attributed to lupin densities were discernable. *Hypochaeris radicata*, the principal exotic species, is the main benefactor. Its cover is weakly correlated with lupin abundance in grids and permanent plots, while it is sporadic in a similar grid that lacks lupins. *Hypochaeris* is stimulated only after lupin has been established on a site for several years. On balance, naturally occurring lupins appear to be accelerating succession by enhancing the rate of biomass accumulation and by facilitating seedling survival.

Tolerance to herbivory in *Lupinus angustifolius* was not related to alkaloid concentration

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Resistance to herbivory may assume two main ways, according to Rosenthal and Kotanen (1994), tolerance or defense. Tolerance traits do not affect herbivores but allow plants to re-grow or to have acceptable yields after suffering damage. Defense involves diverse characteristics being chemicals, secondary metabolites, one of the best known forms of defense. Tolerance to herbivory is usually assessed by comparing growth after defoliation, that is re-growth ability. As both re-growth and defensive metabolites depend on plant resources allocation priorities, the existence of a trade off between tolerance and defense after defoliation was postulated. In lupin, low alkaloid varieties (sweet) are expected to incur is less defensive costs than bitter varieties and so more resources would be available for growth after defoliation.

An experiment was conducted in 1996 and 1997 to assess re-growth ability, as an expression of herbivore tolerance after damage, in sweet and bitter blue lupin varieties. Sweet varieties sown were Yorral (1996) and Gungurru (1997) and the bitter variety Vila velha that was used in both years. Sowing dates were 5/6/96 and 2/7/97; the 1997 sowing delay resulted in a shorter growing cycle. By flowering, plants were cut leaving 50% of the initial biomass to simulate herbivory and two weeks later, cut and control plants were harvested and aboveground dry matter was evaluated.

Results showed differences between years in re-growth ability. When the environmental conditions were more favorable, re-growth ability could express with no effect of the initial alkaloid concentration as cut plant biomass of both sweet and bitter varieties equaled that of the controls two weeks after the defoliation. When the growing cycle was shorter, biomass lost to defoliation could not recover so cut plant biomass was less than that of the controls ($p=0.025$). In conclusion, tolerance to herbivory in blue lupin was not related to constitutive alkaloid concentration but the ability to express tolerance was conditioned by the abiotic environment.

Inductive responses in white lupin (*Lupinus albus* L.) subjected to defoliation were greater in a sweet variety

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Lupin plants have quinolizidine alkaloids as part of their defensive system against herbivores. Lupin is also known since antique as a legume that provides animals and human beings with a source of good quality proteins, but as alkaloids are bitter before grains were ready for consumption a de-bittering process has to be carried out. One of the major breeding objectives was, then, to get low alkaloids varieties and sweet varieties were get.

Several investigators assigned great importance in deterring herbivores to variation in food quality, due to inductive increases in secondary metabolites after damage. Lupin alkaloids are constitutively present but herbivory triggers inductive responses resulting in an increased concentration. Many authors have reported these inductive changes in bitter varieties, but there is no information about induction in sweet varieties. The aim of the present work was to assess inductive responses in a sweet and a bitter white lupin variety.

An experiment was conducted in Buenos Aires in 1997 and 1998. Rumbo (sweet) and El Harrach (bitter) varieties were sown. In mid flowering, 10 caterpillars (*Anticarsia gemmatalis*) per plant were put in clip cages and allowed to eat during three days. Then treated and control plants were harvested and alkaloid concentration was examined by CGL- mass chromatography.

Results were statistical compared by a two way ANOVA, being the varieties and the treatments the two factors. Defoliation by *Anticarsia* resulted in an increment in alkaloid concentration in both bitter and sweet varieties, but there was a significant interaction ($p<0.01$) due to a greater induction in the sweet (133% more than the control plants) than in the bitter (71%) variety. Induction was, then, more important in the sweet than in the bitter variety. If, as was postulated, variation in food quality could deter herbivores, Rumbo would be a promising variety as it has low alkaloids in grain and perhaps the possibility of defense. Further investigation is required to assess the effect of inductive increases on herbivore performance.

Lupin seeds as a source of nutraceuticals

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Since long, legume seeds are considered to be beneficial in the control of various diseases, including diabetes and cancer. Nonetheless, large debate is still open on the identification of the responsible molecules. A number of application regarding several legume proteins have recently been described and it has been proposed that they may represent nutraceutical food ingredients for the prevention and treatment of important pathologies. In particular, the activities already studied or being tested range from metal binding capacity, peptide hormone receptorial activity, hypoglycaemic and hypocholesterolemic effects. In this respect, a reappraisal of protein antinutrients which are not always harmful but in some cases are able to modify and improve the body metabolism and the health status in general, is presently put forward.

Some of these activities has been attributed to seed proteins that are able to bind active molecules, such as metal ions and hormones. Moreover, peptides and phosphopeptides originated from the hydrolysis of major protein have effect on the blood hypertension and can be exploited as carrier for they metal binding capacities.

The detailed description at molecular and biological level of the protein fractions involved still deserves further studies as far as its biological function in the plant and its effect as a food component are concerned.

Lupin seeds are also a potential source of proactive compounds, specially the protein fractions, being the non-protein molecules relatively less represented.

This communication will describe the progresses in the exploitation of lupin protein fractions as food ingredients of potential nutraceutical activities.

Proteolytic enzymes and their inhibitors in various lupine species growing in Belarus

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Proteolytic enzymes play an important part in protein metabolism of plants. One of the methods for regulating their activity is realized via inhibiting proteins forming with enzymes reversible inactive complexes. Seeds and leaves of various lupine varieties, yellow, blue and white one, growing under Belarus conditions were analysed. Activity in proteolytic enzymes of different classes (acidic, neutral and alkaline) was shown to make up, on the average 8.4, 12.4, and 125.0 respectively in yellow lupine; 7.5, 10.5, and 65.0 in blue lupine and 6.5, 8.9, and 72.6 units/g absolutely dry weight in white one. The highest activity of proteinases was also characteristic of leaves in yellow lupine. There were species differences too for trypsin protein inhibitors the level of which varied from 2.5 to 6.0 of inhibitors units. The relationship was revealed between the activity of proteolytic enzymes, inhibiting proteins in leaves and protein accumulation in seeds. Lupine genotypes different in resistance to fusariose were shown to have a different level of inhibiting protein in trypsin. It was revealed that the inhibitor preparation from lupine seeds was able to suppress the activity of proteolytic enzymes of Fusarium oxysporum by 75% and to inhibit germination of conidia and growth of fungus mycelium by 45 and 70% respectively. Proteinases and inhibitors of endogenous proteinases and phytopathogenic infection were isolated and purified by chromatography methods from leaves and seeds of various lupine species. Molecular weight of preparations was about 25 kd. Species-specificity was revealed in electrophoretic spectrum of protein inhibitors in polyacrylamide gel.

The research results have established the role of proteinases and inhibiting proteins in protein metabolism and phytoimmunity.

Importance of growth habit, sowing time and sowing density of *Lupinus angustifolius* in conventional and organic farming systems

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Over the last five years an important change in farming systems as well as in the use of Lupinus species in German agriculture has taken place. The annual increase of organic farming is approx. 20%. Now, L. angustifolius is the most important Lupinus species in Germany and the second important grain legume after peas. For both farming systems the demand for seed and information is still rising because of higher yields compared to L. luteus on poor soils and less susceptibility to Anthracnose compared to L. albus and luteus. Over a six years period (1996-2001) eleven branching and spikelike types (strains and varieties, low alkaloid, thermoneutral) were tested at three sites of lower soil fertility in north-east Germany. Sowing density ranged from 80-140 germinating grains/m² (gg/m²) in branching types and 100-150 gg/m² in spikelike types. Sowing time was mid March, beginning of April and mid April. The aim was to advice farmers to choose the right variety according to their farming system to optimize grain yield and minimize costs. In spite of the fact that the effects of climate and trial site were much higher than the influence of sowing time and sowing density every growing type showed its own typical reaction. The highest yield of a branching type was obtained in 1998 with cv. BORA (6,2 t/ha) on a loamy sand with 110 gg/m² . The best yielding spikelike type was cv. BORUTA (3,7 t/ha) in 1996 on a loamy sand with 150 gg/m². Spikelike types are generally less yielding (10-30%) than branching types. Branching types responded less to decreased sowing density but significantly to delayed sowing time. They are more competitive against weeds than spikelike types but more susceptible to shattering and lodging. Under wet harvest conditions branching types may cause problems in organic farm systems. Yields of spikelike types increased significantly with increased sowing density. Because of less sensitivity to late sowing combined with early maturing they give farmers with organic systems the possibility of mechanical weed control before sowing and more security to get the crop rip in time. Recommendations on sowing density and sowing time for the different growing types and farming systems and further prospects in research and breeding will be given.

Result of lupin breeding in Ukraine

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In Ukraine the breeding of two varieties of white and yellow lupin species is conducted. As a result of there investigations a number of fodder white and yellow lupin varieties with high protein content is developed.

Feed lupin is a value of a ble protein rich crop for stock-breeding due to high protein content and availability of essential amino acids in grain and green material; moreover, lupin is a source of biological nitrogen what secures the considerable increase of soil fertility.

Economic value of white and yellow lupin varieties is that its grain contains 38-42% of high-quality, easily available protein, the yield of it makes up 1200-1500 kg per hectare. Protein of lupin varieties on the essential amino acid content doesn't be different from soybean protein, has the same biological value for combined fodder industry.

There are developed the white fodder lupin varieties Pishchevoy, Olezhka, Syniy Parus, Volodymyr, Borky, Tuman, Veresnevy which are characterized by high protein content (up to 42%), lysine one (2.0-2.2%), fat one (10-11%) with potential grain yield 4-5 metric tons/ha, green material one 65-75 metric tons/ha what ensures the protein yield per hectare of crop 1200-1500 kg.

The yellow fodder lupin varieties Promin, Motyv 369, Obriy belong to the intensive type with short-term vegetation period (95-98 days), contain 42-45% protein, resistant to Fusarium wilt, tolerant to virus yellow mosaic and bacteriosis, secure the grain yield 2.0-2.5 metric tons/ha and fresh one – 50-60 metric tons/ha.

The growing of these white and yellow lupin varieties in basic and intermediate plantings is a way for forage balancing with protein, the increase of soil fertility and considerable reduction of power inputs for the protein and fodder production.

Cultivation of Pleurotus spp. on *Lupinus montanus* and *Lupinus rotundiflorus* stubble

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The Lupinus species have been classified in "sweet" and "bitter", according to their alkaloid content, sweet lupin are exploited for human and animal consumption, bitter lupin stubble might represent a substrate potential for cultivation of edible mushrooms if these doesn't represent risks in their consumption. Stubble (leaves, stems and pods) of two wild lupins (bitters), used as substratum for the cultivation of *Pleurotus* sp. was evaluated. This material was wet to 80%, placed in poly-paper bags, sterilized at 121°C and inoculated with sorghum grains invaded previously by the mushroom mentioned and incubated at 27°C in darkness. Days of fruiting initial, appearance and biological efficiency (%) were evaluated the alkaloid contain body fruit was evaluated. The primordies appearance was observe to 47 and 55 days in *L. montanus* and *L. rotundiflorus* stubble, it was longer that in wheat straw used commonly, and the biological efficiency was of 126.4% and of 124.2 % for *L. montanus* and *L. rotundiflorus,* respectively, it is better that the harvest obtained with wheat straw, agave and sugar cane bagasses. Alkaloids content was low, 0.025 and 0.022% in body fruit harvest in *L. montanus* y *L. rotundiflorus* stubble respectively.

Development of the white lupin crop in Poitou-Charentes (France)

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The overall objective of the project "Agrotransfert lupin" was to promote the white lupin crop in Poitou Charentes (France). The project was supported by the Région Poitou Charentes council, the French government funding and the U.E. The lupin crop mets the need for a new crop in the rotation and the need for home-produced feed stuff. Four thematic priorities were defined : the autumn-sown white lupin breeding, the crop management (crop protection, agronomic practices), the identification of non food uses, and the dissemination of available technical knowledge. Field trials were conducted by the members of GIE Prolupin and by the agricultural chambers. In the Poitou-Charentes Région, the lupin crop raised to 2600 ha in 2001 while it was only 600 ha in 1997.

Perennial lupins in Fennoscandia

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Three North American perennial species of *Lupinus* occur as established aliens in Fennoscandia: *L. nootkatensis, L. perennis* and *L. polyphyllus. L. nootkatensis* and *L. perennis* were introduced mainly in connection with railway construction in the late 19th century and have spread from a focus in southwest Norway. Their expansion has been slow and fairly regular through 110-120 years, and both species have a potential to become naturalized. *Lupinus nootkatensis* has perhaps not reached all parts of Fennoscandia potentially (climatically) best suited to it, whereas *L. perennis* perhaps is already at the margin of the climatically favourable range in Fennoscandia. *Lupinus polyphyllus* was introduced early, probably in the 17th century, partly as a garden ornamental and partly as a 'green fertilizer'. It had a significant period of stasis before it began a nearly explosive expansion, mainly from 1930-1940 onwards. It is currently spread partly as a frequent escape from gardens, partly by uncontrolled use of its seed with other alien species in road verge management. *Lupinus polyphyllus* is now extremely common in many parts of southern and western Fennoscandia, but less so in the northern and eastern continental parts. It has nearly reached its assumed climatically potential area in Fennoscandia. *L. polyphyllus* is less able than either *L. nootkatensis* or *L. perennis* to sustain populations for a long time and to invade 'natural' habitats.

Lessons of seven years' experience and investigations on *Lupin anthracnose* in Poland

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The occurrence of anthracnose on cultivated lupins (*Lupinus albus, L. angustifolius, L. luteus)* has been detected in Poland in 1995. Since the first local incidents observed, the disease become widespread all over the country. It should be noticed that weather conditions conducive to fungal infections (rainy, warm, high humidity) appeared prevailing along several lupin vegetative seasons, until the 2000. Contrasted situations were experienced both, in the 2000, with warm but dry spring/early summer months and in the 2001 – just opposite, as rainy enough, but rather cool period during seedling and early plant growth stages, up to the mid of July, where pods were developing. In general, considerably less anthracnose incidents and apparently low severity level occurred in both these years, independently on different shifts of adverse weather conditions to anthracnose development. The impact of the coarse of weather conditions on plant growth stages, in relation to plant – pathogen interaction may be implicated. At the same time in 2001, some puzzle observations were made occasionally in several single commercial yellow lupin plantations (cvs. Polo, Juno), as being completely damaged by heavy anthracnose epiphytotic attacks, irrespectively of the above mentioned adverse to the disease weather conditions – prevailing in the growth season. Problems of climatic (weather coarse) variabilities, the *Colletotrichum* seed transmission and lupin cultivar differences in susceptibility/resistance response to infection have been focused on the question of prognostic diagnosis, possibilities of monitory and early warning signals against high potential risk of epidemics and evaluation of rational perspectives of lupin crop production. Investigations are being continued to provide verified initial lines for disease resistance breeding programmes. Conclusive results of screening tests for disease resistance in glasshouse and field evaluations of about one thousand lupin entries (over 50 000 individuals), in range of *Lupinus spp.* (cultivars, breding lines, landraces, accessions), as well as *Colletotrichum spp.* biodiversity and comparative diagnosis of strains infective to lupins will be discussed.

Grain yields of white and narrow-leafed lupins (*Lupinus albus, Lupinus angustifolius*) in Switzerland and Southern-Germany

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Since the Swiss and German ban on animal meal for feeding, the incorporation of new sources of plant proteins in diets is necessary. One of these sources could be lupins. Due to the soil and climate conditions in Switzerland and Southern-Germany, sweet white and sweet narrow-leafed lupins are suitable.

A 2-year study of white and narrow-leafed lupins was carried out under Swiss and South-German conditions to find the best adapted high yielding varieties. The field trials were situated on several locations in Switzerland and South-Germany on commercial and one organic farms. Three varieties of white lupins (cvs. Amiga, Fortuna, Bardo), four varieties of undetermined narrow-leafed lupins (cvs. Bolivio, Bora, Boltensia and Bordako) and two varieties of determined narrow-leafed lupins (cvs. Borweta, Sonet) were examined in a randomized complete block design with replications (four in Switzerland, three in Germany, respectively).

Sown in April, the narrow-leafed determined lupins reached harvest maturity after about 105 days at the end of July, the indetermined narrow-leafed lupins about 15 days later. The white lupins were harvested on average after 140 days, not before Mid-August.

In Switzerland, the mean grain yield of the white lupin cv. Amiga was 4,6 t/ha over two years. In South-Germany, also the white lupin cv. Fortuna was convincing by high yields, whereas the variety Bardo disappointed. The yields of the narrow-leafed lupin varieties were about 3 t/ha on the average, no variety was outstanding. The protein content was 36% on the average of all varieties, the variation was between 32 and 43%.

As for the grain yield, the varieties Amiga and Fortuna can be recommended for Switzerland and South-Germany. But in organic farming systems, the yields may be threatened by anthracnose because no chemical seed treatment is allowed. For this reason, only narrow-leafed lupins are recommended for organic farming at the moment. Further research will be focused on the evaluation of biological treatments to control anthracnose.

Seed recruitment and loss of Russell lupin seed in a Canterbury riverbed

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In New Zealand many native birds nest on the ground. The black stilt (*Himantopus novaezelandiae*) breeds mainly on braided riverbeds and is endangered under IUNC criteria. The birds require shallow water for feeding and sparsely vegetated shingle for nesting. A combination of hydroelectric power generation, use of water for irrigation and invasion by exotic plants including Russell lupin (*Lupinus polyphyllus* x *Lupinus arboreus*) has degraded the habitat for the birds. The plants reduce the suitability of the riverbeds for birds by acting as primary establishers for other plant species, which stabilise shingle islands. The plants also provide cover for introduced mammalian predators, which have been implicated as causal agents in the decline and extinction of New Zealand's terrestrial fauna.

A possible method of improving the habitat for birds is to remove invasive plant species. This work was undertaken to measure annual production and loss of Russell lupin seed in a braided riverbed. However, because of hard seed Russell lupin would probably persist even if all plants were removed.

This work describes average seed production over a growing season and loss of seed that occurred over the summer in a braided riverbed.

Among lupin stands the seed production was 754 seed/m^2. However, by the end of summer 86 % of this seed had disappeared. However, the remaining seed was highly viable at 99 %. The number of plants that reached maturity and flowered at 0.73 plants/m^2 was considerably less than the number that germinated in the spring at 46.3 plants/m^2.

These results suggest that if the lupins were prevented from seeding there would be a rapid drop in the number of seeds in the soil seed bank. What is not known is how long the remaining hard seed will remain viable and thus provide a potential source of reinfestation.

Evaluation of two narrow-leafed lupin varieties for silage and grain production

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Plant form has the potential to affect both the yield and chemical composition of conserved feeds prepared from lupins. To investigate this further, a single-stemmed variety (cv. Borweta) and a branching variety (cv. Bordako) of narrow-leafed lupin (*Lupinus angustifolius*) were inoculated and sown in replicated plots at a rate of 100 kg/ha in early May. Both varieties were then harvested as whole-crop for ensiling, crimped grain for ensiling or dry grain. The Borweta crop was harvested at 13 weeks (whole-crop), 18 weeks (crimped grain) and 21 weeks (dry grain) post sowing, and the Bordako crop at 17 weeks (whole-crop), 21 weeks (crimped grain) and 25 weeks (dry grain). The whole-crop forage was cut, wilted for 24 hours, and then passed through a precision chop forage harvester. The chopped material was then treated with a *Lactobacillus* inoculant and ensiled in 10 kg silos. The crimped grain was ensiled in 10 kg silos after applications of molasses and Crimpstore 2000 acid. At each harvest stage forage or grain DM yield was estimated. The whole crop DM yield of Bordako was higher than that of Borweta (8450 vs. 6620 t DM/ha). Borweta yielded well when harvested for grain, but lodging of Bordako during pod formation resulted in comparatively low yields (1985 vs. 4263 t/ha crimped grain; 1142 vs. 2863 t/ha dry grain). Both lupin varieties ensiled successfully as whole-crop and crimped grain silage. The chemical composition of the whole-crop silage was similar for both varieties, with the Borweta and Bordako silages having crude protein contents of 206 and 193 g/kg DM respectively. The Bordako crimped grain silage had a higher crude protein content than the Borweta (408 vs. 309 g/kg DM), and although harvested much later had a low DM content (501 g/kg). Dry grain quality was similar in both varieties although the crude protein content of the Bordako was higher than that of Borweta (358 vs. 300 g/kg DM). The results from this experiment indicate that Bordako is more suited to whole-cropping due to its high forage DM production, but that the earlier maturing Borweta is more appropriate for grain production in the wetter climate of western areas of the UK.

Evaluation of different lupin species in low Silesia region of Poland in regard with some morphological characters

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The study was conducted to evaluate morphological characters and phenological phases of wild species of *Lupinus* in Lower Silesia conditions. Lupine wild species were obtained from Washington State University – Regional Plant Introduction Station as well as species maintained in the collection of the Department of Plant Breeding and Seed Science. Plant material was 23 introductions, which included sections: Luteus, Pilosus, Atlanticus, and such species as *L. perennis*, *L. elegans*, *L. albicaulis*. The species differed in the length of growing season – *L. hispanicus subsp. bicolor* (118 days), *L. cosentinii* – 126 days, *L. atlanticus* – 139 days. The other forms had growing season over 148 days. Significant differences were observed among morphological traits. *L. palaestinus* no. PI 15616 had the tallest plants (123,5 cm) and the shortest plants were observed in *L. atlanticus* no. PI 384612 (55 cm). The main stem was always shorter than the lateral stems in all analysed populations. The highest main stems had forms of Pilosus section (55-80 cm) and the shortest plants were in Atlanticus section (43–57 cm). The length of inflorescence was different in various species. The *L. palaestinus* no. PI 491182 had the longest inflorescence (26 cm). The shortest it was observed in *L. pilosus* no. PI 491182 (5,1 cm). The highest number of flowers (over 50) and whorls (13) was observed in *L. elegans* and *L. perennis*, *L. pilosus* no. PI 491183/22 had the lowest number of the flowers (17), and whorls (4). The thousand seed weight was the greatest in section Pilosus, ranging from 397 g to 512 g. Accessions of Atlaniticus section had smaller seeds (thousand seeds weight from 148 g to 245,2 g).

The material collected includes interesting accessions of wide spectrum of variability of the analysed traits, which would be useful for genetic research.

Inhibition in the *Fusarium* growth by a new lupanine thionoanaloge, (+)-2-thinosparteine and (+) lupanine

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The aim of these study was to evaluate the fungistatic activity of a new thioanalogue of lupanine ((+)-2-thionoesparteine) and (+) lupanine. The biological activity of modified alkaloids (+)-2-thionosparteine or (+) lupanine on the growth of *Fusarium* was evaluated in potato dextrose agar medium. A strain of *Fusarium* sp. was isolated from withering *Agave tequilana* Weber plants. Alkaloids concentrations were 0, 1, 3 and 5 mM, and growth rate (mm/day) and inhibition percentage with respect to control was determined after 5 days of incubation to 28°C. After these time of incubation the mycelium covered all media with different concentrations of alkaloids, except with 5mM of (+)-2-thionosparteine. The alkaloids delayed the growth of *Fusarium* with (+)-2-thionosparteine 0.4% and 22.0%, with 1 and 5 mM respectively. With (+) lupanine, inhibition of 2.5% in 3 and 5 mM was obtained, whereas with 1 mM increase the rate of growth 0.7%. Modified alkaloids reduce the growth of *Fusarium* but in lower concentrations than extracts rich in lupanine.

Breeding Of *Lupinus albus* Cultivars with Different Plant Architecture and Characteristics of their Development Pattern as a Photosynthetic System

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White lupin cultivation in Russia is important due to its high potential seed and protein yield. Lupin studies have been condicted in Central-Chernozem zone (500 km south of Moscow) in order to determine the physiological, agronomy and breeding aspects of *Lupinus albus*. The main objective of white lupin breeding in Russia is to obtain early maturing cultivars. It was possible to select lines with reduced branches by using artificial mutagenesis. Then we were successful in breeding early maturing spring cultivars with different plant architecture. Cv. Deter 1 is without any branches and with pods set only on main stem. Cvs. Start and Gamma are characterized by a low plant height. The pods are formed on the main stem and short branches of the first level. Cv. Delta has short branches of 2-d level with pods on them. Cv. Manovitsky is characterized by the same branching and pod set, but the main stem and branches are higher.

These cultivars and other lupin forms with different plant architecture were studied. Dynamic characteristics (plant height, wet and dry matter accumulation, leaf area index, photosynthetic potential, net assimilation) are presented and discussed in connection with development pattern of *Lupinus albus* cultivars, seed yield variability and stable maturity. Though branchless cv. Deter 1 has the smallest value of the dynamic characteristics, it may be improved by increasing the plant density. Deter 1 matures 10-15 days earlier than Start. Net photosynthetic assimilation and harvest index are better for Deter 1 than for other cultivars.

Photosynthetic Characteristics and Seed Yield Of Lupin Species and Cultivars Under Conditions Of Moscow Region

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Non-Chernozem zone is a large territory of Russia, and Moscow region is a part of it. The climate of the region is moderate. August and September are cool.
The field experiment has been conducted for two years to study the impact of species genotype and meteorological factors on plant development, photosynthetic characteristics and seed yield of lupins under conditions of the Non-Chernozem zone.

Three species of *Lupinus* (*L.angustifolius*, *L.luteus* and *L.albus*) were studied. Each of them was presented by early cultivars with normal branching and determinate cultivar without branching. Period of vegetation, harvest date, seed yield, harvest index and dynamic characteristics (leaf area index, wet and dry matter accumulation, net day assimilation and others) differed greatly depending on genotype and meteorological conditions.

Period of vegetation for cultivars with branches for *Lupinus angustifolius* was 110 days, *L.luteus* – 115-125 days and *L.albus* – 120-125 days. Determinate cultivars of all three species are characterized by smaller period of vegetation (10-20 days), leaf area index, photosynthetic potential and dry matter accumulation (1.5-2 times). On the other side the net assimilation of determinate cultivars was higher by more than 20% compared to the branching cultivars. Seed yield of *L.luteus* and *L.angustifolius* cultivars was about 2 t per ha and of *L.albus* - 3 t per ha. Seed yield of determinate cultivars was less or the same due to their higher harvest index.

The peculiarities of determinant and semideterminat white Lupin cultivation in Ukraine

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The correlation between cultivation technology (terms, modes and standards of sowing) and grows, development and productivity of white lupin (semideterminant line 53/40 and determinant line 59/23) investigated in the Institute of Agriculture of UAAS during 1999-2000. As was shown the delay of lupin sowing term for 7-14 days versus the optimum has not leads to the considerable change of the yield level. The yield sufficiently depended on the hydrothermic conditions of the lupin growing season. As was shown in 1999, the displacement of the sowing term on the 7-14 days regarding to regional optimum leads to the reducing of yield up to 3-9%. However, the lateness of the sowing was not affects on the yield in conditions of year 2000. In conditions of year 2001 the displacement of the sowing term on the 7-14 days in semideterminant line 53/40 leads to the increasing of yield to11,6-4,8% correspondingly, but in determinant line 59/23 - from 22.6 to 18.3% correspondingly. It is testified that the investigated plants are thermoneutral.

In contrast from indeterminant lupin forms the sufficient part of the seed yield (more than 50%) forming at the shorted lateral branches both in determinant and semideterminant forms. The simultaneously maturity of the seeds and the equal weight of 1000 seeds both on the central and lateral branches are also characteristic for the investigated breeding lines. The optimality of the sowing with rows width 45 cm, sowing rate with 0.6-0.8 million germinated seeds per hectare and lowered sowing standard for the investigated lines also was shown. The yield amount to 35.4-38.2 quintals per hectare for line 53/40 and 38.4-40.8 quintals per hectare for line 59/23 under mentioned sowing technology.

The nature of some morphological characters inheritance in the white lupin

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A series of crossings between the forms that contrast by length of lateral branches and determinance have performed for investigation of these characters inheritance. As a result, the dominance by the lateral shoots observed in F_1 hybrids in the combinations where the line 500 with long lateral branches was used as maternal. In contrast, in the reciprocal combinations where the line 500 used as parental the lack of dominance was observed. The sufficient differences in segregation also observed in F_2 hybrids obtained from direct and reciprocal combinations. Conceivably the cytoplasmic genome influences on the manifestation of characters in the mentioned cases.

The blockade of the lateral branches by flower bud was not observed in F_1 hybrids between determinant and indereminant forms. In the second filial generation the regular determinant, intermediate and regular indeterminant plants are obtained. All F_1 and F_2 hybrids between determinant forms have the same mode of brunching. Thus, we believed that the determinance is a recessive character with reference to the regular mode of branching.

The new forms of white lupin resistant to *Colletotrichum gloeosporioides*

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The periodical anthracnose outbreaks on the lupin are indicated in the Ukraine beginning with 1983. These outbreaks of the disease correlated with the conditions wherein the value of the monthly humidity coefficient ranged up to 0.8-1.2 and the hydrothermal coefficient ranged up to 1.0-3.0 in the first half of the lupin vegetation. The agent of disease from Ukraine may classified to VCG-2 group (corresponding to H.A.Yang et M. Seetingham, 1998).

Several breeding lines of Lupinus albus that characteristic of high field resistance to the anthracnose, were isolated during 1989-1991. One such line (2247) was incorporated into programme of crossing with most productive mutant lines. The most resistant among 2247 progenies were determinant breeding lines 59/23, 55/5, 55/7 and complex hybrids obtained in result of the crossings between just mentioned lines and other progenuies of the line 2247.

The year 2001 was favourable for the disease development in the Ukraine. The damage levels of the all breeding lines of white lupin by anthracnose were estimated. More than 50% of new breeding material was carried off resistant. The anthracnose development was not registered on 57.3% of breeding numbers. All these numbers have a hybrid parentage and are obtained with engaging of a line 2247. In F_3 nursery result of crossing between resistant and unresistant lines the scission was recorded for mentioned characteristic. Thus the high lesion level was resulted for broodings obtained from combination of high resistant line 59/23 and unstable line 133/6. However even in this combination the 20% of hereditary were not damaged. The interesting were hereditaries obtained resulting of direct and reversed crossing combinations between determinant high resistant line 55/5 and line 206 (Sinij Parus variety). The progenies of the direct combination (55/5 x 206) were practically not damaged with an anthracnose (84.4%) whereas only 25.6% progenies of the reversed combination were not damaged. The moste perspective breeding lines of the white lupin were multiplied and after progeny tests will be used for developing of the new varieties with high field resistance to the anthracnose.

Characterisation of the fibre-rich fraction of *Lupinus amiga* L.; functional properties and polysaccharide structure

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Aqueous fractionation of previously de-hulled and blanched sweet white lupin seeds yields a protein isolate and a fibre-rich fraction[1], as a result of a process which may be conducted under food-grade quality conditions. White lupin fibre-rich fractions, whilst by-products of protein isolate, are potentially interesting as food ingredients, not only as potential source of healthy fibre ingredient but also as a technological agent with specific functional properties[2].

In this paper, the functional properties of such a product, obtained during a pilot-scale fractionation[3], were determined by standardised methods.
The water and oil holding capacity of this product are shown to be its main interesting features, and a food product manufactured with it as an ingredient is compared to a commercial product.

The chemical structure of the fibre fraction is characterised in terms of molecular weight distribution and mono-saccharide content. A preliminary characterization of the polysaccharide structures was attempted using selected enzymes and identifying the composition of released sugars.

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[1] Axel Borcherding, Fraunhofer-Institute Process Engineering and Packaging, personal communication.

[2] "Comparative flavour release profiles from oregano (*Origanum virens*) formulated into powdered materials" Paulo M. Ferreira, José A. Empis, Gabriela Bernardo-Gil, Proceedings of Euro Food Chem VIII, Vienna, **Vol. 2**, 333-6, (1995).

[3] Obtained from Fraunhofer-Institute Process Engineering and Packaging, c/o Dr. A. Wäsche (wae@ivv.fhg.de).

Impact of the Controlled Instantaneous Pressure Drop (DIC) on Lupin quality

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Legumes are good nutritional sources. To be used by industry they should have in addition to their nutritional aspect functional properties. Nowadays, different kinds of processing (heat treatments, fermentation, etc.) are used in order to enhance nutritional aspect of legumes and ameliorate their functional properties. However an excessive heat treatment may affect negatively quality by decreasing digestibility and proteins solubility. Therefore, a well controlled treatment, in terms of heat level used, duration and energy consumed becomes a main factor for food industries. The DIC process is a new operation with high potential in many food fields (extraction, drying, texturization, antinutritional factors reduction, etc.). It consists of submitting the product under steam pressure for a short time period. The end of DIC treatment is related to an almost instantaneous pressure drop into a vacuum. An immediate fall in temperature will be obtained. This pressure drop generates by self-vaporization a quantity of water which induces a porous structure and an eventual modification of the product's functional properties (water absorption, extraction, drying etc.). In a previous study on Lupin, good results on alkaloids removing after DIC treatment followed by water extraction have been obtained. The objective of the present work is to study the effect of DIC operation on other Lupin components such as protein and lipid content in relation to seed texture. Two types of Lupin were studied : *Lupinus albus* and *Lupinus mutabilis*. A central composite experimental design of 22 points was used. Protein content was determined by the "Kjeldahl" method while Lipid content was obtained using solvent extraction by "Soxhlet" method. Gas Chromatography GC was used for fatty acids analysis. Unlike other treatments, DIC treatment did not alter Lupin proteins content or fatty acids profile, and an amelioration in Lipids availability after DIC due to texture modification has been obtained. The obtained results show the efficiency of the DIC process for legumes treatment.

Effect of the controlled instantaneous pressure drop (DIC) on lupin alkaloids

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In spite of their high protein content, lupin seeds are not fully utilized like other grain legumes. The drawback in their utilization is mainly due to the presence of water soluble, poisonous alkaloids present in the seeds. The selection of relatively sweet lupin lines did not resolve the problem due to the low palatability of the diet, presence of off-flavors and subsequent reduced growth rates. On the other hand, alkaloids are also likely to play a role in the defense mechanisms of seeds against pathogens and as possible therapeutic agents. Thus, lupin seeds need a processing step to ameliorate their nutritional and functional aspects. Different kinds of treatment (heat, fermentation, etc.) have been used, most of them are time consuming or not applied at an industrial scale. The new DIC process having many applications (extraction, drying, texturization etc.) could be promising for legumes treatment. The DIC consists in a steam treatment for a predetermined time at a predetermined pressure. It induces a modification of the product's texture and its functional properties. The objective of the present work is to apply DIC treatment followed by an aqueous extraction on Lupin seeds in order to ameliorate their nutritional value by reducing their alkaloids content. Two species of Lupin were studied: *Lupinus albus* and *Lupinus mutabilis*. we have opted in the case of *Lupinus albus* for a variety with low initial level of alkaloids (0,025%) where the *Lupinus mutabilis* variety has a high amount of alkaloids (5,5%). The alkaloids content was examined by capillary gas chromatography (GLC). Results obtained prove the efficiency of the DIC treatment. Thereby, the alkaloid content of Lupin following an optimized DIC treatment combined to a water soaking of two hours has dropped from 5,5% to 2,2% (*Lupinus mutabilis*) and from 0,025% to 0,0075% (*Lupinus albus*). All of these results prove the high potential of the DIC technology in the treatment of Lupin seeds. The applications could be easily transposable at an industrial scale.

Genotypic and environmental effects on pod walls of cultivars and breeding lines of *Lupinus angustifolius*

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Primitive traits remain in lupins, such as thick pod walls that might be improved by further domestication, increasing both harvest index and grain yield. Thinner pod walls would also favour a more rapid desiccation of pods, a valuable feature in areas with risk of rain at harvest. Fourteen genotypes (ten Australian cultivars, three breeding lines, one wild) of *Lupinus angustifolius* were evaluated for pod wall proportion (PWP) and pod wall specific weight (WSW) during 2000-01, with four replications, at four locations in southern Chile. Five pods from the mainstem and five from branches (mostly first order) were sampled from five random plants per plot. When pods came from the mainstem, PWP mean was 34.0 ±0.12(SE), ranging 31.7 to 35.9% for genotypes and 32.9 to 35.0% for locations, whereas WSW mean was 31.3 ±0.29, ranging 28.0 to 35.5 $mg \cdot cm^{-2}$ for genotypes and 28.4 to 36.4 $mg \cdot cm^{-2}$ for locations. For pods from branches, PWP mean was 35.7 ±0.11, ranging 33.6 to 37.2% for genotypes and 34.9 to 36.3% for locations, whereas WSW mean was 32.4 ±0.25, ranging 28.9 to 37.0 $mg \cdot cm^{-2}$ for genotypes and 29.5 to 35.5 $mg \cdot cm^{-2}$ for locations. Regardless of the origin of the pod sample (mainstem or branches) the environmental effect on PWP was significant, and highly significant for the genotypic and GxE effects. Similarly, highly significant genotypic, environmental and GxE effects were found for WSW. Broad sense heritabilities, estimated on pods from mainstem and branches were, respectively, 0.35 and 0.35 for PWP and 0.24 and 0.34 for WSW. Phenotypic and genetic correlations between PWP and WSW, were 0.69*** and 0.80***, respectively, when estimated on mainstem pods, and 0.57*** and 0.62***, respectively, when estimated on pods from branches. These results agree with previous findings in *Lupinus albus*, and corroborate PWP as a trait amenable to improvement, whose selection for may be assisted by WSW. However, a greater variation for these traits is needed, and should be sought preferably beyond the elite germplasm.

Dwarf autumn-sown white lupin : present status and future prospects in France

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The lupin crop area reached 15 000 ha in 2001 in France (40% increase), mainly spring sown lupin (90%). Nevertheless a further development of lupin acreage is expected to be due to the increase of the autumn-sown crop. The seed yield potential of autumn-sown crop is theoretically higher than that of spring sown crop. The autumn-sown lupin breeding programme of INRA Lusignan has achieved this objective : a newly released cultivar (Luxe) shows a high seed yield potential. This cultivar is an early flowering type and is cold tolerant. It has an indeterminate growth habit.

Luxe has been compared to cv. Ludet (determinate) and cv. Lunivers (dwarf-determinate) in a multilocal trial (5 to 8 sites during 3 years) in small plots. Luxe yielded significantly more than the other cultivars. The site*cultivar or year*cultivar interactions were significant, but the cultivar effect was significant when tested against both interactions. The mean yield of Luxe was 45.98 q/ha and those of Ludet and Lunivers were respectively 34.96 q/ha and 37.24 q/ha. Luxe seems to be a promising cultivar, especially in adverse conditions : its indeterminate growth habit enables it to compensate for low density but its very early flowering prevents it from excessive vegetative development.

The autumn-sown white lupin breeding programme which started at INRA Lusignan is now transferred to private breeders (GIE Prolupin) who will go on with the same breeding objectives and criteria. The seed multiplication of the genetic resources collected by INRA Lusignan will also be ensured by GIE Prolupin.

Variation in seed size, seed coat proportion and protein content in *L. angustifolius*

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Lupin has a thick seed coat compared to other grain legumes, which increases the fiber content and reduces the digestibility. Improved nutritional value could be expected by lower seed coat proportion.

The variation in seed coat proportion of the total seed weight is investigated in 38 genotypes of *Lupinus angustifolius,* varying in seed size.

The seed size ranges from 50 mg to 225 mg and protein content from 32% to 40%. The crude protein content in the seed coat is low and varies from 2.2% to 5%, and in the nucleus from 43% to 53%.

There is no tendency for big seeds to have lower nucleus protein concentration than small seeds, and genotypes with high nucleus protein concentration also have high seed coat protein concentration.

Over all genotypes analyzed, the seed coat proportion and thus thickness, and the protein concentration in the nucleus are not related to the seed size. The weight proportion of seed coat to whole seed consequently decreases with increased seed size. However, outliers with small seed and a low seed coat proportion are identified.

The general picture of constant seed coat thickness and nucleus protein concentration at various seed sizes, and the identification of genotypes with small seed and thin seed coat could allow for breeding of new big seeded, thin-coated varieties with increased protein content.

Annual lupins grown for green fodder in Iceland

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There has been a conscious effort in recent years to increase the contribution of forage legumes in Icelandic agriculture. This relates to their ability to fix nitrogen and provide fodder rich in protein. Annual lupins are traditionally grown for seed but they do not reach maturity during the short and cool growing season that prevails in the north. However, they may be a valuable addition as a green fodder crop. A number of experiments have been carried out in recent years in order to evaluate the potential of annual lupins (*Lupinus angustifolius*, *L. luteus*) for green fodder production along with a number of other annual legume species. The experiments addressed the following issues: Selection of species and cultivars, the effect of oats as a companion crop, the effects of different sowing and harvest times, fertiliser requirements and suitability for preservation of fodder in round bales.

The annual legumes turned out to be more sensitive in cultivation than other types of green fodder such as barley and oats. In addition to the two lupin species both *Pisum sativum* and *Vicia sativa* gave acceptable yields under good conditions or around 5 tons DM ha^{-1}. Annual lupins should be grown in pure stand and they require only limited amounts of P and K fertiliser. The other two species, on the other hand, depend on the presence of a companion crop and they need both P and K fertiliser to give reasonable yields. All legume species fixed more nitrogen when grown in sandy soils than in drained peat soils. The green matter gave adequate preservation in round bales if it was not harvested too late in the autumn. The production cost per kg DM of the legumes was comparable to that for more traditional green fodder such as oats and Italian ryegrass.

The effect of water stress and nitrogen on the nodulation and dry matter partitioning of *Lupinus angustifolius* compared with *Pisum sativum*

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To determine the effect of water stress on nodulation and dry matter partitioning in narrow-leafed lupin (*Lupinus angustifolius*) and peas (*Pisum sativum*) plants were grown in sand in 15 cm diameter by 80 cm deep pots Plants were given a complete nutrient solution which was lacking in nitrogen. However, all plants were inoculated with *Rhizobium* and there was a +nitrogen control. Water was provided to return pots to 100 %, 75 % 50 % and 25 % of field capacity. Harvesting, of both species commenced when all pea plants had at least one flower. There were three further harvests at 20 day intervals.

In both species growth was severely limited by water stress and in the irrigated to 25 % of field capacity there was no increase in plant dry matter (DM) from first to the last harvest. With increased water supply the lupins and peas continued to grow. Lupins held at 100 % field capacity increased in weight from 3.1 g/plant to 12.9 g/plant. In peas the increase was from 4.1 g/plant to 6.3 g/plant. In both species when held at 100 % of field capacity there was no difference in final DM production between the +N control and the -N plants which relied on biological N fixation.

In both species nodule number tended to increase with increased water availability. The maximum number of nodules in peas was at 40 days after the start of flowering at 323 nodules/plant when held at field capacity. In lupins the maximum number of nodules was 384/plant 60 days after flowering. In both species nodule number was reduced in the +N control pots. In both species water stress hastened the onset of physiological maturity.

The results suggest that in both species water stress severely reduces nodulation, which reduces N fixation and plant growth.

The effect of narrow-leafed lupin incorporation on soil physical and chemical properties compared with other grain legumes and barley

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The effect on soil structure and chemical properties of growing *Lupinus angustifolius* was compared with the growing of *Lens culinaris*, *Pisum sativum* or *Hordeum vulgare* or leaving the soil in fallow. At harvest maturity of the crops the following treatments were imposed. All above ground plant dry matter (DM) was soil incorporated, seed was removed and all remaining DM was soil incorporated or all above ground DM was removed. Following harvest of the legumes and the barley all plots were sown with a winter active Italian ryegrass (*Lolium multiflorum*).

Soil was sampled before cultivation, after harvest of the legumes and barley and at 90, 120 150 and 190 days after sowing (DAS) the ryegrass. Soil aggregate stability and bulk density were determined. Chemical measurements were total nitrogen (N), organic carbon (OC), cation exchange capacity (CEC) and pH.

Water stable aggregates tended to increase with increased plant DM incorporation. Among the crops and the fallow treatments, lupin consistently had the greatest proportion of water stable aggregates (59.7 to 73.6). All crops reduced soil bulk density. Values ranged from 1.55 in fallow plots at 90 DAS ryegrass to 0.85 in lupin plots where all DM was incorporated at 190 DAS.

At 190 DAS ryegrass the soil pH varied from 6.1 in fallow plots to 6.9 in the lupin plots. Soil total N at the same time ranged from 0.21 % in fallow plots to 0.32 % in the lupin plots and soil OC from 21.0 t/ha in fallow plots to 31.5 t/ha after lupin. All crops tended to increase the CEC, which ranged from 11.2 in fallow plots to 14.3 in lupin plots where all plant material was incorporated. Generally CEC increased as the amount of incorporated plant DM was increased.

The results suggest that increased crops yields observed in crops following lupins do not only depend on increased soil nitrogen.

RILS in white lupin *(Lupinus albus* L.)

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Recombinant Inbred Lines (RILs) were created in white lupin (*Lupinus albus* L.) through crossing two extreme genotypes. Five oligogenic traits differed among parents as well as numerous quantitative traits including flowering earliness, frost resistance, vernalisation requirements, protein and oil content and mean seed weight.

The female parent was a bitter indeterminate spring-type accession, TR19, collected in Ankara region. The male parent was an autumn-sown dwarf determinate sweet line.

220 F7 lines were produced. They will be studied in 2002 for segregating for alcaloid content, growth habit, internode length, seed colour, flower colour, flowering earliness. This mapping population will be available for QTL detection and to map the genes controlling mono or oligogenic traits.

Feeding trial in pigs and broilers used *Lupinus albus* seeds cultivated in Mexico

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The purpose of this study was to evaluate weight gain and feed conversion ratio on pigs and poultry fed diets formulated with *L. albus* seeds flour (38.0 % protein and 0.003 % total alkaloid content) that replaced to soybean as a protein source. Seeds were obtained from an agricultural trial carried out at Jalisco, Mexico. Ten Pigs (Landrace x Duroc x Hampshire) of 56 ± 2.3 kg and 144 broilers, one day old, were used to perform this feeding trial. The pigs were divided in two groups of five animals each, while broilers in three groups of 12 five animals each and four repetitions. Levels of protein soybean substitution were 0% (P1) and 50% (P2) for pigs, and 0% (B1), 50% (B2) and 100% (B3) for broilers, respectively. The average weight gain for pigs and broilers under P1, P2, B1, B2 and B3 treatments were 41.25 ± 1.53, 30.2 ± 1.02; 1.77 ± 0.05, 1.62 ± 0.06 and 1.7 ± 0.035 Kg respectively. There was not difference on feed conversion ratios among control and experimental groups of pigs and broilers. Base in our results can be conclude that *L. albus* can replace protein soybean to formulate pigs and broiler diets.

Genetical control of flower color in *L. angustifolius*

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The L. angustifolius flower color diversity includes blue, pink, white-pink, rose- white, violet, lilac and pure white.

Genetical experiments shows that the blue flower color is a wild mark and controlled by a block of wild genes (+++++). The pink, white-pink, rose-white, violet, lilac flower colors are all mutant marks and are controlled each by one different recessive gene. We have given the names for this mark: flowers color. For the mutant genes controlling this mark we have given the names: fco1 (pink), fco2 (white-pink), fco3 (rose-white), fco4 (violet) and fco5 (lilac).

Pure white is a principle new mark and is controlled by a block of genes containing a minimum of 2 two non-allelic recessive mutant genes, for example in our material (fco2 fco5, fco2 fco4, fco2 fco3, fco3 fco5).

Crossing non-allelic mutants for example rose-white to lilac, results in reversion to the wild (blue) flower color in F1. In F2 in results of recombination of the non-allelic genes the segregation is: 9 blue: 3 rose-white: 3 lilac: 1 pure white (principal new mark with the gene block fco3 fco5). Crossing the pure white with the wild genotype results in F1 in solely blue flowers, and in F2 in the same segregation as for rose-white to lilac.

We recommend to use the mutants genes controlling different near white colors, fco2, fco4 and fco5 and blocks of genes controlling the pure white color in breeding as a clear distinction and domestication mark.

Adaptation of lupins for Northern European maritime conditions

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Lupin are in Maritime areas in Northern Europe - The Scandinavian counties, United Kingdom, Ireland, Part of Germany known as a late unstable ripening crop. However, during the last 5 years new varieties with restricted branching, especially in *L. angustifolius* has allowed for an expansion in these areas. Therefore it is very important to study the various canopy structures (Fig. 1), for yield and stability in this region.

White winter lupins has a poor winter survival in Denmark and both white and yellow lupins ripen too late. New yellow lupins have earlier ripening, however, they are later and lower yielding than narrow leafed lupins. Results with narrowed leafed lupins have been obtained from 6 locations in Denmark, 2 in Ireland, 3 in England and one in Norway. The trials were protected from animals by alarm and fences, sprayed with herbicide and insecticide before and after flowering. The highest measured grain yield was 5,5 ton per ha. The yield potential of spikelike types is about 20% lower than of the pseudo-wild type, however, the spikelike types demonstrate the highest stability in development and timely ripening over years and locations. A major problem in the spikelike types is the weed control due to a smaller leaf area index; lower positioned leaves and a shorter duration of the canopy. For many varieties (Bordako, Borweta, Prima etc.) yield higher than 4 tons are often recorded in practical farming. These varieties are a good start for lupin growing in the maritime areas. However, new genotypes indicate that taller spikelike with bigger succulent leaves has better yield potential and better weed competition ability. For the pseudo-wild types higher resistance to lodging, simultaneous senescence of leaves and stems with the ripening of pods is important.

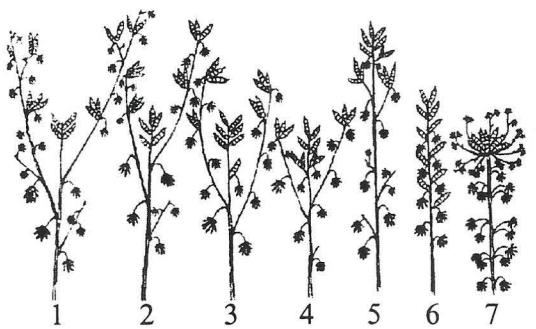

Fig. 1. Canopy structures. 1. Wild, 2 pseudo-wild, 3 quasi-wild, 4 corymbouse, 5 panicular, 6 spikelike, 7 palm

α-Galactooligosaccharides, starch and proteins changes in germinating Lupin seeds

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To improve the nutritional quality of grain legumes for non-ruminant animals, the level of α-galactooligosaccharides should be reduced, either by plant breeding, the extraction of seed, germination, or by using microbial α-galactosidase. Germination is possible to use as the most effective and simple way for this reason, which affects undesirably the nutritive value of lupin seeds. The aim of this paper is to investigate the effect of germination on the changes in concentration of α-galactooligosaccharides, starch and proteins in seeds of Lupinus albus. The seeds were germinated in aerated water media, water was changed after 24 hrs, temperature 20 °C, time of germination 24, 48 and 72 hrs. Soluble carbohydrates were monitored by HPLC technics, total and damaged starch contents were determined according Megazyme assays procedures and crude proteins content was calculated from total nitrogen according to the Kjeldahl method using a nitrogen autoanalyzer. While the content of proteins increased from 33.9 to 36.0 g/100 g d.m., changes of carbohydrates were as following: content of sucrose (SUC) increased from 3.18 to 3.84 g/100 g d.m., content of stachyose significantly decreased from 5.63 to 2.09 g/100 g d.m., content of verbascose decreased slightly from 0.58 to 0.50 g/100 g d.m., but content of raffinose increased from 0.68 to 1.50 g/100 g d.m. Total content of α-galactooligosaccharides (RFO) decreased from 6.90 to 4.09 g/100 g d.m. and ratio RFO/SUC changed from 2.17 to 1.07. These changes in contents of soluble carbohydrates are favourable from nutritional point of view.

Lupinus angustifolius: growthregulating and adapting action of 24-epybrassinolide

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Effect of 24-Epybrassinolide (24-EpyBR) on yield of Lupine corn, storage and nonhistone chromatine proteins, IAA and ABA level, lectin and protease-inhibitor system activity in Lupine plants (L.angustifolius) in normal conditions and under the salt-stress (0,1M NaCl) were studies and the following results were obtained.

It was found that 24-EpyBR-spraying of Lupine plants during the budding-flowering stimulated the yield of lupine corn throught the increasing of thousand-grain weight and number of the beans per plant, seed protein content up to 3,3% without deterioration of its aminoacid composition in normal condition. At the same time thus hormone was shown to stave off the action of 0.1 M NaCl-stress.

The comparative study of electrophoretic spectra of storage(α- and β-conglutine) and chromatine nonhistone proteins (NHP) have been shown that 24-EpyBR induced the increasing of low molecular components of β-conglutin and some changes in high and medium regions of NHP spectra.

In addition, it was also noticed that 24-EpyBR induced the increasing of IAA/ABA ratio, stimulated lectin phytohemagglutinating activity, protease-inhibitory system either in normal condition or under NaCl-stress. These findings seem to suggest that 24-EpyBR induces the changes of adaptive strategy of Lupine plants from ruderal (R-strategy) to stress-tolerance (S-srategy). The possible mechanism of brassinosteroidal growth promoting action on maturing seeds connected with the changes of nuclein-protein metabolism, lower intensity of catabolic processes, an increasing of attractive ability is discussed.

The acceptability and harvestable yield of Russell lupins for sheep

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Pasture mixture experiments in the South Island of New Zealand have shown that the Russell lupin (*Lupinus polyphyllus* x *Lupinus arboreus*) has potential as a pasture species, for sheep, in the hill and high country an area, which covers some millions of hectares.

Preliminary experiments with offering of Russell lupin to sheep showed that despite the alkaloids in their foliage they were readily consumed. There is little published work on the total dry matter (TDM) production of the hybrid or its acceptability for grazing by sheep. The work described reports on an experiment where Russell lupin was grown and offered to sheep at three physiological growth stages: at full bloom, green pod and at dry pod stage. Two-tooth Coopworth ewes grazed plots.

The lupin TDM yield varied from approximately 4 t/ha at full bloom to 16 t/ha at the dry pod stage. Estimated animal intake of lupin forage increased as the plants matured and varied from approximately 0.74 kg/animal/day to 3.03 kg/animal/day. However, as intake increased utilisation feel from 90 % to 75 %.

When sheep, which had not previously been fed on Russell lupins, were introduced to them at the green pod stage there was an initial significant difference in the rate of dry matter disappearance. However, this difference only lasted for 24 hours. This suggests that even for unaccustomed animals that Russell lupin forage is acceptable to sheep as a pasture legume.

Evaluation of white lupin (*Lupinus albus* L.), temperate corn (*Zea mays* L.), tropical corn (*Zea mays* L.), or hybrid pearl millet (*Pennisetum glaucum* [L] R. BR.) silage for lactating cows

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Temperate corn (TC) silage is unexcelled as a forage but ensiling unconventional crops may be profitable in specific situations. White lupin (L), tropical corn (TrC), hybrid pearl millet (PM) and three TC silages were evaluated with 54 Holsteins in a 91-d lactation-digestion study and with six ruminally cannulated cows in an in situ study. The dry matter (DM %) of TC, TrC, PM and L silages were 38-47, 30, 30 and 26, respectively. Corresponding nutrient values (% DM) were: acid detergent fiber (ADF): 19-24(TC), 32(TrC), 30(PM) and 41(L); neutral detergent fiber (NDF): 39-45(TC), 57(TrC), 52(PM) and 55(L); crude protein (CP), 7-8(TC), 9(TrC), 12(PM), and 14(L). Diets were supplemented so as to be isocaloric and isonitrogenous; the four silages composed 41-52, 36, 36 and 34 % of dietary DM. Intake (DM, kgd^{-1}) was greater for cows on TC (22.7) than for those on TrC (19.8), PM (17.2) or L (19.6) diets. Milk yield (kgd^{-1}) was greater for cows fed TC (30.8) than those fed TrC (26.8), or PM (26.3) and tended to be greater ($P<0.06$) than for cows on L diet (28.5). Milk protein and 3.5% fat corrected milk followed the milk yield pattern. Milk fat (%) was similar for all diets whereas milk protein (%) was lower for cows fed PM than if fed TC. Apparent digestibilities of organic matter, CP, DM, ADF and NDF were highest for L (81-88%), followed by TrC and PM (68-78%) and TC (38-72%), respectively. In situ potentially digestible DM, ADF, and NDF were greater for unconventional silage diets than for TC silage diets. Degradation rate of DM and ADF for L diet was also higher than for temperate corn silage diets. Results indicate that lupin, tropical corn and pearl millet can be ensiled and used in dairy rations, but milk production may be depressed with the latter two crops.

Herbicides in Lupin cultivation

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Crop protection against weed plays the most important role in lupin cultivation. It is not possible to have high yield without elimination of this problem.

Lupins demand early sowing dates and it makes difficult to take additional spring soil cultivations for weed control.

Lupin seed rates are 5 – 6 times lower than the grain crops have and it is impossible to increase crop density to press weeds.

According to its biology lupin has rosette stage during 4 – 5 weeks, it grows slowly, at this period weeds pass it in the growth and depress lupin plants.

Lupin ability to accumulate molecular air nitrogen by its root system has positive effect on neighbor plants, which use nitrogen compounds from lupin rizosphere during significant vegetation part. Additional nitrogen nutrition results in rapid weed development in lupin crops.

Weed population and their distribution in the European part of Russian Federation have been studied. About 12 –15 species are the most harmful for lupin cultivation areas in Russia. Annual weed species make up 55 – 60% and a part of perennial plants is 40 – 45%.

Dynamics of weed species composition has been studied. Threshold of biological weed damage for lupin crops has been determined.

Aspects of ecological safety herbicides use in modern lupin cultivation have been studied based on physical, chemical and biological stability of xenobiotypes.

An herbicide system against annual and a number of perennial weeds has been developed to protect yellow and narrow-leafed lupin crops under sufficient moisture conditions in the European part of Russia. The system results in 25 – 40% yield increase.

Agro-energy productivity of herbicide use in lupin crops under conditions of the European part of Russia has been calculated.

Intercropping as and productive approach to stability increase of Lupin seed yield

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Biotic stresses are the main reason of yield variability and significant lupin seeds losses, which make from 15 to 70%. Lack of polygenic resistance of cultivated lupin species to one of the most dangerous diseases and namely to anthracnose, which causes great economical injury to commercial crops, is the main reason of catastrophic situation in seed production in many lupin growing areas of the world.

The study aimed to increase lupin plants' phytoimmunity to anthracnose and other diseases and to stabilize seed production by means of type and tendency changes of rival relations of intercropping.

Theory of the present study is that it's possible to induce phytoimmunity of less aggressive legumes, such as lupin to disease complex under changing of rival relations' type in agro-coenosis if biological different plant species are cropped. The experiment showed that under intercropping arised chemical rhizospheric allelopathy is the main mechanism of phytoimmunity inducement.

It was obtained that in lupin and grass crop lupin plants accumulate polymer phenols, which are a chemical and physical barrier to prevent pathogen penetration into a plant. These compounds are mainly accumulated in the most anthracnose susceptible plant parts. Polyphenols content of healthy lupin plants from a mixed crop was 28%, 53%, 89% higher in the middle stem part, peduncle and pod valves respectively, compared to healthy plants from a single crop.

Distribution of anthracnose and other diseases decreased in 2 – 8 times under intercropping, and the action of phytoimmunity inducement was like to polygenic resistance. Yearly lupin seed yield variability was 4 – 5% under intercropping, while the latter was 25% and more in a single lupin crop. This index of grass component was 8 – 9%. Grain mixture yield of intercropping was 28 – 32% higher than the average yield sum of components in single crops, which resulted in effective stabilization of grain production.

Our research work resulted in accumulation of new actual material, which was given to a patent of this scientific work.

Nitrogen-fixing activity of nodule and nitrobacteria micro-organisms' in lupin and grass Agro-Coenosis

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Lupin symbiotic accumulation of molecular nitrogen has been tested. The tests have been carried out in mixed lupin and barley and lupin and wheat crops. Nodules bacteria and nitrobacteria micro-organisms have been used for seed treatment. It is known that symbiotic nitrogen accumulation activity could be increased by nodule- and nitrobacteria microorganisms resulting in seed and agro-coenosis green mass yield increase.

The aim of the work was to increase symbiotic nitrogen accumulation activity in a mixed crop to produce higher seed and protein yield.

The tests have been developed on $50m^2$ plots in 4 replicates 1994 – 1999 on gray wooden soils of the South-West part of Russian Federation. The narrow-leafed lupin var. Crystal, the barley var. Zazersky 85, the spring wheat var. Voronezhskaya 6 have been used for sowing. Seed mixture consists of 0.8 mln lupin seeds and 1.2 mln seeds of other grass crops per 1 ha. Before sowing the seeds had been treated with nodules bacteria strain 363a and with nitrobacteria micro-organisms' flavobacterin, mobil and misarin preparations.

The tests showed that bacteria preparations affected the lupin nitrogen-fixing level in lupin and barley crops and in lupin and wheat ones. Lupin root and nodules weight increase was the main character of the effect. The highest root weight increase was observed when nodules bacteria 363a and flavobacterin, mobil and misarin had been used jointly. Compared to the standard where crop mixture seeds have not been treated with bacteria preparation, lupin root and nodules weight increased in 17 – 20% after their treatment with 363a bacteria and flavobacterin and were approximately the same as lupin root system weight in single crop was. Lupin and barley seed mixture treatment with mixed misarin and 363a bacteria preparation had anti-stress effect in dry seasons. To the glitter pod stage lupin root and nodules weight were 23% higher compared to the standard. Dry matter weight of overground lupin plant part was in 29% higher and of barley – in 80% compared to the standard. Grain mixture yield increased in 3.3 – 3.6 metric center per ha or 13.5 – 14.0% compared to standard, protein output increased in 24%.

Non- allelic gene recombination and its use in the breeding of *Lupinus angustifolius*

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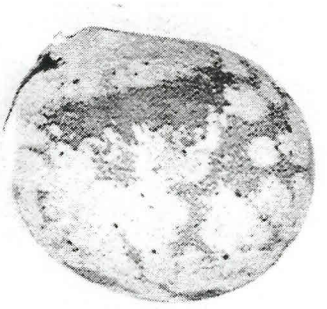
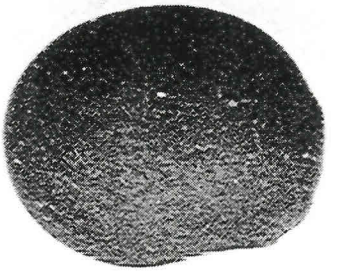
For quickly expansion of the lupin belt in the northern hemisphere we need principal new varieties with high yield and adaptivity potential and good quality. This can only be obtained by new association of genes, and therefore it is very important to study the role of allelic and non-allelic genes in this process. By comparing hybrid populations with their parents for qualitative and quantitative traits numerous experiments shows that only non-allelic gene recombination produce principal new genotypes and increase polymorphism, whereas allelic gene recombination only repeat in the hybrids the parents genes marks. We cite results of the use of non-allelic genes in practical breeding in following direction:

- Reversion to wild marks (xeromorph leaf structure, dark green leaf color, seed with semimoon (fig. a)).
- Increases expression of marks (raise in protein content and resistance to diseases, decrease in alkaloid content etc.) .
- Creation of principal new marks (pure white color of flowers and seeds, red-brown and black seed colors (fig. b)).





The semimoon mark is dominant in relation to the wild type pattern and is controlled by minimum two genes. Red-brown and black seed color are recessive in relation to the wild type pattern, however, black is dominant relative to the red-brown seed color. Both colors are controlled by a block of 4 genes. These principal new marks we recommend to use in breeding for distinction of varieties. Beside black seeds are recommended in humid harvest conditions because they are heated more by sunshine and ripen and dry quicker.

Greenhouse screening for fusarium wilt resistance in lupine

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The interest in growing *L. angustifolius* is increasing in humid maritime areas in northern Europe due to new earlier and higher yielding varieties. However, these conditions favor fusarium root rot and fusarium late wilt development, which could be accentuated by a short rotation of grain legumes in organic fields. Thus fusarium resistance is highly important in these conditions.

To evaluate the resistance, susceptible and resistant genotypes and F2 and F3 populations were grown in greenhouse in a sandy soil which 2 years before was taken from a lupin field. The precedent crop in the greenhouse was also lupin. The dominant fusarium species in the soil was in descending order *F. oxysporum then F. avenaceum, F. culmorum, F. solani, F. gibbosum.* Large fusarium wilt presure was observed and fully susceptible lines were completely destroyed by fusarium wilt caused by *F. oxisporum.*

In *L. angustufolius* total resistance to wilt was among others observed in Crystal (Russia), Mitan (Belarus), E104, E105, E106 (Denmark), Tanjil (Australia). In *L. albus* Giza (Egypt) and MA (Denmark). All tested *L. luteus* were resistant in these conditions.

Very susceptible *L. angustifolius* lines were Prima (Denmark), Sonet (Poland), Borweta (Belarus), Kalya (Australia). The larger part of the *L. albus* lines was 100 % destroyed eg. Lublanch (France), E1 and P1 (Denmark). These results correlate well to known resistance under field conditions in various countries.

Single pod descent F2 and F3 hybrid populations in *L. angustifolius* showed that resistant genotypes have two dominant non-allelic resistance genes to wilt. We call this gene Relation to fusarium oxisporum (Rfo1,Rfo2). Susceptible genotypes have either two wild genes (++) or one wild and one dominant resistant gene (+ Rfo2, or Rfo1 +). Crossing '+ Rfo2' to 'Rfo1 +' segregates in 9:7 resistant to susceptible in F2, the same segregation was observed by crossing 'Rfo1,Rfo2' to '++'.

It is recommended to use these resistant varieties as a source of resistance genes for breeding in areas with potential fusarium wilt problems.

Evaluation of antifungal activity of bacteria-antagonists towards lupine pathogens

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One of the main trends in successful lupine cultivation is control plant pathologies, especially widely distributed, like anthracnose (*Colletotrichum gloesporioides Sacc.*), grey mould (*Botrytis cinerea Fr.*), brown spot (*Pleiochaeta setosa Kirchn.*). The growing of susceptible or low-resistant lupine varieties demands application of chemical fungicides that cause environment contamination and development of fungicide-tolerant strains of the pathogens. One of the promising alternatives to the chemical control is biological method envisaging use of antifungal property of bacteria-antagonists.

Antagonistic action of bacteria towards phytopathogenic fungi was observed by placing both these organisms on the same agar medium with Hottinger broth and incubating them at 28 °C for 2 days. Phytoprotective effect of antagonistic bacteria was studied on the 9 days old narrow-leafed lupine seedlings derived from the seeds inoculated with fungal spore suspension ($1 \cdot 10^7$ spores ml^{-1}) and treated with bacterial culture ($1 \cdot 10^9$ cells ml^{-1}).

Isolated soil bacteria and collection strains (300 samples) were evaluated for antagonistic activity to phytopathogenic fungi. High fungicide activity against *C. gloesporioides* on the agar medium was displayed by soil isolate *Bacillus subtilis B-37* and collection strains *Pseudomonas aurantiaca 9* and *Bacillus pumilus BIM B-263*. Strong antagonistic effect was observed between soil isolate *Bacillus sp. K-3* and *B. cinerea*. Bacteria *Bacillus sp. K-3* and *B. subtilis B-37* possessed antifungal activity towards *P. setosa* as well.

All tested antagonistic bacilli produced significant growth zones on phytopathogenic fungi during dual culture on agar medium. Most of them caused small transparent zones of fungal growth inhibition (FGI) around of bacterial growth. In distinction of bacteria *Bacillus* genus strain *P. aurantiaca 9* created well-developed FGI zone while his growth on the phytopathogen was very slight. These facts suggested different mechanisms involving into antagonistic interaction between bacteria and fungi.

Preliminary selected bacteria-antagonists have been tested for phytoprotective activity on the lupine seedlings against anthracnose and grey mould. According to obtained data high fungicide effect against anthracnose was recorded during seed treatment with *P. aurantiaca 9*. *B. subtilis B-37* and *B. pumilus BIM B-263* possessed moderate phytoprotective capacity in relation to *C. gloesporioides* infection. Strain *B. subtilis B-37* confirmed its fungicide activity in the field experiment lowering anthracnose severity when was applied on diseased plants. Grey mould development on the seedlings was completely stopped by soil isolate *Bacillus sp. K-3*. It is necessary to note that all studied bacteria did not damage lupine and therefore can be used as potential biocontrol agents.

We would like to conclude that bacteria-antagonists selection is multi-step process including model experiments on agar medium, seedling tests and field trials. Screened microorganisms, possessing high antagonistic activity against lupine pathogens are valuable initial object for further investigation of their antifungal activity *in vivo* on lupine plants to develop effective biofungicides.

Periodic system of narrow-leafed lupine taxons and its using in ecological breeding

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Biological genebank (BGB) of narrow-leafed lupine consisting of 14 complementary by most genes components have been developed. All controlled genes were experimentally concentrated in BGB. As result of complementary and other kinds of non-allelic genes interaction and their recombination large diversity of new genotypes was discovered in hybrid progeny of a crossing between BGB components. Many years using of BGB in the breeding allowed to create significant intraspecific variety that caused difficulties with its traditional botanic description. With the aim of botanical systematization of narrow-leafed lupine diversity and further directional synthesis of new genotypes we elaborated the periodic system of intraspecific taxons (PSIT) similar on periodic system of elements in chemistry.

For the development of PSIT we used experimental data of homological heredity of the taxonomic characters and took into account the Rules of International Code of Plants Nomenclature.

In the PSIT we set up 7 periods which are based on the color of flowers corolla (1 – blue, 2 – pink, 3 – white-pink, 4 – rose-white, 5 – violet, 6 – lilac, 7 – white). Periods include subperiods which are differed by the seeds complex color (background color, presence or absence of pattern, type and color of pattern). First and second periods contain 15 subperiods of each; third and fourth periods – 9 subperiods of each; fifth, sixth and seventh periods – 1 subperiod of each. Subperiods consist of 6 classes which are recognized by presence or absence of a stripe under the hilum, triangular spot and semi-moon mark on the seed coat. Classes have groups which are distinguished by the color of vegetative organs (1 – green, 2 – dark-green with anthocyane, 3 – anthocyane color). Every group is divided onto 4 subgroups which are varied by the type of branching and by the form of stem (1 – unrestricted branching, unfasciated stem, 2 – restricted branching, fasciated stem, 3 – unrestricted branching, fasciated stem, 4 – restricted branching, fasciated stem).

PSIT includes 2528 taxons (276 variations, 356 subvariations, 1896 forms). First and second periods have 85 variations, 170 subvariations, 765 forms of each; third and fourth periods – 49 variations and 147 forms of each; fifth period – 6 variations, 12 subvariations and 54 forms; sixth and seventh periods – 1 variation, 2 subvariations, 9 forms of each.

The using of PSIT in the botanical investigations, genetics and practical breeding showed that it brightly reflected objective reality of forms variety of narrow-leafed lupine.

Due to PSIT the directional synthesis of new genotypes with unique associations of characters have being conducted for the using in ecological breeding in the Belarus, Russia, EU countries and formation of lupine belt on the Planet.

Thus, periodic system of narrow-leafed lupine intraspecific taxons reflecting the potential of its botanical diversity allows to plan and develop new genotypes for the breeding.

Breding of fodder perennial forms of multifoliate lupin (*Lupinus polyphyllus* LINDL.)

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The aim of the work was development of the methods allowing creating fodder (sweet) varieties of *Lupinus. polyphyllus* Lindl.with stable nature of low alkaloidness character. Research materials were represented by the lupin collection of the N.I.Vavilov Institute of Plant Industry: cvs. *Belorusskkij 1*, *Borovlyanskij*, *Chernigovskij*, *Stodolishchenskij*. However, bitter alkaloidal plants had appeared in these accessions. Cross-pollination of these forms resulted in heterozygosis in F_1 with the presence of dominant alleles in all pairs of genes (AL_1al_1 AL_2al_2 AL_3al_3). This, in its turn, provided for the restoration of alkaloids. For elimination of this lack new approaches are offered. The principal distinctive feature of the developed new approaches are that only compatible forms are involved in hybridization, with their low alkaloid content controlled by one and the same genetic system. The first method of obtaining fodder (sweet) forms of *L. polyphyllus* Lindl. was as follows: the selected low-alkaloid plants were crossed with each other and progeny from every crossing was grown separately. Populations entirely consisting of low-alkaloid plants were selected as initial materials for breeding. Regarding the second method, each low-alkaloid plant was crossed with a productive alkaloid-containing form possessing other valuable characters, and populations with stable low alkaloid content were selected in F_2. The fodder (sweet) varieties of multifoliate lupin with sufficiently stable and low content of alkaloids are created using the developed methods. Positive results is demonstrated the commercial cultivar *Pervenec* (the first sweet variety) that has been listed in the State Catalogue of Breeding Achievements in Russia. We carry out breeding work with multifoliate lupin in Finland since 1996. Our major tasks are breeding of cultivars having stable low alkaloid content, different types of pollination, non-dehiscent pods, winter hardiness and frost tolerance, capable to produce high yields of green matter (40.0-50.0 t/ha), maintain shading of cover crops and with white flowers and seeds, in analogy with white flowered and white seeded varieties of blue lupin (*L.angustifolius* L.) in Australia.

Possibility of selection and cultivation of narrow-leafed lupin in Finland

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The purpose of our researches was studying the opportunities of breeding and cultivation of narrow-leafed lupin (*L. angustifolius* L.) in Finland. The object of the studies was cultivars and lines of narrow-leafed lupin with determinate branching: *Ladny* from Russia, Mut-*1* from Poland, *Lanedeks-1* and *Pershatsvet* from Belarus and early lines and hybrides created on their basis. Parental forms as well as most productive, early and stable hybrids were tested also in 1995-2001 in Finland near Pellosniemi (Province of Mikkeli,61^0 N. Lat.) on two sites: with sandy soils and clay soils at spring sowing. Besides, cv. *Pershatsvet* was tested in Jokioinen on clay soil. Seed sown near Pellosniemi were inoculated with commercial strain *363A* of *Bradyrhizobium* sp. (*Lupinus*) produced in the All-Russian Research Institute of Agricultural Microbiology.

As a result of hybridization the early andconstant lines of narrow-leafed lupin with determinate branching were selected. Best of selected lines were surpassed the parental forms by on early-maturity and productivity. The maturity of seeds at spring sowing (in may) at the best lines came usually on sandy soils at the end of August or at the beginning of September, before fall in temperature. However, on the site with clay soils full maturing of seeds did not come in most cases before chills. Boreal Plant Breeding (in Jokioinen) has carried out scientific and industrial test of cv. *Pershatsvet* received from Belarus (Zhodino).

Our researches have shown, that early forms of *L. angustifolius* L. with determinate branching are quite suitable for cultivation on sandy soils in the south of Finland and others Scandinavian countries. Svs. *Ladny, Pershatsvet* and created on their basis lines represent value for future breeding for boreal conditions. The important circumstance of its successful growing is application of preparations of nodule bacteria, especially in those regions where lupin is cultivated for the first time.

Diallele analysis of pod wall proportion

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The pod wall proportion of the currently grown white lupin (*Lupinus albus* L.) varieties is high (0.30) while the pea and fababean varieties average 0.13 and 0.19 respectively. As this trait is highly correlated with seed yield, its reduction through breeding is a possible route to select high yielding varieties. The analysis of genetic resources showed a wide range of variation, from 0.19 to 0.36. A diallel mating design was built to determine the genetic inheritance of this trait.

Results showed a mainly additive inheritance and a strong correlation between the GCA values and the own values of the parental lines. Some F1 progenies had pod wall proportions as low as 0.16 while the best parents reached 0.21

Evaluation of natural lupin populations from the northwest of Iberian Peninsula

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Three lupin species (*Lupinus angustifolius*, *L. luteus* and *L. hispanicus*) grow naturally in Galicia, northwest of Spain. This region, with more than 1 million of cattle heads, almost 20% of spanish total, is no under cultivation of any protein legume for feed. Lupin crop would contribute to the supply of vegetal protein at low cost. For these reasons, a program to characterize and evaluate lupin populations is being carried out at the Mision Biologica de Galicia (CSIC) since 1999. According to the preliminary results, there are three narrow leaf lupin populations with suitable characteristics for their possible future cultivation in this area and local farmer utilization.

Effect of different forms of nitrogen supply on the protein content and mineral composition of lupin leaves.

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Under different conditions of nutrient supply, plants can show changes in metabolic pathways. This can lead to qualitative and quantitative alterations in organic compounds, such as protein and amino acid content, organic acids composition and clorophyl content which may be implicated in the reduction of growth observed.

Two cultivars of white lupin (*Lupinus albus* Lublanc and *Lupinus albus* Estoril) were grown in aerated nutrient solution, with different concentrations of nitrogen, supplied as nitric and ammonium nitrogen. Nitrogen was added as NO_3 alone, NH_4 alone and as different combinations of both nitrogen forms. The plants were grown for 5 weeks and the leaves were analysed for Kjeldhal nitrogen content, soluble protein, mineral composition (sodium, calcium, magnesium, potassium, manganese, iron, copper and zinc) and biomass production. Some correlations with the variations in the nitrogen supply were established.

The obtained results were similar for both lupinus cultivars. The decrease in the level of nitrate in the nutrient solution led to a lower plant yield. Protein content showed a peak in intermediate concentrations of NO_3. A higher protein concentration in leaves was observed when the plant was grown in a mixed nitrate/ammonium solution than in only nitrate or ammonium solutions. An increase in zinc concentration with the decrease of nitrate concentration was observed. When the nitrate content was progressively substituted for ammonium a decrease of manganese concentration was detected.

Optimization of the expression of a *Lupinus campestris* conglutin gamma gene fragment rich in essential aminoacids

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Conglutin gamma is one of the four globulins present in lupin seeds, such protein is one of the richest nutritionally. In contrast with the rest of the globulins, it has the highest essential amino acids composition of them. Conglutin gamma contains 499 amino acids, from which 198 possess the biggest amount of essentials (59.5%), and for this reason it is worth to produce this fragment in large-scale through DNA recombinant technology to introduce it in human or animal feeding. Our work's objective was cloning and expressing the conglutin gamma fragment from *Lupinus campestris* in *E. coli*. In order to achieve it, the fragment was inserted into pPROEX-1 vector and the construction was characterized through PCR amplification and restriction enzymes. The insert was sequenced. And the sequences compared with that from *Lupinus angustifolius*. Then, *E. coli* AR68 strain was transformed with the recombinant vector and induction levels were determined with IPTG at 32°C. Four hours later protein expression was detected. Current investigation is trying to obtain the purified protein.

Lupinus albus breeding objectives in Russia

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Lupinus albus breeding programs in Russia are aimed to develop early ripening (vegetation period is 110 – 120 days), determinant grain varieties with high harvest index (55 – 60%), low alkaloid content, Fusarium wilt and anthracnose resistant, producing 4.5 – 5.0t/ha with 40 – 42% of protein in seeds.

As initial material N.I. Vavilov's institute collection material as well as own hybrid and mutant material is widely used for breeding characters.

Late maturity is one of the main limiting factors in *Lupinus albus* cultivation in Russia. Together with Tambov plant research station early ripening, fusarium resistant vars. Gamma (1998) and Delta (2000) with restricted lateral branching have been developed by means of radiation mutagenesis based on var. White 7 (k-1605). At present var. Gamma is the earliest ripening among adapted white lupin varieties and is widely used in the further breeding as early maturity and Fusarium resistance source. Polish determinate lines k-3494, k-3495, k-3496, k-3497, k-3498 are used as the second early maturity source. Unlike to ordinary late lines the mentioned ones have blocked lateral branching, therefore they ripe early and uniform. Their vegetation period is by 5 – 10 days shorter compared to standard Gamma. However they are not fusarium resistant, therefore they have been included into crossing with our and Ukraine indeterminate fusarium resistant varieties. These crossings resulted in lines with different branching and early maturity levels as well as in productivity. Seed yield of new early ripening lines is 5.0 - 5.5t/ha under competition test.

Fusarium and anthracnose resistance breeding of white lupin is doing on special infectious backgrounds. Vars. Olezhka, Siny Parus, Pitshevoy, Dieta, Gamma, hybrid lines (Kiev 51 x Gamma) and our lines BL 72, BL 246-98 are used as fusarium resistance source. High resistant lines BL 241-98 and BL 243-98 developed by crossing of fusarium susceptible ecologically and geographic distant lines k-2588 (Australian Ultra x Start) are of great interest. The lines are early ripening, have restricted lateral branching of the second order level.

BL 241-98 and BL 243-98 are under further research and are used in breeding programs as new resistance source with a number of economical and biological characters.

Plant succession in areas colonized by the introduced Nootka lupin in Iceland

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Nootka lupin (Lupinus nootkatensis) has been used in land reclamation in Iceland for 50 years. We studied the effects of the plant on vegetation and soil at 15 sites, where the lupin had grown for 10 – 40 yrs and colonized barren eroded areas, braided river beds, partly vegetated moss heaths and denser dwarf-shrub heaths.

In southern Iceland, where annual precipitation is 900 – 3400 mm, the lupin plants were relatively high (80 – 120 cm) and formed dense patches. In northern Iceland, where annual precipitation is 500 – 800 mm, the lupin was lower and the patches were open in the driest areas. At sites where the lupin formed dense, long-lasting patches the vegetation developed towards a forb-rich grassland. Species richness was, however, greatly reduced within the patches compared to adjacent control sites. The effects of the lupin were generally greater in the southern area and the vegetation of old patches was rather uniform. It was more diverse in the drier north where the lupin had less effect on vegetation composition.

Carbon (C) and nitrogen (N) content of soil increased considerably where the lupin had colonized barren or partly vegetated areas. The changes were greatest at sites in the south, where C increased about 0,1% (~1300 kg/ha) and N 0,01% (~120 kg/ha) per year. At sites in the north where the lupin had colonized dwarf-shrub heathland with a relatively humus rich soil there were indications of net-carbon loss from the soil.

The Nootka lupin is a very effective plant for land reclamation in Iceland. Dense plant cover and soil fertility is gained within a relatively short time, where the growth of the lupin is not limited by droughts. The lupin is well suited for reclamation of large, barren areas. The nitrogen fixation of the lupin, rapid growth, relative height and patch formation, on the other hand, enables it to invade mossheaths and dwarf-shrub heathlands that it will take over and displace. This calls for strict management guidelines on the future use of the plant.

Functional properties of protein isolates from two mexican lupin species and their enzymatic modification

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Wild lupins are abundant throughout in Mexico, about 100 species have been identified, their seeds contain 35 to 45% protein and 2 to 4% alkaloids. We thought on the possibility of preparing a protein isolate and it modified enzymatic in order to determine their functional properties for use as a food additive. The protein isolates were prepared from *L. elegans* and *L. exaltatus* flour, by isoelectric precipitation and were modified with trypsin 1%. Crude protein content in *L. elegans* and *L. exaltatus* protein isolates were 95 and 93 % with a protein yield of 31 and 33%, respectively. Functional properties: maximum nitrogen solubility, maximum foaming stability, maximum foaming capacity, least protein concentration endpoint for gelation, water and oil absorption capacity were significantly modified for trypsin action. Lupin protein isolates were similar with respect to other legume protein isolates. Therefore, these products might be safely used as food additive.

Influence of P-deficiency on white lupin N_2 fixation

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It is known that white lupins have developed elegant adaptations to a P limited environment. E.g. proteid roots exude large amounts of organic acids as well as acid phosphatase. The N_2 fixation apperatus of white lupins has as well special adaptational features. The objective of our study was to evaluate N_2 fixation of white lupin in a P limited environment. White lupin plants were grown in sand culture at 25 and 500 µM P and N_2 fixation (H_2-evolution), the activity of key enzymes of nodule C/N metabolism and nodule O_2 uptake was determined. P stressed lupins maintained intensive nitrogen fixation for several weaks. P-efficiency of N_2 fixation was strikingly increased (N_2 fixed/nodule P). Nodules adapted through increased O_2-uptake and increased organic acid production. Decreased nitrogen fixation and visible P-deficiency started prior to flowering about 3-4 weeks after imposing the treatments.

Effect of enzyme supplementation on nutritive value of lupin diet for broiler chickens

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The nutritive value for poultry of the seeds of low-alkaloid white lupin, depends mostly on protein and fat content. Its carbohydrate fraction consisting mainly of non-starch polysaccharides (about 400g per kg DM) and oligosaccharides (about 105 g per kg DM) is poorly utilized by poultry, due to the lack of respective endogenous enzymes in digestive tract. The aim of the study was to check if supplementation of lupin containing diets with different feed enzymes improves its nutritive value for broiler chickens.

The wheat based diet, containing 300 g/kg of seeds of white lupin cv. Butan was mixed with following feed enzymes: BioFeed Wheat (BFW, xylanase), BFW and Energex (E, pectinase, β-glucanase) or BFW, E and α-galactosidase each in amount of 1 g per kg diet. Unsupplemented and supplemented diets were cold pelleted. The experiment was performed according to Smulikowska and Mieczkowska (1996). Each diet was fed ad libitum from 8 to 21 day of life to group of 24 female Starbro broiler chicken, kept in individual cages. Body weight and feed intake were registered at weekly intervals. At the 22 day of life 10 birds from each group obtained the same diet mixed prior to pelleting with 3 g/kg of Cr_2O_3. In balance experiment feed intake was measured and excreta collected from 25 to 27 day of life. Diets and excreta were analyzed for dry matter, nitrogen (total and fecal), ether extract, crude ash, Cr_2O_3 and gross energy. The apparent digestibility of protein and fat, organic matter retention and metabolizable energy of diets were calculated. Remaining 14 birds from each group were killed at 25 day of life, digesta were collected from jejunum, ileum and caeca for viscosity and pH determination

The supplementation of lupin-containing diet with enzyme preparations designed to hydrolyze wheat arabinoxylans (BFW), lupin non-starch polysaccharides (E) or lupin α-galactosides (α-galactosidase) did not improve significantly body weight gain, feed intake or feed conversion ratio. The apparent digestibility of fat and protein increased by 3.6 and 1%, respectively ($P< 0.05$) after xylanase supplementation, but addition of one or both remaining enzyme preparations depressed apparent digestibility of fat and protein and organic matter retention. None of the enzymes improved significantly metabolizable energy of the lupin-containing diet. The viscosity of digesta from jejunum insignificantly decreased after enzyme supplementation, but viscosity of caecal digesta increased and was the highest in birds fed the diet supplemented with xylanase and pectinase/β-glucanase (21.3 mPas.s vs 2.4 in control diet, $P<0.05$) the changes in pH of caecal digesta were non significant. The significant increase of caecal digesta viscosity after pectinase/β-glucanase supplementation may indicate, that enzyme released viscous NSP from bigger, probably formerly unsoluble polymers.

It may be concluded that nutritive value of white lupin seeds was not affected positively by enzyme supplementation.

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Possibilities of non-traditional using of alkaloidness in the breeding of narrow-leafed lupine

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Because of in last years to improve yield potential and adaptivity of sweet narrow-leafed lupine breeders widely used wild forms of *Lupinus angustifolius*, *L. linifolius* and *L. opsianthus* it is very necessary to continue researches on the alkaloid complex of new breeding material and new cultivars.

Determination of individual and total quinolizidine alkaloids in lupine seeds was carried out by gas chromatograph. Nutritional value of the seeds was studied by use of the test-organisms of *Tribolium confusum* larvae and their sensitivity to quantity, quality of individual pure alkaloids and alkaloid complex of wild and sweet lupine forms. Chemical and genetic researches were conducted on the wild forms, feed cultivars and varieties, on the hybrids of first and second generations.

It was found that flour beetle larvae displayed variable sensitivity to different pure alkaloids, toxicity degree of which can be set up in the following order: lupanine, lupinine, gramine, sparteine, angustifoline and derivatives of lupanine and sparteine. These results are suggested by literature data obtained in the experiments on rats, pigs and other animals.

With the help of *T. confusum* larvae lupine varieties containing low-toxic alkaloid complex (LTAC) have been selected from very bitter (1,0 – 2,0% alkaloids) wild forms. When the seeds flour of selected varieties was used for the larvae feeding their live weight gain was 50 – 60% more than live weight gain received on the best sweet lupine cultivars.

Chromatographic analysis of LTAC showed its specific composition: 70,8% of complex is hydroxylupanine (10 times less toxic than lupanine), 11,6% - lupanine, 15,1% - angustifoline, 1,0% - multiflorine, 1,5% - other seven alkaloids. Alkaloid complex of sweet cultivars and varieties (0,1 ... 0,006% alkaloids) have the next content: lupanine – 50,2%, hydroxilupanine – 33,4%, angustifoline – 13,8%, α-isolupanine – 2,5% that is significantly differed from low-toxic composition.

Genetic analysis of narrow-leafed lupine material revealed the block of normal (wild) genes controlling high alkaloid content in the seeds (more 1,8%) and four mutant recessive genes lowering alkaloidness. Gene *alk1* decrease alkaloid level until 1,2%, gene *alk2* – 0,3%, gene *alk3* – 0,2%, gene *alk4* – 0,12%. Recombination of these recessive genes (two and more genes in one genotype) almost completely blockade alkaloid synthesis (0,001 ... 0,1%).

It is necessary to underline that belarusian lupine cultivars Danko, Metel, Mirtan, Mitan, Pershatsvet and others contain the blocks of three recessive genes of alkaloidness (*alk1*, *alk2*, *alk3*). Although the parents genealogy of these cultivars indicate one gene *iuc* responsible for alkaloid control. Probably, this gene is a block consisting of at least three mutant genes. This fact should be taken into account during breeding of narrow-leafed lupine.

Moreover we found that the character "high-toxic alkaloid complex" dominate to "LTAC" character. This information was used when cultivars having LTAC have been developed.

Summing up, in the breeding of sweet narrow-leafed lupine it is necessary to combine recessive genes of low alkaloid content and genes of low toxic alkaloid complex into one genotype.

Thermal and Rheological Properties of *Lupinus albus* Flour Meal

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There is very little research done in the area of structure and function relationships of lupin meal or lupin native protein. The scope of this work is to study lupin's native proteins thermal and rheological properties in whole meal. The effect of pH and heat treatment on the thermal properties of lupin meal was studied. *Lupinus Albus* grain was hand dissected and the separated endosperm was milled to flour meal. Suspension (20%) was prepared with three phosphate buffers (pH 4, 6.8, and 8) and heat treated at 75 and 90 ^{0}C for one hour. The treated samples were freeze-dried and later used for MDSC analysis at low moisture (3.2%) and 20% slurry. The DSC data produced a glass and exothermic transitions for all samples regardless of the kind or the level of treatment. The exothermic reaction indicates lupin protein aggregate when heated in a meal form. At low moisture and 90 ^{0}C lupin proteins showed higher glass transition energy requirements and higher temperatures while the exothermic transition showed lower temperatures and ΔH when compared to the control. Proteins solubility increased at higher pH values. At pH 4, the temperatures and denaturation energy values were lower when compared to pH 8, indicating protein stability at higher pH versus lower pH values. Defatted untreated flour meal was used for rheological study. By measuring the linear rheological properties of a series of concentrations of defatted lupin meal suspensions, we obtained some insight of structure and property relationship. Defatted lupin suspensions exhibited strong viscoelastic solid properties, which were similar to those of wheat gluten. Both storage (G') and loss (G") moduli increased dramatically over a narrow range of lupin meal concentrations. But the linear range of the rheological properties of lupin was very small. And stress relaxation studies showed that lupin suspensions relaxed within a short time indicating that the molecules of lupin were not cross-linked. To some extend, our studies of lupin meal suspensions implied that lupin exhibited some wheat gluten properties.

Andean lupin (*Lupinus mutabilis* Sweet.) – forty years research in Peru

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Research has been carried out for 40 years on the Andean lupin or tarwi (*Lupinus mutabilis* Sweet.) in Peru and other Andean countries, with the objective of solving major agronomical problems in the production in general, harvest, conservation, characterization of germplasm, analysis of the nutritional value, crop rotation, inoculation and fertilization, control of pests and diseases, agroindustry, and transformation. The investigations have been carried out in greenhouses and laboratories of UNA in Puno, Peru (3850 masl). Through the obtained results, which have increased our knowledge of this native crop, we have been able to transfer technology to agronomists and farmers of the Andean highland.

The germplasm collection of Peru consists of 1200 accessions, characterized as follows: vegetative period (140-230 days), days to flowering (56-86 days), seed yield (800-2700 kg/ha), protein content (35-45%), oil content (15-23%). In addition has been shown a content of 7.7% raw fiber, 4.1% ash, and 35.8 carbohydrates, with a positive correlation between protein and alkaloid content, and a negative correlation between protein and oil content. The wild species have highest protein content.

The best crop rotation was found to be: quinoa-Andean lupin-potato/barley/quinoa, with a sowing density of 0.70 m between rows and 3 seeds per row, using 80 kg seed/ha. The best sowing date for the Andes is September. In the Andean highland the recommended fertilization is 50-50-0 NPK. Inoculation is of great importance in the production of tarwi, when sowing in soils without presence of *Rhizobium lupinii*, increasing seed and dry matter yield. Tarwi fixes 160-220 kg/ha of atmospheric N. Water consumption for the Andean lupin varies with method of calculation, such as Hargreaves (803.3 mm), Penmann (655.7 mm) and Blaney-Criddle (569.6 mm). It has been determined that the main pests affecting the Andean lupin are: *Copitarsia turbata* H.S., *Agromyza* sp., *Frankliniella tuberosi* Moulton, and *Myzus* sp., and the main diseases are *Colletotrichun gloeosporiodes*, *Uromyces lupini*, and *Fusarium oxisporium*. Baking trials have been carried out using tarwi flour, substituting up to 10% of wheat flour without reducing the quality of the bread with respect to volume, texture, aroma, softness, color, symmetry, and flavor. This was also the case for a bread elaborated with 80% wheat + 10% quinoa + 10% Andean lupin flour.

Why do determinate types of *Lupinus albus* L. yield less than indeterminate types in the Southeastern USA.

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Determinate cultivars are the way of the future for autumn-sown white lupin cultivation in France and Great Britain. The determinate growth habit makes plant maturity earlier and more predictable, and improves grain yield in northern Europe. One advantage of determinate lines cited by Chilean workers is the more uniform seed size, a prerequisite for industrial scale processing. Yet we hardly ever find higher yields in determinate lines compared to indeterminate lines of similar origin in Virginia and Alabama, USA. A study comparing determinate, indeterminate, and dwarf lines in Alabama, USA and in France demonstrated this differential behavior very clearly. The physiological benefit of determinate over indeterminate types in northern Europe is the lack of competition between vegetative and reproductive sinks during grain fill in the former. Could it be that the increased PAR at about 30 vs. 50°N provides enough photosynthates to satisfy both sinks? The average PAR in France is only about 60% of that for Alabama. Results from a Chilean location at a similar latitude as Virginia seem to support this contention. Indeterminate types in the southern USA are also environmentally terminated due to rapidly increasing temperature in late spring and rarely develop secondary branches. Together, these phenomena may conspire to alleviate the advantage that determinate types have at higher latitudes. Furthermore, lupin will develop numerous basal branches in the southeastern US, whereas such a phenomenon is rarely observed in northern Europe. One way of testing this hypothesis may be through a shading study, where shade cloths differing in light interception are positioned in such a way as to reduce light interception to a varying degree without changing the ambient temperature within the crop canopy.

Variation of nuclear DNA content in *Lupinus luteus*, its wild progenitor *L. hispanicus* and the hybrid *L. x hispanicoluteus*

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Previously we found, that cultivated *Lupinus luteus* has about 13% more DNA per nucleus than its wild progenitor *L. hispanicus*. Unexpectedly, the hybrid *L. x hispanicoluteus* was in the range of *L. hispanicus* (OBERMAYER et al., 1999). A broader investigation of C-values within these taxa therefore seemed necessary. *L. hispanicus* sspp. *bicolor* and *hispanicus* (5 accessions each), *L. luteus* (10 accessions) and *L. x hispanicoluteus* (3 accessions) were investigated using PI as DNA fluorochrome. All taxa were heterogeneous ($p<0.05$). The 1C values were: *L. hispanicus* ssp. *hispanicus* 1.07-1.12 pg, *L. hispanicus* ssp. *bicolor* 0.94-1.14 pg (1.06-1.14 pg without the lowest sample), *L. luteus* 1.17-1.26 pg, and *L. x hispanicoluteus* 1.07-1.11 pg. The hybrid taxon, a multiple backcross of *L. hispanicus* with *L. luteus*, is well within the range of the wild parent, which is difficult to explain. The DNA differences in the parent species suggest that GISH may help in elucidating the fate of the parental chromatin in the hybrid genome. - This work was supported by the Austrian Science Foundation.

Effects of fertilization on tree seedling establishment and growth in a lupin field in southern Iceland

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Large areas in southern Iceland are glacial outwash plains, with soil composed of coarse gravel that contains only slight amounts of organic matter. Such barren and nutrient-deficient areas have been regarded as unsuitable for afforestation. Rehabilitation of such areas using Nootka lupin (*Lupinus nootkatensis*) has, however, been practiced in Iceland for several decades, and lupin-covered areas represent a potential forestland.

The aims of the study were; (1) to test if fertilizer application had any effect on survival and growth of tree seedlings planted at a site previously rehabilitated with lupin, and (2) to examine the long-term vitality of downy birch (*Betula pubescens*), Sitka spruce (*Picea sitchensis*) and lodgepole pine (*Pinus contorta*) growing at the lupin site.

The trial located in a 12-year-old Nootka lupin field at Markarfljótsaurar (N63°38'; W20°01') that had previously been used for lupin seed harvesting. The field was ploughed and the trees were planted in the furrows in early July 1997. Ten fertilizer treatments were established for each species; five types of slow release fertilizer (SRF), two types of easily soluble fertilizer (ESF) two types of combined SRF and ESF and a control treatment.

Soil analyses reveal significant enrichment of soil organic matter, nitrogen and available phosphorus in the top 5 cm of soil after 12 years of lupin growth. Survival at age 5 years was high for all tree species, with pine showing the lowest survival (91%). There was a significant fertilizer effect on the volume index for all species ($p<0.05$). The SRF yielded on average the highest volume index, especially SRF with high nitrogen ratio. ESF was intermediate and the control treatment (no fertilizer) yielded the poorest growth. A mixture of SRF and ESF yielded growth similar to SRF. Birch and spruce grew best when the density of lupin was high, while pine grew best at intermediate density.

The results after five years suggest that afforestation of glacial outwash plains in southern Iceland is a feasible option when preceded by Nootka lupin establishment. Fertilization at planting, when combined with the facilitative effects of lupin at such sites, improves early seedling growth, but does not affect initial survival.

Variation among lupin genotypes in drought tolerance

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The Lupin is the main pulse crop grown in the Mediterranean climatic region of Australia, but the crop frequently encounters terminal drought. As a consequence, seed yields are reduced. Five to nine genotypes of lupin were grown rainfed during the 1998, 1999 and 2000 growing seasons at Merredin, Western Australia. Merrit the cultivar grown in the majority of the growing areas was used as the check cultivar against which the other cultivars were evaluated. The 1998 growing season was average with 57 mm of rainfall between flowering and final harvest and the cultivar Belara outyielding Merrit by 29%. The 1999 growing season also was average, but there were 37 mm of rainfall between flowering and final harvest and the cultivars Tanjil, Belara and Quilinock outyielded Merrit by 33-53%. In the extremely dry season of 2000 with 0.4 mm of rainfall only between flowering and final harvest, the cultivars Belara and Quilinock outyielded Merrit by 80%. The high yield of Belara and Quilinock under both favourable and dry seasons resulted from faster rates of seed growth, which maintained seed yield. The high yield of Tanjil under favourable conditions resulted from high pod retention. The high pod retention in Tanjil was not an advantage under extreme dry conditions since seed number per pod and hence seed yield was markdly reduced.

Symbiotic nitrogen fixation estimated by use of 15N dilution method in annual blue lupin and perennial Nootka lupin in Iceland

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Symbiotic nitrogen fixation in annual (*Lupinus angustifolius, c.v. Uniharvest*) and perennial lupin (*L. nootkatensis*) was estimated by 15N dilution method on soils of andosol type in Iceland. (Pálmason et al. 1992 and Danso et al. 1993, Pálmason, Guðmundsson and Sverrisson (2002). The symbiotic nitrogen fixation in field experiments was 93, 89 and 98 % of nitrogen (%Ndfa) in the overground parts of annual lupin and 212, 32 and 185 kg/ha in a period of three years.

Phosphorous in triple superphosphate was applied in increasing amounts from 0 to 90 kg/ha P to a seeding mixture of annual lupin (*L. angustifolius, var. Uniharvest*) and early oats (Sol II) in a pot experiment in the greenhouse. The soil was basaltic sand. The phosphorous application raised the symbiotic nitrogen fixation in the lupin from 72 to 176 kg/ha. Ndfa increased from 93 to 98-99% of total N in aboveground lupin with increasing levels of P applied. The symbiotic fixation in roots increased from 9 to 21 kg/ha at 60 P kg/ha applied. The %Ndfa in roots increased from 80 without P applied to 82% with 7,5 kg/ha P but decresed to 72% with higer levels of P applied.

Symbiotic nitrogen fixation was estimated in perennial Nootka lupin (*L. nootkatensis*) by use of the 15N dilution method. The Ndfa ranged from 97,6 to 99,6 % of the total uptake. The symbiotic fixation per hectare in above ground organs of lupin ranged from 6 kg/ha N in experimental plots three years after sowing to 61 kg/ha N in a seven year old land reclamation field both in the inland site at Gunnarsholt. The N fixation from the atmosphere in the field estimated five years from sowing was 37 kg/ha in the tops of lupin and 41 kg/ha in the roots. In the coastal site Vík the fixation estimated on experimental plots three years after sowing was 23 kg/ha in the tops and 69 kg/ha in roots. The perennial Nootka lupin can thus fix symbiotically approximately 80-90 kg/ha N per year in land reclamation of eroded or alluvial sands three to five years after sowing 5 kg/ha of lupin seed in the south of Iceland.

Variation in pod wall proportion during pod development at different inflorescence levels

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The proportion of pod walls was studied on the white lupin (*Lupinus albus* L.) and measured on the main stem inflorescence. A wide genetic variability was detected as well as a strong negative genetic correlation with the seed yield.

The variation in pod wall proportion among inflorescence levels was analysed through the kinetics of dry matter accumulation in the pods.

Seven samplings were performed from the early flowering and full maturity of a dwarf determinate autumn-sown pure line, dtn156, and a spring-sown indeterminate line, Lublanc. For each sampling, three replications of 30 consecutive plants each were taken. On each plant, one pod was sampled on each inflorescence level. Seeds and pod walls were separated, dried and weighed.

Remaining pods from each inflorescence level were gathered. Stems, branches and leaves were bulked per replication. Each of those samples were dried and weighed.

For both genotypes, the curves of the number of pods per inflorescence and number of seeds per pod decline during the first 600°C.d from flowering (above 3°C) and then become stable. Mean seed weight follows a sigmoid growth curve and reaches its maximum after 1200°C.d from flowering whatever the inflorescence level and genotype. Pod wall proportion reaches its final value at that stage.

The pod wall proportion proved to be the same whatever the inflorescence level. It only increased for the last upper inflorescence level where it decreased as a consequence of a sharp decrease in number of seeds per pod. In absence of abiotic stress, other seed yield components, seed per pod, mean seed weight and seed weight per pod, behaved similarly.

DETERMINATION OF WATER PATHWAY DURING IMBIBITION IN TWO LUPINS SPECIES

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The main water pathway during imbibition was studied related to the seed coat morphology of *Lupinus albus* L. and *L. angustifolius* L. The seed coat thickness was measured at different regions: opposite to the hilum in the lens, behind the lens, in the border sides, in the pit, and in the radicle lobe. The measurements were taken with a Tastknirps Ernstmessner gauge-meter. Ten seeds for each species composed the experimental units. The seed coat thickness data were submitted to a variance analysis to set the significance of the differences between regions in both species. To determine where the water entrance takes place at the beginning of imbibition, the seeds were immersed in a 1% of 2,3,5 Trifenil Tetrazolium (TZ) solution at a room temperature of 20°C, in darkness. After the first signs of imbibition, the seeds were rinsed and placed under white light until the reaction of TZ was observed. Different stages of the red coloured seed coat were registered and photographed. In both species the thickest seed coat values were found at the lens. The thinnest seed coat values were those recorded behind the lens and at the opposite side of the hilum, eventhough there were no significative differences with the other seed coat regions. In this work, there was sufficient evidence to conclude that the water entrance at the very beginning of imbibition is related to the lens region, and the pores present in the surrounding.

Introduced yellow bush lupine (*Lupinus arboreus*) in coastal dunes of northern California, U.S.A.

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Yellow bush lupine (*Lupinus arboreus* Sims), native to southern and Central California, was introduced to northern California and the Pacific Northwest during the early to mid 1900s to stabilize coastal sand dunes. The native, sparse, near-shore vegetation on these dunes (dune mat) lacked a shrub component, and yellow bush lupine rapidly naturalized and invaded herbaceous dune vegetation and open sand areas, creating large-scale changes to vegetation and dune processes over the following 100 years. In addition to the direct displacement of vegetation, invasion results in enrichment of soils and facilitates colonization by other introduced species, particularly annual grasses. The result is a closed-canopy shrub community dominated by yellow bush lupine and eventually by coyote brush, a native species not typically found on semi-stable dunes. This community stabilizes previously mobile dunes, accelerating natural rates of succession. The resulting, localized extirpation of native dune mat may prevent recolonization following periodic, large scale tectonic events that remobilize stabilized dunes and maintain early successional stages. Additional impacts from yellow bush lupine invasion include loss of preferred floral resources and nesting habitat for native solitary bees and wasps, and the threat of extirpation of a native lupine through genetic introgression. Control of yellow bush lupine has been accomplished in northern California using several methods. Manual removal is suitable in early invasions, but must be repeated until the seed bank is depleted. In heavy infestations, manual removal is accompanied by litter removal and repeated harvesting of weeds (including yellow bush lupine) from the seedbank over four years. Mechanical removal using a tractor fitted with specialized blades is most efficient in large, accessible areas. Both manual and mechanical removal can be followed by the placement of weed mat which "solarizes" the soil, killing buried seeds, but this method must be followed by revegetation with native species.

Lupin stem proteins involved in drought responses

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Lupins are able to resist water stress and to recover from severe drought conditions. The stem is particularly interesting in drought survival mechanisms since stressed lupins discard most leaves, maintaining mainly the terminal bud. On rewatering, the bud rapidly produces new leaves.

We have been studying metabolites, namely proteins, connected with the imposed stress. Previous work showed that polypeptide resolution by SDS-PAGE is not sufficiently powerful, so the identification of the proteins of interest is being performed through two-dimensional gel electrophoresis (2-DE). The proteins (60 to 80 g) are first separated according to their charge in denaturing conditions (isoelectric focusing, IEF) in 13 cm pH immobilised gradient gels. For optimal resolution it is necessary to use several pH intervals. The polypeptides are next separated according to their size in 12.5%T SDS-PAGE gels. Triplicates were performed and gels were analysed through appropriate software.

Several polypeptides were found to be tissue-specific and dependent on the stress intensity. Our purpose is to characterise them by mass spectrometry in order to understand their relation with the stress intensity and with the subsequent relief from drought.

Occurrence of galactosyl cyclitols in *Lupinus elegans* seeds

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Lupinus elegans were grown in greenhouse. Fully opened flowers were tagged, and seeds harvested at 5-day intervals from 15 days after flowering (DAF) to maturity at 40 DAF. Eleven ethanol-soluble carbohydrate components were identified in *Lupinus elegans* seeds. The analysed carbohydrates included: monosaccharides, disaccharides, cyclitols, galactosyl cyclitols and raffinose family oligosaccharides. Stachyose was dominant carbohydrate component in seeds. The analysed seeds accumulated 44.5 mg/g d.m. carbohydrates, including the raffinose family oligosaccharides 70% of the identified carbohydrate component pool. Galactosyl cyclitols were represented by two fraction: myo-inositol fraction (galactinol), pinitol A fraction (galactopinitol A, digalactopinitol A (ciceritol), trigalactopinitol A). Approximately 25 DAF the intensive accumulation of galactinol began. Its levels decreased as the raffinose family oligosaccharides content increased. Acute accumulation of galactosyl cyclitols occurred during the same phase of seeds development as the synthesis of RFO. The analysed *Lupinus* seeds contained 3 unidentified carbohydrate components. Soluble sugars were analysed according to Górecki at al. (1997) with slight modification.

Potencial uses of wild lupins as ornamental and garden plants

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The habitat, habit, plant architecture, inflorescence and flower color and characteristic were analyzed in six wild lupins species in order to evaluated its potential cultivation as garden plant. Mature seeds from wild populations of *Lupinus polyphyllus* Lindl., *L. albescens* Hook & Arnott, *L. gibertianus* C. P. Sm., *L. magnistipulatus* Planchuelo & Dunn, *L. honoratus* C. P. Sm. and *L. grisebachianus* C. P. Sm. were treated to different scarification methods to allow imbibition and germination of hard seeds. All growing conditions were recorded and evaluated. The data from the assays were submitted to a statistical analysis to determine efficiency in growing and development of the plants. The results showed that the best scarification method is scratching the testa of the seed in a lateral side with sandpaper. Seedling requirements for plant establishment were considered the most important step for a successful development of the plant in garden conditions. From the six species tested the best performance was for *L. polyphyllus* which had the highest number of germinated seeds, completed all growing stages and developed a main inflorescence. The three species natives of Northeastern Argentina (*Lupinus albecens, L. magnistipulatus* and *L. gibertianus)* showed a good adaptation to garden conditions but after loosing between 50 and 65 % of germinated seeds at seedling and rosette stages. The only two species tested from the Andean region were the ones which cropping requirements were not well determinated and only few plants reached rosette stage with a poor performance as garden plant.

The effect of seeds laser biostimulation of white lupine (*Lupinus albus* L.) growth in differentiated temperature conditions

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To researches were taken *Lupinus albus* L. dry seeds, Wat variety. Experiment was carried out in pots which were placed in climatic chambers. Various temperature conditions were regarded as factor I - optimal: 10 ^{0}C during the day, 8 ^{0}C at night and stress: 4 ^{0}C during the day, 2 ^{0}C at night (as well optimal as stress conditions were changed every week by +2^{0}C) and different doses of laser irradiation: D_0 - without irradiation, D_1 - single irradiation ($4 \cdot 10^{-3}$ J$\cdot$ cm $^{-2}\cdot$ s^{-1}), *D3* - 3 fold irradiation, D_5 - 5 fold irradiation, D_7 - 7 fold irradiation) - as factor II. Plants emergence were depended on temperature and laser irradiation of seeds. In low temperatures plants were emergence about 6 days late in comparison to plants growing in optimal conditions. Three fold irradiation of seeds had the best profitable effect on improvement of plant emergence quality, independent of thermal conditions. Besides plants were emergence about 2-3 days earlier in comparison to plants from not irradiated seeds. Clear influence of seed irradiation on length of white lupine developmental phases was observed. Especially important observation is that plants which were grown from irradiated seeds were better developing at lower temperatures than plants from seeds without laser treatment. Laser light influenced profitable also on increase of plants height, root length and dry matter of roots and aboveground parts. The most of studies with irradiation of seeds referred to state the optimal dose of irradiation and increase of seeds yield. There is lack of investigation results at literature on development and yielding of plants grew from irradiated seeds and growing at stress environmental conditions. So there are troubles with comparison of obtained results but on their base is possible to state that irradiation of white lupine seeds favourable influences on emergence and plant development also at lower air temperature conditions.

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Why very little Lupin is grown in Florida at the beginning of the 21st century

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At first glance, the climate of the state of Florida appears ideal for winter and spring production of lupin (*Lupinus* sp.). Indeed yellow (L. *luteus*), blue (L. *angustifolius*) and white (L. *alba*) lupines were grown on sizeable acreages at times in the 1900's. It is the occasional hard killing freeze after a warm non-hardening period, that mostly limits the growth of white and blue lupin. The big freeze that first broke up lupin plantings in Florida and lower South USA was the "Thanksgiving freeze" in November, 1950. The arrival of cheap nitrogen was also a contributing factor against the recovery of lupins. Three lupins, 'Frost', 'Tifton white 78' and 'Tifton blue 78', developed at Georgia Coastal Plain Experiment Station at Tifton, GA promised to furnish cold tolerance in sweet lupines. In the decade of 1980's, four seasons occurred where these three lupins did not complete their life cycle because of winter freezes. Lupin fly and thrips; anthracnose, gray leaf spot and several viral diseases; and root-knot nematodes also may reduce growth of lupin so three or four years of rotation between crops of lupin are recommended. A seed-borne virus disease killed out yellow lupin. Thrip buildup on sweet lupin can seriously reduce seed production. When lupin does grow it is an excellent crop in Florida, producing high biomass yields containing a high percentage of protein and digestible dry matter. When used for green manure, large amounts of nitrogen may be added to the soil for following summer crops. Sweet lupines are very palatable and digestible and can be browsed, green chopped or made into silage. Seed production is high and adequate for producing seed for replanting and as a grain. Lupin can be a big crop in Florida if we find lupin cultivars which can dependably survive our environment.

Agroecological zoning for crop production of white lupin (*Lupinus albus* L.) in Argentina

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During 1998, 1999 and 2000, experimental field trials were carried in 19 locations of the Pampas of Argentina to assess the regional suitability for growing white lupin. Three cultivars: Lolita, Rumbo and Typ top from Baer's seed company were used on three sowing dates from May to June in a two-week interval between dates. Seed was inoculated and treated with fungicide. Standard cultural practices were observed in every location. Those locations with temperate climate and uniform rainfall distribution and located in the wheat belt were found to be the most appropriate for lupins. Other locations with predominately summer rainfall and water stress during the winter showed a marginal suitability for lupins being the water deficit the major crop yield reducing factor. In addition, the maturity and harvesting process was hampered by excessive moisture conditions.

Weather and soil data were the major inputs to the soil moisture budget program. A threshold of less than 100 mm of accumulated soil water deficit for the crop growing season was used to identify climatically suitable areas. Soil texture was obtained from a soil map and loam and sandy-loam soils were selected as adequate using a geographic information system. Cooling degree days were not considered as limiting factors given the cultivar used in the analysis.

The final product was a lupin zoning map showing excellent, good, poor and not suitable areas for growing white lupin crops. The best area for lupin crop production for all cultivars was characterized by a sandy soil and a soil water deficiency less than 100 mm. It is located in the South Eastern portion of the Buenos Aires province. The map could be used as a guideline by farmers at the time of selecting the next winter crop.

The use of *Lupinus nootkatensis* in a revegetation and afforestation program in Southwest Iceland

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Vegetation and soils in the Sudurnes region of Southwest Iceland have been highly degraded since settlement. A successful revegetation program initiated in 1996 on the Keflavik NATO base has resulted in establishment of several hectares of *Lupinus nootkatensis* and grass cover in an area of high winds, oceanic salt spray, and nitrogen-poor soils. Lupine seedlings were transplanted and grass seed sown with an application of an organic mixture of manure and decomposed peat soil. An afforestation project was started in 2002 to examine tree establishment within the young lupine stands. It is hypothesized that lupine will facilitate colonization by Sitka spruce (*Picea sitchensis*), willow (*Salix* sp.), and native birch (*Betula pubescens*) in the Sudurnes region by ameliorating microsite conditions.

Impact of nitrogen and sulphur nutrition on the N-fixation potential of lupins

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Field trials have been carried out to investigate the impact of nitrogen and sulphur nutrition on the N_2-fixation potential of lupins. Symbiotic nitrogen fixation in the nodules of leguminous plant roots is of considerable ecological significance. The function to fix atmospheric nitrogen and thereby supply a major input into the nitrogen cycle is affected by a variety of physicochemical factors. The results show that high supply of available nitrogen will not provide a high rate of fixation (Fig. 1). Fertilizer nitrogen is prefered by lupin roots more than atmospheric nitrogen. Sulphur addition may decrease the rate of N_2-fixation because of sensitivity to low pH (Fig. 1). The inoculation of lupin seeds with rhizobia was not effective in the field trial at the Braunschweig site. The factors that determine the success of a microbial inoculum in soil will be investi-gated in the following years.

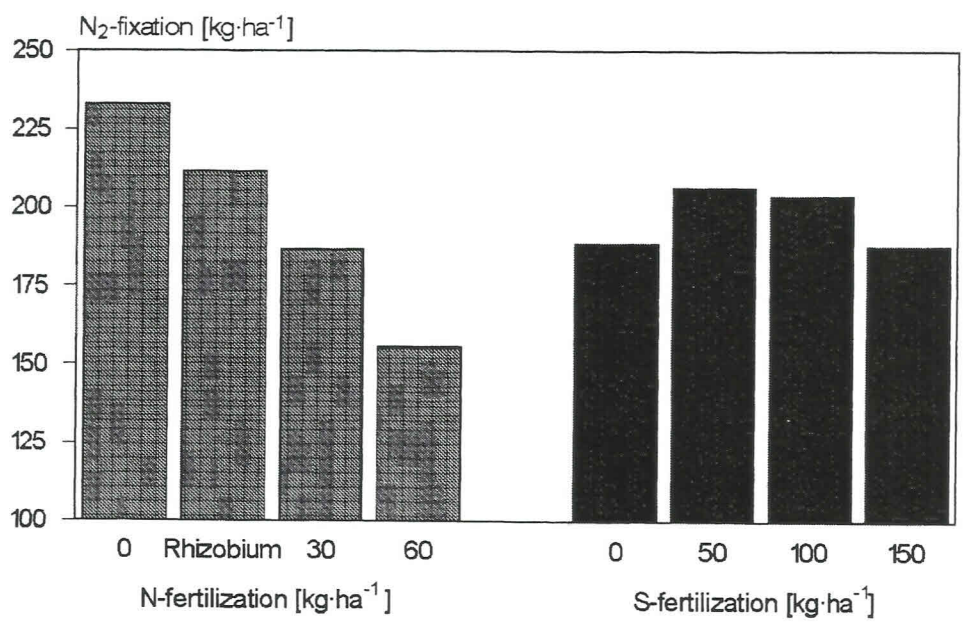

Figure 1: Effect of N- and S-fertilization on N_2-fixation of lupins (related to N-uptake of grain yield)

Approaches to marker analysis in white lupin (*Lupinus albus* L.)

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A population, segregating for traits of agronomic interest was derived from a cross between two inbred lines in white lupin (*Lupinus albus* L.) The traits of interest were: height, branching, flower and seed colour, leaf number and time to flowering. Two approaches to the analysis of segregating molecular markers, and their association to traits of agronomic interest, were adopted. A progeny testing approach was used for the analysis of ISSR markers. Associations of mean progeny phenotype with marker data from the previous generation were made using single factor ANOVA. In parallel, semi-automated AFLP is being used to construct a putative map from SSD lines of the same cross. This will also be used as a basis for associating the same traits with the molecular markers. The effectiveness of the two techniques in associating markers with traits of agronomic interest in white lupin is discussed.

Blue and Yellow Lupin Seed (*Lupinus angustifolius* L. and *Lupinus luteus* L.) in the Feeding of Broiler Chicks

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As there are only few results about the nutritional value and feeding concepts of yellow (*Lupinus luteus*) and blue lupin seed (*Lupinus angustifolius*) for poultry, two trials were conducted. In a digestibility trial with a total of 108 broiler chicks the nutrient digestibility and energy contents of the blue lupin seeds Bordako and Borweta were determined. Nutrient digestibility was different for Bordako and Borweta, e.g. 43 vs. 50 % for organic matter, 43 vs. 36 % for protein, 69 vs. 83 % for fat, 46 vs. 58 % for N-free extracts, resulting in a lower energy concentration of 7.54 MJ AME_k/kg for Bordako and 8.22 MJ AME_k/kg for Borweta.

Additionally a 5-week fattening trial with a total of 350 day-old male broiler chicks (Ross) in 5 groups was conducted. Sweet yellow lupin seed variety Borsaja and sweet blue lupin seed variety Bordako were used in isoenergetic (12.5 MJ AME/kg) and isonitrogenous (22 % crude protein; 1.2 % Lys, 0.9 % Met) diets in amounts of 20 % and 30 %, respectively. Control feed consisted of 36 % soybean meal, 30 % wheat, 21 % corn, 6 % soybean oil, 4 % oats bran, and 3 % vitamin-mineral-amino acid supplement. Lupin seed was included in replacement for soybean meal, corn and oats bran (as a source for crude fibre). Differences in amino acid contents between the diets were equalized by adequate amino acid supplementations.

Acceptance of feed was not impaired even with 30 % lupin seed in the feed mixtures. In contrast, feed intake (averaging 68 g/d) was higher when lupin seed was included. As growth performance was similar for all the groups (42.8 g/d; with 40.9 g/d for the group with 30 % blue Bordako) this resulted in a higher feed expense for the lupin seed diets.

The results show that up to 30 % yellow lupin seed can be included in broiler diets instead of soybean meal without impairing growth performance (provided amino acid supplementation is adjusted). With 30 % blue lupin seed in the diet, however a slight impairment of growth performance by 4 % (not significant) may occur.

Blue and Yellow Lupin Seed (*Lupinus angustifolius* L. and *Lupinus luteus* L.) in the Feeding of Pigs

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Data on nutrient digestibility, energy contents and feeding concepts of sweet blue lupin seeds (*Lupinus angustifolius* L.) for pigs are rare. Therefore a digestibility trial with a total of 10 pigs was conducted to examine the blue lupin varieties Bordako and Borweta. There were no significant differences in nutrient digestibility between the both varieties averaging 77 % for the organic matter. Concentration of metabolizable energy was 14.4 and 14.2 MJ ME per kg dry matter for Bordako and Borweta, resp.

Bordako and the yellow lupin Borsaja (*Lupinus luteus* L.) were also used in an 84-days feeding trial with a total of 48 fattening pigs. To determine the recommendable amount of lupin seed in the diet either 10 % or 20 % of each variety were used in the isoenergetic and isonitrogenic feed mixtures (13.0 MJ ME/kg, 17/15 % crude protein, 1.0/0.8 % Lys in grower/finisher feed) consisting of barley, corn, soybean meal, and vitamin-mineral-amino acid supplementation. Pigs' daily weight gain between 30 and 110 kg live weight averaged 835 g/d and tended to be lower with lupin seeds in the feed mixture up to a 5 % reduction with 20 % of the blue lupin Bordako. Feed intake (2.16 kg/d) was not impaired of any kind or level of lupin seed in the feed mixture. Feed conversion (kg feed/kg weight gain) rose from 2.5 to over 2.6 with significantly higher (worse) values for 20 % lupin seeds. Carcass performance was quite equal for all groups with an excellent proportion of lean meat averaging 58.9 %. Only with 20 % Bordako some parameters of muscles (diameter, area of eye muscle) were slightly lower. The carcass classification reached also slightly poorer scores for the groups with 20 % lupins in the diet.

The results of this fattening trial indicate, that (adequate amino acid supplements provided) yellow lupins can be included up to amounts of 20 % in the diets of pigs with increased feed expense but without impairing growth or carcass performance. With 20 % blue lupins in the feed about 5 % (not significant) lower growth performance and an increased fat deposition in the carcass at the expense of muscle protein must be taken into account.

Nutritional Values of Blue Lupin (*Lupinus angustifolius* L.) and Yellow Lupin (*Lupinus luteus* L.) for Ruminants

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To determine the values of blue lupin (*Lupinus angustifolius*) and yellow lupin (*Lupinus luteus*) for animal nutrition the seeds of the four sweet blue lupin varieties Bordako, Borweta, Boltensia, and Bolivio, and of the two sweet yellow lupin varieties Borsaja and Borena, all cultivated in Germany, were analyzed on their concentrations of various nutrients including protein and amino acids, fibre fractions, fat, sugar, starch, minerals, trace elements, vitamins, and alkaloids. Yellow lupin seeds were higher in their concentrations of ash (4.7 vs. 3.3 %), crude protein (38.7 vs. 30.3 %), and sugar (6.3 vs. 5.0 %) but lower in crude fibre (14.0 vs. 15.4 %), cellulose, lignin, fat (4.1 vs. 4.5 %), N-free extracts (27.4 vs. 37.0 %) and starch (7.5 vs. 11.4 %) than the blue varieties. Amino acids were lower in blue lupins than in yellow lupins with Lys and particularly Met being generally low in all of them (4.6 % Lys and 0.6 % Met in crude protein). Ca was higher in blue lupins, P, Mg and the trace elements Cu, Fe, Mn, and Zn were higher in yellow lupins. Vitamin concentrations were equal. Although all varieties were poor in alkaloids (< 5%) yellow lupins were lower (0.6 %) than blue lupins (3.6 %). At least some of these differences are important and must be considered in animal nutrition.

Additionally a digestibility trial with a total of 8 wethers was conducted to determine the nutrient digestibility and energy concentrations of the blue lupins (Bordako and Borweta) and of the yellow lupins (Borsaja and Borena) for ruminants. Digestibility of organic matter was between 72 % (Borena) and 79 % (Borweta) with higher values for blue lupins than for yellow lupins. Concentrations of energy per kg were between 11.0 MJ and 11.9 MJ ME (metabolizable energy) and 6.5 MJ and 7.2 MJ NEL (net energy lactation).

INSECTISTATIC ACTIVITY OF *Lupinus* SPP. (FABACEAE) AQUEOUS EXTRACT AGAINST FALL ARMYWORM *Spodoptera frugiperda* (LEPIDOPTERA: NOCTUIDAE)

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The "in vitro" activity of an aqueous extract at 5 % from foliage or seeds of six Mexican wild lupin species (Fabaceae) was evaluated to determine the effect on the growth, development and viability of fall armyworm *Spodoptera frugiperda* (Lepidoptera: Noctuidae). The results showed that at the concentration evaluated, the activity of the extract was not insecticidal since there was no mortality in the larval and pupae phases. On the other hand, it affected the biological cycle of the insect. The foliage extract of *L. mexicanus* and the seed extract of *L. mexicanus, L montanus* and *L. rotundiflorus* deterred feeding and inhibited growth, while seed extracts of *L. stipulatus* inhibited the feeding and *L. exaltatus* inhibited the growth. *L stipulatus* foliage extract and *L. reflexus* seed extract did not show any effect on fall armyworm.

Control of Anthracnose (*Colletotrichum spp.*) in white lupins (*Lupinus albus*) grown in organic farming systems

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Anthracnose is the most important disease in lupins. It occurs in all lupin growing areas world-wide. The main source of infection is contaminated seed. Thus, seed treatments are of major importance to control the disease. Among the lupin species white lupin (*Lupinus albus*) is the most susceptible to Anthracnose. Nevertheless there is an increasing demand for seeds of *L. albus* for animal and human consumption. Whereas effective fungicides both for seed dressing and foliar spraying have been identified to control Anthracnose successfully, little is known about non-chemical treatments which could be used in organic farming where lupins are grown to an increasing extend. The aim of the work presented here was to find possibilities to combat the disease without chemicals.

We used physical treatments (seed storage over a period of 12 months, hot water treatment, electron radiation), seed treatments based on plant extracts and bacteria and applied a moss fern foliar spray.

The hot water treatment is very effective to control the disease but not feasible for big lots of seeds. Seed storage for a period of 2 years in an usual barn could reduce the seed infection level from 67 % infected seeds to less than 1 % without being detrimental to the germinative capacity of the seeds.

Even though the growing conditions were not favourable in 2001 some interesting results could be obtained:

- some of the plant extract preparations and the electron radiation variants could reduce the infection level
- products based on bacteria seemed to be less effective
- in plots where the seed treatment had been less effective the spraying of moss fern spray (2 applications) could reduce the infection obviously.

The trial will be repeated in the year 2002. The first 2 year-results will be presented at the 10th International Lupin Conference in Laugarvatn, Iceland.

Biodegradation of lupanine by soil bacterial isolates: kinetics and intermediate metabolites

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The isolation from soil cultivated with *Lupinus* sp. of two Gram-negative bacterial strains, capable of using lupanine as sole carbon and energy source, was reported by the authors [1]. These strains, IST20B and IST40D, are of interest for the biodegradation of alkaloid-containing effluents, which might conceivably be originated from a lupin seed fractionation process (submitted for publication), and to debitter *Lupinus* flour [2]. In this work, characterization of lupanine biodegradation kinetics by those bacterial strains during batch experiments in mineral medium with 1 or 2 gL^{-1} of lupanine, at 27°C is reported. Cell density and substrate concentration were monitored during incubation. Plots of the specific growth rates as a function of the lupanine concentration remaining in the growth medium were fitted by non-linear regression to kinetic models derived from Tessier equation. Parameters such as maximum specific growth rate, half-saturation constant and inhibition constant agreed among the two independent cultures carried out, to within a factor of 3.8. Although lupanine inhibits bacterial growth, maximum specific growth rates were high (0.19 and 0.29 h^{-1} for IST20B and IST40D, respectively). During growth in mineral medium with 2 gL^{-1} lupanine, both strains were capable of removing 99% of the initial lupanine after 24 h of incubation. Gas chromatography indicated the presence of the following three major lupanine intermediate metabolites in chloromethane extracts of the IST20B culture filtrates: 3-hidroxylupanine, 13-hidroxylupanine, 17-oxosparteine. Two other major metabolites were however identified during IST40B growth in lupanine: 3,4-dehydrolupanine and α-isolupanine. The alkaloids were identified by Gas Chromatography-Mass Spectrometry, using standards or by comparison of the spectra obtained with published data. With the exception of α-isolupanine, which exhibited a maximal concentration at the early stationary phase, the concentration of the other intermediate metabolites increased during the first 8 h of exponential growth, then decreased to undetectable levels.

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[2] Santana, F.M.C. and Empis J.M.A. (2001). Eur Food Res Technol. **212**, 217-224.

Influence of sulfur nutrition on yield and dietary quality of lupin seeds

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Legumes in general are of good nutritional values due to their high protein contents. During bad times when there was lack in food stuffs lupins have been grown and used - besides as animal feed - also for human consumption. Due to difficulties in growing lupins and due to low and uncertain yield levels they have not been grown in times with sufficient nourishment. Meantime there starts to be interest in lupins for human consumption again.

Since lupins also show a lack of sulfur containing amino acids besides the uncertainty of the yield levels pot trials had been done during growing season 1998/99 and field trials have been done during growing season 1999 to investigate the effect of sulfur on yield level and percentage of sulfur containig amino acids -which are the limiting dietary factor- to help bringing lupins into levels of standard growing crops.

Harvesting has been done by hand in both experiments. Nitrogen determination has been done using the Kjeldahl-method and sulfur determination has been done using a Leco instrument. The amount of sulfur containing amino acids is determined indirectly by calculating the difference of the content of total sulfur and the content of inorganic sulfur.

So far it can be stated that sulfur fertilization has a positive effect on yield level, TSW and total sulfur content of lupin seeds.

The lines and prospects of white sweet Lupin breeding in the Ukraine

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The demand for white lupin seeds considerably increasing in the Ukraine now. Correspondingly the white lupin breeding is underway both in fodder and food lines. The producing of initial source with various plant architecture and vegetative period needs to be realised of mentioned aims.

The seed growing of the following fodder varieties performing now: Pishevoj, Olezhka, Sinij Parus, Borki, Tuman and Veresnevyj. The food varieties Volodymyr and Dieta have obtained based on the low alkaloid mutant lines originated in the Institute of Agriculture.

The varieties of intermediate maturity with good balanced green mass are need to be obtaining the yield of full value. Thus, the determinant and semideterminant lupin forms with short vegetation and synchronous maturing of the beans both in central and lateral shoots have sufficient benefits in conditions of Ukraine.

The anthracnose is a common limiting factor for increasing of white lupin sown areas now. However, there are several breeding lines that practically not damaged by the Colletotrichum gloesporoides. The most resistant lines have observed among hybrids between different mutant varieties and line 2247. This provided the basis for overcome the crisis of white lupin breeding and for creation the new generation both of fodder and food lupin varieties.

Distribution and abundance of *Lupinus stipulatus* J. AGARDH (LEGUMINOSAE) at NEVADO DE COLIMA, JALISCO, MÉXICO

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The objective of this work is to provide data concerning the ecological distribution of *Lupinus stipulatus*, its abundance and relation to some environmental factors for the purpose of obtaining data and greater knowledge about this species. This is necessary because there have been no studies carried out in Jalisco concerning this type. Furthermore, this plant has important attributes from any perspective (ecological, pharmaceutical, agronomic); it could be used principally as food source due its content of proteins in comparison with other species. According to available information, the species grows in five locations in the area of the Nevado de Colima. A location was selected where 68 plots were established totaling a surface area of 17,408 m^2 and a total of 155 individuals were counted which are classified as scarce in the study area. It develops in areas with oak-pine forest type vegetation in hilly terrain with abrupt slopes that range from 21° to 50° in places with hillsides exposed toward the N and NE at elevations ranging from 2,100 to 2,200 m in sandy soils with an average depth of 38.7 cm.

Micropropagation and regeneration of *Lupinus stipulatus* J. AGARDH (LEGUMINOSAE)

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The process of domestication has been lengthy in some *Lupinus* species, but it is considered that with the application of biotechnological tools in *Lupinus stipulatus*, this process can be achieved in a shorter time. The objective of this paper was to establish propagation techniques through axillary shoots and regeneration by means of somatic embryogenesis. For axillary shoots induction, epicotyls were used and the effect of two different sources of cytokinins was studied (KIN and 2iP), in combination with auxin (NAA) in different concentrations and combinations. Maximum averages of 5.5 shoots per explant were obtained with KIN and NAA, and 4.5 with 2iP and NAA in both combinations the auxin-cytokinin interaction was statistically significant. The model for axillary shoots was established. For somatic embryogenesis, different explants were used. Combinations of growth regulators were made of 2,4-D with KIN and TDZ, the callus formed had a grainy appearance and white-yellowish color in the most of cases. Few embryos in different stages of development were observed in some treatments.

Changes of alkaloids during germination of Lupin seeds

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Alkaloids are an important class of compounds that have pharmacological effects on the human body. Although a wealth of information is available on the pharmacological effects on these compounds, little is known about how plants synthesize these substances or about how this synthesis is regultated. Alkaloids belong to the broad category of secondary metabolites. This class of molecules have historically been defined as naturally occurring substances that are not vital to the organism that produces them. Alkaloids have traditionally been of interest only due to their pronounced and various physiological activities in animals and humans.

Quinolozidine alkaloids, contained in lupins, are the largest single group of legumes alkaloids. Actually it is clear that these alkaloids have important ecochemical functions in the defence of the plant against pathogenic organims and herbivores and are found to play and important role un plant interactions with animals and higher and lower plants.

During germiantion, the seed need more defence and although there is little data in the literature on the effect of germination on seed alkaloid composition, it appears that some degree of transformation of the alkaloid in other more bioactive compounds as esters, occurs during germination.

The aim of this work is to investigate the transformations of some alkaloids during germination in four species of *Lupinus (L. albus, L. luteus, L. angustifolius, L. campestris).*

May lupins be used as feed after growth on cadmium contaminated soils?

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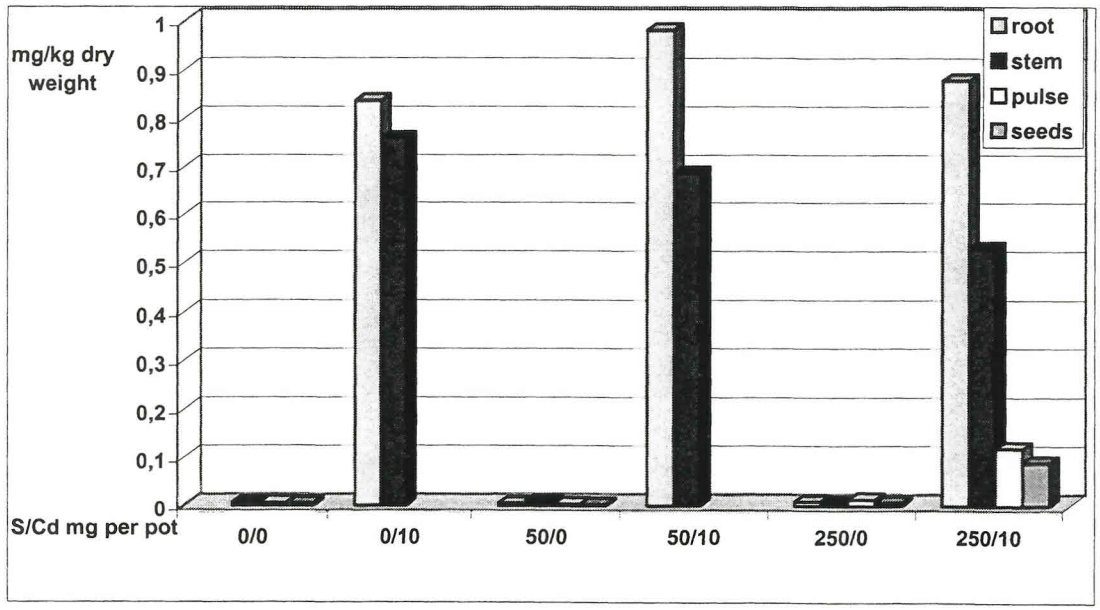
Pot experiments have been done to find out about the influence of sulfur nutrition on Cd absorption and translocation of cadmium within the plants grown on cadmium contaminated soils.

The results showed that due to Cd in the culture medium yields are lower for all plant parts than for those samples from lupins grown on culture medium without Cd, but yields had become higher with higher sulfur nutrition.
Cadmium concentrated mainly in roots and stems and to a lesser amount in pulse walls. Almost no cadmium could be found in seeds. In all cases Cd content in seeds has been less 0.2 mg / kg dry plant material.

The results from the pot experiment show that lupin seeds might be used as feed after growth of the plants on cadmium contaminated soils. Nevertheless a field trial should be done on a Cd contaminated plot to underline the results.

Cd content in different plant parts of yellow lupins



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Genetics studies of Andean lupin (*Lupinus mutabilis* Sweet)

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Lupinus mutabilis is source of protein in human diet in Andean region more than 2000 years. The crop is characterised by numerous important characters: nitogen fixation, high protein and oil content in seeds, soft seeds and tolerance to long day conditions. Adaptation to European conditions is connected with low seed yields and long vegetation period.

The main purpose of the undertaken study is to develop more yielding and precocious material for moderate climatic conditions. The collected material evaluated in regard to yield structure traits. The best populations were chosen as parents and they were crossed with representatives of the section Albus.

Interspecific hybrids were studied in order to evaluate of chromosome number and structure in mitotic and meiotic divisions. The modified method of enzyme maceration and fluorescence staining (DAPI) of chromosomes were used. The chromosome numbers of parents were 2n=48 for *L. mutabilis* and 2n=50 for *L. albus*. Hybrids were mostly characterized by 2n=48 chromosomes independent of mother parent (*L. mutablis* or *L. albus*) but hybrids morphologically were usually similar to mother.

Main problems of ILA

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The given conference is not only first in XXI century, but also twice anniversary. **25 years** have passed after discussion 1978 in London, Kuy-Garden on the special symposium at II international Legumes congress. It's theme: what culture should become second Soy-been? I managed to prove that most of all of establishments to apply for this place lupin. Therefore I have offered to frame the specialised organisation for intensification of works with this culture. After the second attempt such organisation (ILA) was built **20 years** ago in 1982 in Spain.

All these dates and my participating to birth ILA induce to serious, widescale works analysis of our organisation for the past period and statement of the basic problems to the future. The objectivity demands to recognize, that increase of the lupin sowing areas and intensification of scientific examinations with this culture prove correctness of the solution about building ILA. Naturally, on the first stage the major attention was given to improvement of it's technology of cultivation, seed production and selection. However, after 1996, San Francisco, all delegates have recognized lupin culture main grain leguminous as culture for all world the level of our requirements to scale and quality of works with lupin should be essentially increased.

Prime problem – rise of grain yields lupin till 4-5 t/ha and decrease grain loss to 5% and wounded to 3-4 %. For this purpose it is necessary to introduce the harvesting by rotor-type combines with a pneumoreel. On trials 1988-89 of rotor-type combine for a wet climate of a construction of the doctor Klyonin, grain lupin losses have not exceeded 5 %, wounded of a grain only 3 % (the serial combine in the check has yielded 27 % and 62 % accordingly). By such seeds it is possible to sow with diminished twice norm of seeding. The construction, designed in Russia, of the electropropagator has proved, that is capable effectively to solve the problem of struggle with weeds. The following problem - pest and illnesses control of lupin without pesticides by wave methods (electromagnetic generators). For the first time this method is successful and widescale was applied in USA on a cotton plant at pre-war years. But the firm, founded by the scientist, was ruined. Now we anew fulfil this method in Russia. Now - only against the aphid and anthracnose. For obtain of lupin stable high grain yields spray application by regulation-nutrient admixtures is needed. At last, the major prospects are available in developing compositions of microorganisms for lupin culture.

In range of selection to already coordinated and solved problems it is necessary to add in model of a "ideal" variety of lupin - ability to nectar manufacture, for in modern rotation deficit nectariferous cultures is more and more felt. The second difficult problem - developing perennial large-seeded lupin varieties. The third problem - developing of not split fodder varieties of perennial lupin species. Not only for cultivation by human, but also for enriching a food supply of the wildings, is simultaneous and for ecological regeneration sloping and erosive ground. The fourth problem - developing of pasture lupin varieties for various climatic zones. And last - developing small-seeded lupin varieties for green manuring. The available lupin gene pool yields actual basis for the solution of these problems of selection on prospect. But the traditional methods of selection will be necessary extended by gene-engineering, first of all to fulfil procedure of culture of a tissue of various lupin species. It is necessary to look more closely at hypothesis of wave genome P.Garyaev etc., the method of wave transfer of the genetical information. In Russia and China it seems works. All-round checkout by the scientists ILA is necessary.

Earthworm activity in a lupin patch in Heidmörk, Southern Iceland

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The activity of lumbricid earthworms was investigated in 1991-1993 in a lupin patch (*Lupinus nootkatensis*) in Heidmörk, Southern Iceland in order to study the effect of Nootka lupin and earthworms on soil fertility under poor soil conditions. The lupin patch was growing in a barren area near small islands with soil and vegetation. The Nootka lupin has increasingly been introduced in the reclamation of denuded areas in Iceland. It is a hardy plant that forms a complete cover a few years after planting or seeding, its litter production is high, it nourishes soil fauna and microorganisms and has a considerable effect on soil conditions. Every fortnight in the summer 1991 five soil samples were taken randomly in transects placed in different age of the lupin patch and outside the patch. Individual samples were wet-sieved. The average number, biomass and species composition of earthworms differed between the age of the lupin patch. The highest values for number and biomass of earthworms were found were the lupin had been growing for 10-25 years (viz. 300-500/m^2 and 10-12 g dry wt/m^2). No earthworms were found in eroded areas outside the lupin patch. Three earthworms species were found in the lupin patch, i.e. *Dendrobaena octaedra* (Sav.), *Dendrodrilus rubidus* (Sav.) and *Lumbricus rubellus* Hoffm. *D. rubidus* were the dominant species of the oldest part of the lupin patch and *L. rubellus* were also abundant. In 1991-1993 decomposition of lupine litter was studied in the lupin patch in Heidmörk. The decomposition of lupin litter was faster in corase litterbags (6 mm) than in fine litterbags (1mm) where earthworms and bigger invertebrates that grind plantlitter are excluded. In litterbags of both mesh sizes the lupin leaves had almost vanished the year after defoliation while 50-60% of the straw was still undecomposed. Earthworms, especially the rather small and hardy surface dwelling species, follow the lupin during its establishment in sparsely vegetated areas, if they are present in the vicinity. The abundance and high production of earthworms in lupin patches and their role in decomposition of lupin litter reflects the importance of lupin and earthworms as particularily successful colonisers and represent key factors in early stages of soil development in denuded areas in Iceland.

Seed ecology of Nootka lupine (*Lupinus nootkatensis*) in Iceland

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The introduced Nootka lupine (*Lupinus nootkatensis* Donn ex. Sims) has been used increasingly for land reclamation in Iceland during the last two decades. A prerequisite for its use as a valuable reclamation tool is that its distribution can be controlled. Therefore it is important to study the seed ecology of the species. The present project took place at seven different sites in Iceland, where the lupine has been introduced and formed patches. At the sites, seed production, seed dispersal and active seed bank in soils were investigated. The seed production was found to be variable within the lupine patches. The production was highest in younger parts, close to the expanding edge (maximum 1800 seeds m^{-2}), and much less in inner and older parts (generally 200-500 seeds m^{-2}). At the expanding edge seeds did not disperse further than 3 m. Seed dispersal started in early August, peaked in late September and ceased in early November. The lupine forms a persistent seed bank in the soil. The highest number of buried seeds (6700 and 2900 seeds m^{-2}) was found in older lupine patches, where the lupine had not yet retreated. Even where the lupine had retreated and was replaced by grassland, a large viable seed bank remained in the soil (760 seeds m^{-2}). The seed bank was also buried significantly deeper in older plots, which indicates that the seeds may last for many years in the soil. This has both positive and negative implications for the use of the plant in land reclamation. If erosion starts in a grassland that replaces the lupine, it can recolonise the area from the active seed bank. The long-lived seed bank, however, makes it difficult to fully control the distribution of the lupine.

Iron and phosphate acquisition strategies in the genus *Lupinus*: two for the price of one?

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The genus *Lupinus* consists of some 500 species, distributed across the Old and New Worlds. Of these, eight Old World species produce special structural aptations under low phosphate or iron conditions. These structures are called cluster roots, and are structurally similar under both iron and phosphate deficiency. In this paper, a number of questions will be addressed. Why are these structures induced under both low Fe and P levels? How different are they in terms of function? Has evolution fine-tuned the same structure for different ecophysiological interactions?

The physiology and development of cluster roots induced by phosphate in *Lupinus albus* L. has been well characterized. This paper reports on work done on the physiology of cluster roots induced under iron stress, allowing a comparison of these two systems, and providing an opportunity to investigate how one structure is fine tuned for two different roles.

The activities of aconitase, citrate synthase (CS), isocitrate dehydrogenase (both NADP-specific and NAD-specific forms) and lactate dehydrogenase (LDH) were measured over the first eight days of development in -Fe cluster roots, and in + Fe and –Fe lateral roots.

Aconitase levels were depleted in both –Fe systems. CS activity was slightly elevated in –Fe lateral and cluster roots compared to +Fe lateral roots. NAD-specific IDH showed a marked decline in the cluster roots, but a higher level in –Fe lateral roots. NADP-specific IDH activity, however, was highest in cluster roots and lowest in +Fe lateral roots. LDH activity was highest in +Fe laterals. Under –Fe, LDH activity was higher in cluster roots than in lateral roots for the first four days of cluster root development.

Results are discussed within the context of structural and functional evolution.

Lupinus: diversity of nutrient acquisition systems

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The genus *Lupinus* is currently considered to have nearly 500 species, distributed in both old and new worlds. The physiology and ecology of only a very few of these have been studied, but even so, considerable diversity has been found. In this review, I shall consider uptake of nutrients by roots (excluding cluster roots), nodulation and nitrogen fixation as well as the apparent amycorrhizal status of the genus. In all of these processes, lupins have some unique features among legumes. These will be discussed in turn, and an attempt will be made to use them to place lupins in an evolutionary context within the legumes.

Nutrient uptake. Most plant nutrients are taken up in ionic form and the discussion will be restricted to these. Cations are normally exchanged for protons and anions for either hydroxyl or bicarbonate. Depending on the relative levels of these processes, plants may make soils more acid or more alkaline. Among legumes, lupins seem particularly prone to acidify soils, an effect that is most noticeable on poorly buffered soils, such as where they often grow.

Nodulation and nitrogen fixation. Nodulation appears to be a generic character in *Lupinus*. Compared with other legumes, nodules that have been studied show unusual infection, developmental, fine structural and physiological properties. Although most work on lupin rhizobia has been carried out with the acid and aluminium tolerant *Bradyrhizobium* sp. (*Lupinus*), other slow- growing as well as fast-growing rhizobia have been isolated.

Mycorrhizas. Although there have been reports of limited infection of lupin roots by arbuscular mycorrhizal fungi, the genus as a whole does not seem to form the functional arbuscules associated with nutrient uptake by endo-mycorrhizas in other plants, including closely related legumes. In view of the common signalling pathways found for nodules and mycorrhizas in some legumes, lupins again seem to be unusual. Many plant genera which produce cluster roots are known to be amycorrhizal, but in lupins the amycorrhizal nature does not appear to be correlated with ability to form cluster roots.

Distribution dynamics of exotic Nootka lupin (*Lupinus nootkatensis*) on a braided river plain in Skaftafell National Park, Iceland

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In the 1950s, prior to the establishment of Skaftafell National Park, the exotic Nootka lupin (*Lupinus nootkatensis* Donn ex. Sims) was introduced into the area in a known single spot in a birch woodland remnant above a braided river plain. However, it was first after 1980, following landslides in the area simultaneously with retiriement from grazing that the lupin noticeable expanded from its original place and down to the braided river plain below the hill on which it was planted. The objective was to determine the history of spatial distribution of the Nootka lupin on the river plain and to assess the spread of lupin patches outside the main patch. Lupin distribution was mapped using six aerial photos from the period of 1965 to 2000 and compared. Ground truthing was carried out in summer 2001. Five transects, covering 108,000 m^2, were sampled from the edge of the main lupin patch to assess the distribution of lupin outside it. Along each transect, each lupin patch or a group of lupin plants were located and their height and diameter estimated. No lupin patch was detected on the river plain in 1965 but covered 17,000 m^2 in 1988. During the next six years a large lupin patch had established below the woodland and its size was 114,000 m^2 in 1994, 164,000 m^2 in 1997, and 230,000 m^2 in 2000. Outside the main lupin patch, lupin was recorded at 54 locations. Single lupins and lupin patches were estimated to have total cover of 2,300 m^2 and were found up to 2 km from the main patch. The current study shows that lupin in the area has spread with a similar pattern commonly known for terrestrial plant invasions.

Inter- and intra-specific genetic diversity in *Lupinus* evaluated with AFLP, ISSR and RAPD markers

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Molecular markers are contributing to the taxonomy of several groups of organisms. In *Lupinus* genus, molecular phylogeny studies have been done using polymorphisms on the nucleotide sequences of rDNA-ITS region and *rbc*L gene. The purpose of this work is to study the genetic diversity between and within different *Lupinus* species using molecular techniques (AFLP, ISSR and RAPD, capable of generating a large number of data throughout the genome). In *L. angustifolius*, AFLP and ISSR markers revealed the narrow genetic diversity on which domesticated accessions are based, by clustering a set of cultivars and breeding lines together, as a sub-group of a more diverse set formed by wild accessions. In *L. albus*, some morphology-based groups can be correlated to those based on the molecular analyses. ISSR markers showed *L. albus* and *L. mutabilis* with less genetic diversity, as opposed to *L. angustifolius*, with *L. luteus* in an intermediate position. This can be related to the historical evolution of these species, being *L. albus* and *L. mutabilis* cultivated for several centuries, while *L. angustifolius* was only recently domesticated (and mostly cultivated apart from its natural distribution area, unlike *L. luteus*). Results show molecular markers (AFLP, ISSR and RAPD) useful for studying interspecific genetic diversity in *Lupinus*. High levels of genetic dissimilarity were found (57-78%), but still a consensus dendrogram was produced showing patterns of similarity among species mostly identical to those obtained with DNA sequencing techniques. These molecular markers clustered *L. albus* into an unexpected intermediate position between Old World and New World species, as reported independently by A. Ainouche and R. Bayer and by E. Käss and M. Wink in the previous conference. The levels of genetic dissimilarity obtained in this work suggest that these techniques may be useful for the study of taxonomy and phylogenetic relationships of American *Lupinus* species.

Molecular, morphologic and pathogenic diversity of lupin anthracnose pathogen, *Colletotrichum acutatum*

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Anthracnose is the most important lupin disease. The taxonomy of the causal agent has been subject of much debate, some authors classifying it as *Colletotrichum gloeosporiodes* (including the original description) and others as *C. acutatum*.

This work aims to clarify the taxonomy of this pathogen within the *Colletotrichum* genus, and also to assess the genetic diversity existing among isolates of lupin anthracnose pathogen. For such, molecular, morphological and colony characteristics were studied.

Morphological and colony characters failed to distinguish accurately *C. acutatum* from *C. gloeosporioides*, although lupin anthracnose isolates showed growth rates on culture similar to those of *C. acutatum*. Nevertheless, several independent molecular characters (rDNA ITS, beta-tubulin 2, histone 4, AFLP and AP-PCR) show lupin anthracnose isolates as belonging to two different groups, one of them very homogeneous, comprising the vast majority of isolates. rDNA ITS, beta-tubulin 2 and histone 4 nucleotide sequence analyses also show clearly a clustering of any of these two groups together with reference isolates of *C. acutatum*, and apart from *C. gloeosporioides* or other *Colletotrichum* species. AFLP and AP-PCR originate an excess of polymorphism, unsuitable for distinguishing the species but not contradicting other results.

The main homogeneous group of isolates from lupins is distinct, although clustering within *C. acutatum* genetic diversity, suggesting a possible monoclonal origin for most isolates of lupin anthracnose pathogen. Results also suggest the possibility of erecting a sub-specific taxon within *C. acutatum* to accommodate these isolates.

Using of the Gametophit Selection in the Estimation of the Lupines Resistance to *Fusarium* sp.

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In respect of breeding for creation of the samples resistant to fusariose the express methods of earlier diagnostics of stable genotypes is necessary. In this connection we have studied the specific and intraspecific composition of the fusarium population, isolated virulent species and races, created the collection of various pathogen isulates. As far as the number of isolates is concerned Fusarium oxysporum is the most varied in our zone among the studied species. We have improved the methods for determination of the plant resistance to various species, races of fusarium and its mixtures as applied to lupine. By means of the pollen selection method that we have modified the evaluation of the yellow and blue lupine resistance to fusariose has been made. The pecularity of this method is that for pollen greensprouting the selection environment containing 50% of two week culture broth of fungoid pathogen has been used.

The evaluation of genotype resistance to fusariose has been based on such criteria as relevant percentage of pollen-grains germination and length of pollen pipes, that have had significant connection (r=-0,56 and –0,69 respectively) with the resistance of sporophyte (in affection points). The reaction of mature pollen on the influence of virulent and agressive isolates culture broths has been studied separetly as well as in complex. The dependance of pollen reciprocal reaction on the influence of toxic pathogen products from species of fungus isolate and genotype of lupine species has been revealed. The samples (Afus, Pruzhansky, Resurs-720, BSHA-500, BSHA-382 - yellow lupine, Apendrilon, Ashchadny –blue lupine) that are resistant to the complex of fungus isolates have been evolved. In order to evaluate the genotypes for resistance to fusariose and select the stable forms the mixture of culture broths from the complex of agressive and the most widely spred in certain zones isolates should be used. The modified method of gametophit selection allows to select the genotypes resistant to abiotic and biotic stresses and may be recommended for other legumes as well.

Genomic Analysis of Proteoid Root Formation in White Lupin

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In response to phosphorus (P) deficiency, white lupin undergoes striking developmental and biochemical changes resulting in the formation of proteoid (cluster) roots. Greater than 65% of the root mass of P-deficient plants can be comprised of proteoid roots. Proteoid roots display several adaptations that enhance the efficiency of P acquisition and use included among these are: increased abundance of root hairs; secretion of organic acids; release of acid phosphatases; enhanced P uptake; and perturbation of growth hormone metabolism. In efforts to gain an understanding of genes involved in white lupin adaptation to P stress and proteoid root formation, we prepared cDNA libraries at two different stages of proteoid root formation. One library corresponded to the early-juvenile stage of development, while the other corresponded to the later-mature stage. Approximately 2,000 ESTs (expressed sequence tags) were sequenced from these libraries. The nucleotide sequences of each EST was subjected to Blast analysis to ascertain putative function. The sequences were also sorted into contigs to assess the frequency of redundancy. The number of ESTs in contigs ranged from 2 to 10. There were 120 singletons among the EST population. Macroarray experiments were used to evaluate global expression of transcript abundance. Among genes most highly expressed were those involved in: transport of ions and water; metabolism of ethylene and cytokinin; carbohydrate and organic acid metabolism; and stress adaptation. A unique multi-drug toxin efflux gene, potentially involved in anion export, was highly expressed under P and aluminum stress. The promoter regions for lupin genes encoding acid phosphatase, phosphate transporter, and MYB transcription factor were isolated and shown to be responsive to P deficiency. Promoters from lupin P deficiency induced genes were sufficient to control reporter gene expression in the heterologous host, alfalfa. Plant factors affecting gene expression in response to P deficiency are conserved across genera. Proteoid roots of white lupin are an excellent biological system to dissect biochemical and molecular control of plant adaptations for acquiring P.

Evaluation of lupin germplasm to anthracnose resistance

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Lupin anthracnose, caused by *Colletotrichum acutatum*, is a disease that affects leaves, petioles, stems, pods and seeds. The first outbreak in the 1940/50s was solved by the introduction of a single dominant resistance gene into cultivars of *Lupinus angustifolius*, obtained from Portuguese wild germplasm accessions. Later on, lupin anthracnose reappeared in the 1970/80s in different parts of the world, affecting *Lupinus* species and became the most important lupin disease by the early 1990s. Cultivars resistant to the original outbreak are susceptible to the present pathogen populations.

In this work, part of the germplasm collections of *Lupinus albus*, *L. angustifolius* and other *Lupinus* spp. in the Instituto Superior de Agronomia genebank was screened for anthracnose resistance. Cultivars, landraces and wild germplasm, were all tested under field (Germany and Portugal) and glasshouse conditions.

Results show that there are different degrees of susceptibility to anthracnose, pointing out useful lines for resistance breeding purposes. Among the most resistant accessions, some should be stressed out: *L. albus* – germplasm from Murtosa (Portugal), Salamanca (Spain) and the South-African line SAL101; *L. angustifolius* – wild accessions from Arronches and Portalegre (Portugal) and some South-African and German lines.

A field trial settled to evaluate the effect of the disease on the yield components showed that the number of pods per pod-set is the most affected component. Under the trial conditions (Portugal), high flower abortion caused by the fungus was then the main cause of yield reduction.

Correlated responses of selection for grain yield in *Lupinus albus* L. in the Southeastern USA

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Unintended changes or correlated responses are an inevitable by-product of plant breeding and selection. This contribution is not an attempt to analyze or explain various correlated responses but to describe them and initiate a discussion that may lead to new avenues of inquiry. My selection program focuses on grain yield in low-alkaloid material. Parental lines are crossed as cultivated x cultivated or cultivated x wild accession. The selection method can be described as a modified bulk. In each of the first three segregating generations progenies are bulked by alkaloid level and/or growth habit. Low -alkaloid selections remained in the grain selection program in a separate nursery. High-alkaloid indeterminate material was tested again in following generations to extract further low alkaloid lines. Entries for the preliminary F_5 yield trial were selected entirely based on individual-plant seed yield in the F_4. Selection for individual-plant grain yield shifted the population towards an intermediate maturity and reduced lodging. Under our conditions we have found that the French line CH304/70 matures late and is extremely prone to lodging when seeded at the optimum time (4 wk prior to first – 2.2 C autumn freeze). The average maturity of all tested F_5 lines was 3 d earlier than the standard AU-Alpha, a new wildlife sweet cultivar released in 2002. When the top 25% of F_5 lines within populations were selected, their average maturity was the same as AU-Alpha, irrespective of population. The highest yielding entries also tended to be taller indicating that growth habit and the extent of branching had an effect on yield. The pollen parent in one population (CH304/70 x L085P) is a blue, high-alkaloid, indeterminate line of short stature. The average height of the lowest main stem pod of these lines was 22 cm lower than the lowest pod on CH304/70, the overall height was 24 cm more, and they yielded 300 and 600 kg ha^{-1} more than AU Alpha and CH304-70, respectively.

Development of *Lupinus albus* L. wildlife forage cultivars for the Southeastern USA

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Food plots planted to small grains and forages are routinely established in southern USA as part of white-tailed deer (*Odocoileus virginianus*) management programs. Forage legumes such as crimson *clover (Trifolium incarnatum* L.) or vetches (*Vicia* sp.) are components of these mixtures. We discovered serendipitously that deer thrive on lupin when we attempted to grow forage lupin for a dairy feeding trial. Initial deer damage to this lupin planting was so severe that special deer control permits were issued and 34 deer harvested from the 8-ha field over a period of 6 weeks. It was then that I began a separate selection effort for a lupin cultivar suitable for deer plots. Selection criteria differed from other selection efforts (cover crop, grain, silage). Obviously, any wildlife lupin has to be low-alkaloid. It is also desirable for lines to be tolerant of late summer seeding because proper wildlife management requires adequate fall growth. Yet spring-type lupins are not suitable because (a) they tend to flower in early winter and thus do not survive winter freezes, and (b) legumes, including lupin, loose their nutritional quality very rapidly when they switch into a reproductive mode. The first constraint is important because our efforts are intended to help the farm economy by developing another potential cash crop for certified seed producers. The second constraint is aimed at providing high-quality deer browse during a critical time in the reproductive cycle of these animals. AU Alpha, the first cultivar of this selection effort will be released in autumn 2002. It is a low-alkaloid line tolerant of late-summer seeding. Although seed yield is not critical for a deer browse it is eminently important for seed producers. AU Alpha has a seed yield that similar to the first high-alkaloid cover crop cultivar AU Homer released by my program. White lupin has the additional advantage that it poses no danger of becoming an invasive species.

Evaluation of the NPGS *Lupinus* germplasm collection for resistance to Colletotrichum

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The greatest limitation to lupin cultivation world wide is anthracnose. Because cultivated and wild lupin are sympatric in many areas and fungicide treatments are moderately effective at best, breeding for disease resistance offers the best solution for overcoming this limitation. The objectives of our research were to evaluate the three agronomically important species in the US *Lupinus* collection (*L. albus, L. angustifolius, L. luteus*) for resistance to *Colletotrichum gloeosporioides*, the causal agent of anthracnose. We used a "native" *Colletotrichum* isolate from Alabama grown on a standard medium. Spore concentration was adjusted to between 1 and 2.5 x 10^5 spores ml^{-1} with sterilized water. *L. albus* cv. Primorski was the known susceptible control. Plants at approximately the 2-leaf stage of development were thoroughly watered just prior to inoculation and sprayed with the spore suspension until run-off. After inoculation trays were inserted into standard black household garbage bags and incubated at room temperature in the dark for 48 h. Trays were then returned to the greenhouse. Disease severity was scored 2 wk post inoculation on a 0-5 scale. The average score across all plants and replicates was the score for a particular entry. As expected from previous research, *L. albus* was the most susceptible of the three species evaluated with average entry scores of 3.5 – 5.0. Entry scores for *L angustifolius* and *L. luteus* ranged from 1.5 – 5.0 and 1.1 – 5.0, respectively. It was noted, particularly in *L. angustifolius*, that some accessions had the ability to outgrow the fungus even though surrounding plants in a flat had died. This phenomenon manifested itself by new shoot formation from axillary meristems after the terminal meristem had been destroyed by the fungal infection. Identification of resistant *Lupinus* accessions can provide the parent material for a breeding program aimed at improving resistance to this devastating disease.

Tillage and Rotation Effects on Lupin in Double-Cropping Systems in the Southeastern USA

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Successful introduction of a new crop into a region requires that basic crop management parameters be determined and provided to producers through an information extension system. White lupin (*Lupinus albus* L.) was cultivated in the southeastern USA from 1930-1950 on up to 1 million ha, primarily as a cover crop. If it is to be a bona fide crop again, some basic management research needs to be done. Our objectives were two-fold (1) determine the effects of continuous lupin cultivation on yield, and (2) determine the effect of conservation system management on yield. A rotation study was conducted at the E.V. Smith Research Center, Shorter, AL from 1992 until 2001 on a Dothan fine sandy loam (Plinthic Kandiudult). Conventional (disk, chisel, disk, field-cultivate) and strip-tillage (no-tillage with in-row subsoiling) treatments were applied in a factorial combination with 10 crop rotation sequences. The sequences were designed to study the effect of summer cropping system (pearl millet cv. Georgia-Agra Tech HGM-100, soybean cv. Brim, and fallow) and intervening winter wheat (cv. Coker 9835) on the performance of white lupin cv. Lunoble. Forage yield of lupin was highest when it succeeded pearl millet, intermediate for summer fallow and lowest when soybean was the summer crop. Tillage effects on biomass yield of continuously cropped lupin were fairly small and inconsistent from year to year. Grain yield response of continuously cropped lupin was the same as for forage yield; however, response to tillage was more consistent. Strip-tilled lupin grain yields were greater than conventional-tilled lupin in all but one year. Grain yield in a system alternating wheat and lupin was consistently better under strip-tillage than under conventional tillage. This experiment demonstrates, that white lupin can be successfully integrated into cropping systems in the southeastern USA.

The value of *Lupinus albus* L. cv. AU Homer as a winter cover crop for cotton

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Successful cotton (*Gossypium hirsutum* L.) management in the southeastern USA with conservation tillage requires the utilization of winter cover crops to increase organic matter in the top 5 cm of the soil. The objective of our research was to test the newly-developed bitter white lupin cv. 'AU Homer' as a cover crop preceding cotton in a trial conducted for two years (1998-1999) at the Ala. Agric. Exper. Stn.'s E.V. Smith Research Center, in Shorter, Alabama. Three cover crop (white lupin cv. AU Homer, black oat (*Avena strigosa* Schreb.) cv. SoilSaver, crimson clover (*Trifolium incarnatum* L.) cv. AU Robin) and one winter fallow treatment were established each autumn. Each cover crop plot was designed to accommodate four sub plots treated with N-rates of 0, 34, 68, and 102 kg ha^{-1}. In late March existing winter vegetation was killed with glyphosate and cotton planted following non-inversion paratilling. Plant counts were taken on a 3-m section of the two center rows of each plot for 8-wk, beginning 2 wk post seeding; a final count was done just prior to harvest. Emergence was slightly suppressed for cotton following crimson clover. Seed cotton yields were highest for AU Homer followed by black oat and crimson clover. Maximum yields for cotton following AU Homer were reached at 34 kg N ha^{-1}, whereas cotton following winter fallow required 102 kg N ha^{-1} for maximum production. Using extension cost estimates for variable inputs, returns were always higher for lupin winter cover than for crimson clover or fallow treatments. Given the right situation (well-drained fields, timely autumn establishment) producers would experience an increased return compared to winter fallow and crimson clover if they utilized AU Homer as a winter cover crop.

Strategy of preservation of world Lupin genofond in Vavilov institute of plant industry

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Lupin collection in Vavilov Institute of Plant Industry had been initiated in 20th of XX century. Up to day it contains about 3200 accessions. These are commercial varieties, landraces, wild or run wild species from Mediterranean area, East-Northern Africa, North, Central and South America.

The collection preserves 28 species of genera Lupinus. The taxonomy of genera is given in accordance with the system of B.Kurlovich and A.Stankevich (1990). Most accessions belong to four species produced in Russia: *L.angustifolius (968)*, *L.luteus* L. (906), *L.albus* L. (541) and L.polyphyllus L. (161).

The main objectives of the work with the collection are: enlarging, preservation, evaluation and using it in national breeding.

The sources of the collection enlarging are: collecting missions, exchanges with foreign genebanks, seed firms, breeders introductions, botanical gardens, etc.

The strategy of the collection have been changed during the time in dependence of demands and priorities of world and national breeding. The analysis of the accessions origin have revealed that during the last 30 years most accessions came from Byelorussia (537), Russian Federation (184), Ukraine (115), Germany (139) and Poland (159) and less from the southern countries except Australia (220) which during some latest decades had reached a great success in lupin breeding and production and created a rich germplasm collection.

The strategy of maintenance presupposes timely regeneration on the experimental stations in Middle Russia - near Moscow and Tambov. Till quite recently there were some southern points for the long-maturated accessions maintenance. Unfortunately they disappeared because of different reasons (particularly destruction of the USSR), so, the problem of regeneration of these accessions is the question of vital importance. Conservation of the duplicative set of the collection is carried out at the temperature +4° and –4°C in genebank.

Evaluation of the collection for different traits is carried out. The sources of valuable traits are searching for the using in national breeding. The priorities of current time are diseases resistance and nitrogen fixing ability. Every year evaluation of new introductions is conducted at experimental stations. Special attention is devoted to the material valuable for East-North of Russia, where the Institute is situated.

There are some breeding institutes in Russian Federation dealing with lupin. Every year about 300 accessions goes to breeders in accordance with the requests. Besides, there is vast circle of international relations and exchange of germplasm with foreign breeders and genebanks. Productive collaboration has being organized with CLIMA (Australia) and the Institute of Plant Genetics (Poland).

Legumes tripcine inhibitors effect on activity of *C. gloeosporioides* extracellular proteases

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Proteolytic pathogen ferments play an important role in fungi penetration and localization processes in a plant organism. Protein inhibitors of plant origin could suppress their activity. It is intended that tripcine inhibitors are one of the plant resistance factors in case of fungi diseases. The inhibitors hinder fungi penetration into a plant due to inhibition of fungi proteolytic ferments. However protein inhibitors' role in plants is still not studied in details and is questionable among researches.

We have studied interaction type of seed proteases' inhibitors of some legumes (yellow and narrow-leafed lupins, soybeans, vetch, broad beans and kidney beans) with *C. gloeosporioides* extracellular proteases.

Analytical method based on casein has been used to determine tripcine inhibitors of legumes meal. Fungi isolate initially was grown in demineralized agar medium; its growth has been finished in the Chapeck-Dox's liquid medium based on surface cultivation. Cultural liquid has been used as fungi extracellular proteases. Proteases' activity has been determined on N-α-benzoyl-DL-arginine-n-nitroanilide hydrolysis speed.

Legumes seeds, which had been used for protein inhibitors extraction of *C. gloeosporioides* extracellular proteases, significantly differ in tripcine inhibitor activity. Seeds of soybean var. Bryanskaya, vetch, broad beans var. Amber, YL BL 1408, kidney beans and NL lupin var. Chrystal have the average activity of 542.7, 18.1, 15.2, 5.9, 5.3 and 3.5 TIU per 1g of dry meal respectively.

Tripcine inhibitors' activity of legumes seeds does not always correlate to inhibition level of fungi extracellular proteases. So if the level of tripcine inhibitors' activity of vetch seeds is 18.1 TIU per 1g of absolutely dry meal, inhibition degree exceeds 70%; in the case of narrow-leafed lupin it is 3.5 TIU per 1g of absolutely dry meal and 27.0%.

Among tested crops no one was found which inhibitors proteins would fully inhibit activity of exogenous proteases of anthracnose agent. The mentioned crop differentiation according to this character intends possible future successful search of specifically functioned inhibitors of anthracnose agent's extracellular proteases.

In vitro antifungal activity of *Lupinus montanus* extract and lupanine on *Fusarium oxysporum* f. sp. *melonis*

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The cantaloup wilt caused by *Fusarium oxysporum* f. sp. *melonis* is the most important disease in the Central Pacific of Mexico. Wild mexican lupins are important source of alkaloids that might be utilized for control of this disease. The antifungal capacity of lupanine and a crude extract (from *Lupinus montanus*) containing this alkaloid was evaluated in base to mycelium growth and reproductive structure inhibition of *F. oxysporum* f. sp. *melonis*. Four concentrations of 0, 150, 300 and 450 ppm with five replications of extract or lupanine were evaluated. The treatments were incorporated into potato-dextrose agar medium. Then, the petri dishes were inoculated with 50 mm diameter disk of mycelium and incubated in darkness at 25 ± 1 °C. The mycelium radial growth, dry weight and reproductive structures were measured after seven days of the incubation. The results indicate that development of the mycelium growth was lower when increased the lupanine and extract concentrations compared to the control. However, the best inhibition (17 %) was observe with the extract to 450 ppm, also decreased chlamydospores, macroconidia and microconidia number in this concentration. Interaction of all the alkaloids in the extract introduces the better antifungal effect compared with the pure lupanine.

Evaluation of lupine energy-saving role in today land management and its cultivation future in connection with ecological, feed and nutritional protein problems

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Growing of perennial lupine in Ukraine has a long history. This crop is not fastidious about soil and climatic conditions. However, due to high alkaloid content in its green mass and substantial power consuming of its approved alkaloid destruction technologies, the practical use of the perennial lupine feed potential has no future under the energy crisis conditions. At the same time, sharply strengthening interest is currently observed in perennial lupine as a factor of more effective utilization of poor soils and a general biological method for improving soil fertility, especially on agricultural areas exposed to man-caused pollution.

Intensive studying of lupine biology and its creative breeding within the UAAS system over the last 40-50 years have greatly contributed to solving this problem. This work became especially fruitful under the influence of intensive activities of the ILA and due to international cooperation. Over this time there has been made a break-through in breeding non-alkaloid fast-ripening fusariose-resistant varieties of *Lupinus albus* and *L luteus* oriented on integrated resistance to diseases. The State Plant Variety Register has been filled up with new generations of white and yellow lupines for food/feed purposes with a complex of economically valuable traits and high seed productivity. This allows regarding lupine as a significant alternative to other pulses and partly oil crops, first of all as a source of feed protein, especially in the view of the sharp shortage of fertilizers and man-caused pollution of the environment.

Basing on objective analysis of the national scientific achievements and factors of their poor implementation, the report provides a fulfillment concept of the adaptive system of zonal agricultural production that stipulates expanding of lupine areas in connection with the necessity to make land management and crop growing more biology-oriented and environment-friendly. The present national policy provides for optimal saturation of crop rotations with lupine of the new generation varieties and setting up of their seed growing in order to stop the soil fertility degradation. Concerning energy and resource saving, there are recommended to producers lupine growing practices developed by the scientists, as well as promising uses of lupine crop, including rational use of lupine grain and its products for feed and food purposes.

As a result of the conducted program of phytopathological investigations, data on lupine varieties' resistance to antractosis, infection sources, and commercial crop protection were systematized.

The conclusion was substantiated about the enhancing of lupine production as an important feature of the national way of solving the protein problem, which would ensure higher sustainability of crop growing and animal raising, their lower vulnerability in crisis situations.

Development of lupin food products for the elderly

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The aging process is intimately related with food intake. It has been proven that the diet of many elderly lacks essential nutrients. Consequently, lupine becomes an attractive alternative for human nutrition due to its protein contents and quality and its dietary fiber.

Recent studies demonstrate that fiber consumption in chilean normal diet is low (4.5-17g/day) leading to several problems. Furthermore, the recommendations of fiber intake are imprecise.

As a possible means to solve this problem, the addition of dietary lupine fiber (Vitafiber$^{M.R.}$) to food formulations of frequent consumption was studied. Formulations were supplemented with vitamins (A, thiamin, riboflavin, B6, B12, niacin, C, D3, E and folic acid) and minerals (calcium, iron, magnesium and zinc) to restore possible losses that could be generated when increasing fiber intake.

The developed products were cookies, muffins, bread, cakes and noodles with 6.6 – 5.2- 9.0- 10.0 and 11.05% of total dietary fiber, respectively. Formulations were optimized using MSR. The products were controlled for quality (physical, chemical, microbiological and sensory analysis) and the effect of the intake through biochemical and anthropometrics index, pre and post intake, was evaluated. Acceptability studies with elderly consumers and shelf life studies for each product were carried out.

Influence of extracts of oligosaccharides from pea and lupin seeds on caecal fermentation and nitrogen excretion patterns in rats

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The influence of 8% supplementation of casein diet with oligosaccharides from pea and lupin seeds (groups PO and LO, respectively) on the nitrogen balance and functioning of the blind gut (development of tissue, content and composition of LKT, bacterial glycolytic activity in the contents) was investigated in experiments on Wistar rats. Oligosaccharide concentrates of pea and lupin seeds contained 85.5 and 83.5% of oligosaccharides. The control diet was supplemented with cellulose. Addition of pea and lupin oligosaccharides caused an increase in the amount of nitrogen excreted in faeces, compared to the control group, and at the same time had no considerable effect on the nitrogen losses in urea. Significantly lower index of nitrogen digestability was recorded in LO group, while nitrogen retention and protein BV index were similar in all groups. In rats receiving pea and lupin oligosaccharides with diet, a higher amount of contents and weight of the blind gut wall (especially in LO group) as well as a higher pH of contents were recorded, compared to the control group. In caecal contents of PO and LO groups, there was observed a significant decrease in the content of total and ammonia nitrogen and protein. In these groups, compared to the control, a significantly higher activity of bacterial β- and α-galactosidase and α-glucosidase was noted. While the activity of bacterial α-glucuronidase was the highest in rats fed diet supplemented with lupin oligosaccharides. The highest concentration of LKT in the contents was recorded in PO group, while the lowest one – in LO group.

INTERNATIONAL *LUPIN ASSOCIATION*

Notice of Meeting

There will be a meeting of the General Assembly of the International Lupin Association at 1630 on Saturday 22 June 2002 at the Hotel Edda, Laugarvaten Iceland[1].

AGENDA

1. Apologies
2. Minutes of the meeting of the ILA General Assembly held on 23 June 1999 in Klink, Germany. (Attached)
3. Matters arising from the minutes.
4. Election of President, Secretary/Treasurer and members of the ILA Board.
5. Consideration of proposals to host the 11th International Lupin Conference.
6. General Business

[1]Under the constitution of ILA only financial members of the Association may vote at the ILA General Assembly and be nominated and elected to serve on the ILA Board.

Minutes of the Meeting of the ILA General Assembly Held at 1900 23 June 1999 at the Müritz Hotel, Klink, Germany.

Present:

The President Dr Erik von Baer and 44 members.

Opening:

The president opened the meeting by asking all members to observe one minutes silence in memory of Dr V. Golovchenko from Ukraine and Dr W. Plaare from Germany.

Minutes:

The minutes of the ILA General Assembly held on 16 May 1996 at Asilomar California were approved as a true record of that meeting.

Matters arising from the Minutes:

Nil.

Election of Officers:

President:

As the only nomination was for Dr E. von Baer of Chile he was declared elected unopposed.

ILA Board:

The following persons were nominated to serve on the ILA board until 2002.

Professor P. Caligari	United Kingdom
Dr C. Hughye	France
Mr P Nelson	Australia
Dr J Neves-Martins	Portugal
Dr A.M. Plancheulo	Argentina
Dr P. Römer	Germany
Dr W. Święciki	Poland
Dr I Takunov	Russia

As the number of nominations equalled the number of vacancies on the board the above persons were declared elected.

Venue of Further International Lupin Conferences:

The Secretary reported that the offer from Iceland to host the 10th International Lupin Conference had not been confirmed.

A fax was tabled from Dr K. Packendorf in South Africa offering to host a meeting in Stellenbosch in September 2002.

Professor Caligari of the United Kingdom indicated that if by any chance the meeting could not be held in South Africa that the United Kingdom might be prepared to host the next meeting.

The Russian delegation indicated that it was still not possible for Russia to host a meeting because of their continued internal economic problems.

1. It was resolved that the 10th International Lupin Conference be held in South Africa.
2. That provisionally the 11th Conference be held in the United Kingdom in 2005.

General Business

a) Honorary Fellowship:
A.C. Jordan was elected an Honorary Fellow of the International Lupin Association with acclamation.

b) Financial Position of ILA:
The Secretary reported on the current state of the ILA finances. Since the 1996 meeting in California this has improved and ILA now has modest reserves. Aim is to use the money to promote lupins and possibly provide some bridging finance for a young researcher to attend their first international meeting.

c) Proceedings
The Secretary outlined the reasons for the long delay in the publication of the Proceedings of the 8th Conference in California.

Dr van Santen updated the meeting on the state of publication of the Proceedings of the 9th Conference, which he hoped to have completed by 1 September 1999.

d) Failure to Present Posters
Dr van Santen reported that a significant number of posters, which had been accepted, had not been displayed. The papers associated with these posters will not be published in the Proceedings.

It was proposed that at future meetings papers would only be published in the Proceedings on the receipt of the registration of at least one of the authors. Carried.

It was further moved and carried that for future meetings abstracts should sent to regional ILA Board Members for preliminary vetting. Workers to be helped to obtain either funding or a suitable co-author(s).

e) Lupin Database
There was a brief report on the lupin database being developed by Dr D. Enneking. It was hoped that it would be available to all ILA members.

f) Thanks
A vote of thanks to the German organising committee for their excellent organisation of the meeting was passed with acclamation.

g) Presentation by Host of the 10th ILA Conference:
Dr Jan van der Mey was appointed. He reported briefly on the proposed venue for the 10th Conference and hoped to be able to welcome everyone in South Africa in 2002.