Adaptation of lupins for Northern European maritime conditions

by

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Historic review

- Lupin was used as green manure
- Highest average seed yield from 1894 to 1902
  - 3,6 t/ha in angustifolius
  - 2,3 t/ha in luteus

- 1935 - 1990, Sweet lupins 1935-1990, Wild inderteminate types
  - Yield 1,0 to 2.1 (t/ha) for both luteus and angustifolius
  - Peas and Faba beans yielded 2-5 t/ha in the same period
  - Frequent lodging, late ripening and harvest problems

- 1990 - Sweet restricted branching angustifolius, albus and luteus

Lupin species

- White lupin
  - Spring types – late ripening
  - Winter types – poor winter survival- late ripening
- Yellow lupin, earlier grown in Denmark
  - High in protein, late ripening, low yield, anthracnose susceptible
- Narrow leafed lupin,
  - Earlier ripening and more stable and productive
  - anthracnose tolerant

Species of lupin

- Yellow narrowed leafed white

White winter lupin

Maritime conditions

- Warmer Winters and cooler summers
- Humid/rain full conditions
- Delayed harvest result in poor harvest conditions
  - Short days
  - High air humidity

Canopy structures in *lupinus angustifolius*

Wild Pseudo-wild Quasi-wild Corymbouse Panicular Epigonal Palm

Effect of maritime conditions on wild branching lupins

- Vigorous growth and large biomass production
- Increased vegetative development and decreased harvest index
- Later ripening
- Soft Plants, which tend to lodge
- Botrytis and fusarium infections

Canopy structures in *lupinus angustifolius*

Wild Pseudo-wild Quasi-wild Corymbouse Panicular Epigonal Palm

Different growth forms

Canopy structure	Height (cm)	Vegetation period (day)	Yield potential (t/ha)
Spike-like type	40-100	115-140	3-4,5
Corymbouse	60-100	130-140	4-5
Pseudo wild	80-10	138-160	3,5-6
Wild	80-120	138-157	3,5-5,5
Vernalization	80-120	125-155	3-4

Good experimental Practice

- Effective weed control
- Protections from birds and animals by fence , net and alarms
- Protection from insect and transmittance of viruses

- Destroyed experiment or misleading results often follows damaged experiments

Norway Oslo

Genotype	Structure	Yield (t/ha)	Swing date	Harvest date	Veg period
Prima	Spike	3,1	11.05	12.09	124
Lae2-2	Spike	2,4	11.05	12.09	124
Lae1	Spike	3,4	11.05	12.09	124
Lae6	Spike	3,0	11.05	12.09	124
Lag16-3	P-wild	3,5	11.05	28.09	140

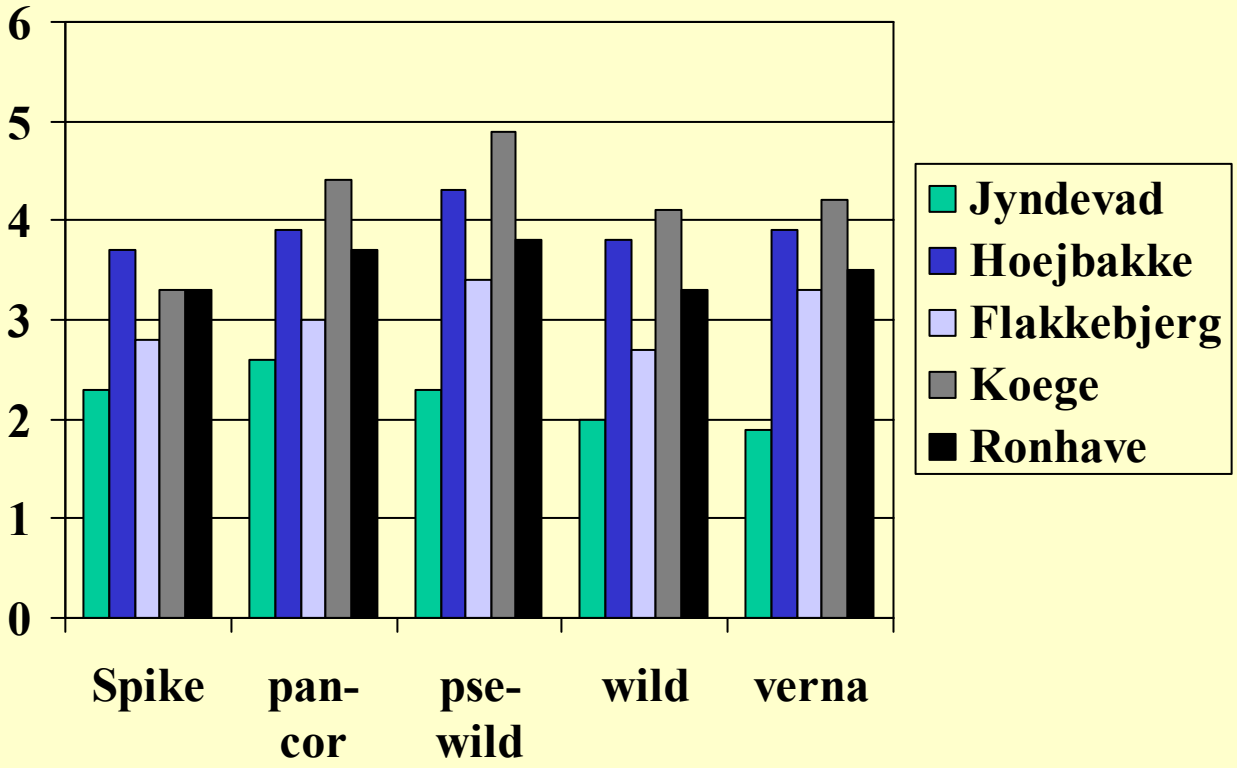
Ireland

Genotype	Structure	Yield (t/ha)	Swing date	Harvest date	Veg period
Prima	Spike	4,4	3.04	27.08	146
Lae2-2	Spike	3,0	3.04	27.08	146
Lae6	Spike	3,8	3.04	4.09	154
Lag 16-3	P-wild	4,1	3.04	4.09	154
Hpb39	Wild	4,6	3.04	4.09	154
Laf8-8	Corym	4,4	3.04	27.08	146
Lag6	Wild	4,6	3.04	27.08	146
Lav8-4	Vernaliz	3,4	3.04	27.08	146

Denmark Official trials

Genotype	Structure	Yield (t/ha)	Swing date	Harvest date	Veg. Period (days)
Prima	Spike	2,8	April	1.09	139
Lae1	Spike	2,9	April	8.09	146
Lae6	Spike	2,9	April	5.09	143
Borweta	spike	2,8	April	1.09	139
Boruta	Wild	2,9	April	8.09	146
Lag16-3	P-wild	3,5	April	6.09	144
Bora	Wild	3,5	april	9.09	147

Multi-location yield trial different morphological types



The yield potential can be realized by:

- Timely sowing at correct density for the given canopy structure
- Effective weed control
- Protection from insects and viruses
- Resistance / protection to diseases
  - Fusarium
  - Botrytis
  - Anthracnose

Fusarium

- *Avenaceum* and *Oxysporum*
- Apparently favourable conditions for fusarium development
- One year growth of a susceptible line results in:
  - High infection level in soil
  - Susceptible lines can not be grown

Fusarium wilt in *L. albus*

Fusarium wilt in *L. angustifolius*

Botrytis

- Apparently susceptible
- Spores always present
- Humidity + flower leaflets can initiate an epidemic development
- Crop failure has been observer
- Importance?

Diseases - anthracnose

- Luteus and albus lupin fully susceptible
- *Angustifolius* is tolerant and resistant material exists
- *Luteus* with anthocyanin appear to be tolerant

Lodging

- Important in maritime humid conditions
- Depend on type of lupin
- Irrigation initiate lodging
- Stem strength and soil contact are important
- Significant genetic variation is present

Ripening

- The traditional wild types are late ripening
- The more reduced the growth form, the more early and stable ripening
- Some genotypes tend to have green stems and leaves after the ripening of the pods
  - Due to viruses
  - Nutrient deficiencies
  - Genetically controlled

Quality

- Alkaloid content
  - Ruminant < 0.06%
  - Monogastrict < 0.03%
  - Human consumption <0.02%
- Protein
  - Thinner seed coat
  - Selection for higher protein in nucleus

Protein content and seed coat proportion

Geno	Seed weight mg	Seed coat prop %	Seed coat thick-ness mm	Protein Nucleus %	Protein whole seed %
G32	223	20	0,25	52	42
G6	105	27	0,30	54	39
Ops	52	22	0,18	46	38
????	225	14	0,18	54	47

Hauksdottir et al, 2002

Shattering

- Over 4 years only insignificant shattering is observed in typical wild types
- Lentus
  - Orange pigmentation
  - Non twisting pods
  - Reduces yield
- Tardus contact of pod walls
- Pods connection to stalk

Conclusion

- L. *angustifolius* has the potential to be developed into a protein crop for northern European conditions

Ideotype

- Potential yield 6-7 ton/ha
- Reduced branching types
- Early flowering and thermo-neutral type
- Lodging resistant
- Fusarium root and wilt resistant
- Botrytis resistant
- Anthracnose resistant?
- Low alkaloid (<0,03%)
- High protein