



Organic breeding of white lupin for regionally produced, plant-based protein foods in Switzerland

Christine Arncken, Monika M Messmer, Ursula Kretzschmar, (FiBL) Miriam Kamp, Sebastian Kussmann (gzpk), András Patyi, Mariateresa Lazzaro (FiBL)

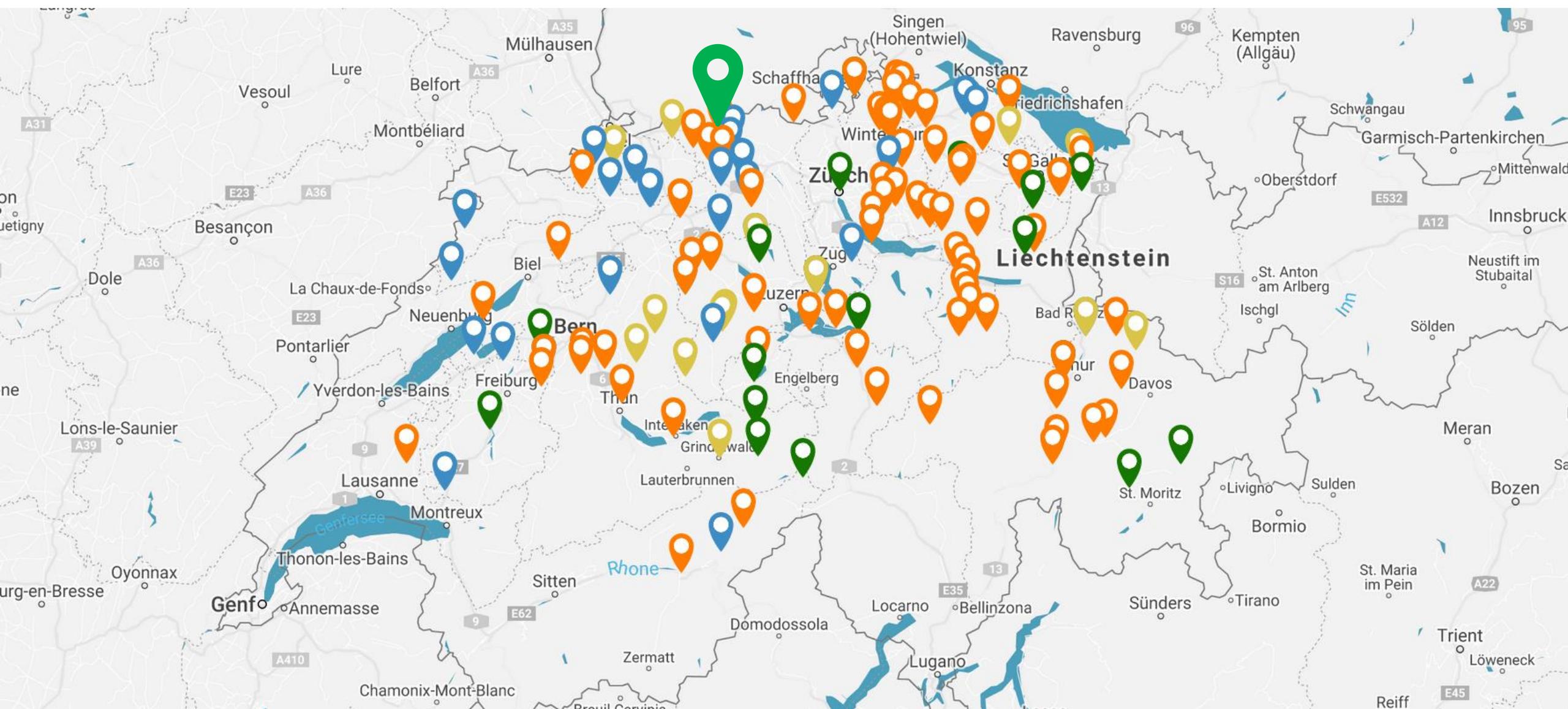
16th International Lupin Conference, Rostock, June 22nd, 2023

FiBL Switzerland

- Founded in 1973
- Run by a non-profit foundation
- 290 employees (sites: Frick & Lausanne)
- Research, consulting, continuing education and development cooperation
- Financing: 38 % basic funding by federal agricultural office, 44 % projects
- Rest: charitable foundations, mandates, cantons, companies, economic activities
- Research institutes of FiBL group in DE, AT, HUN, FR
- FiBL Europe Office in Brussels



FiBL's on-farm farm network at over 150 locations in Switzerland



White Lupin: a chance for sustainable agriculture

- 35 % and more protein content
- next best amino acid composition after soybean
- Legume family → N fixation
- Deep roots
- Soil structure improvement,
- P mobilization
- Pollinator attracting flowers
- frost tolerant summer crop
- drought tolerant
- Particularly interesting for organic or agroecological farming systems
- Increasing demand:
 - feed
 - food: vegetarian / vegan trend



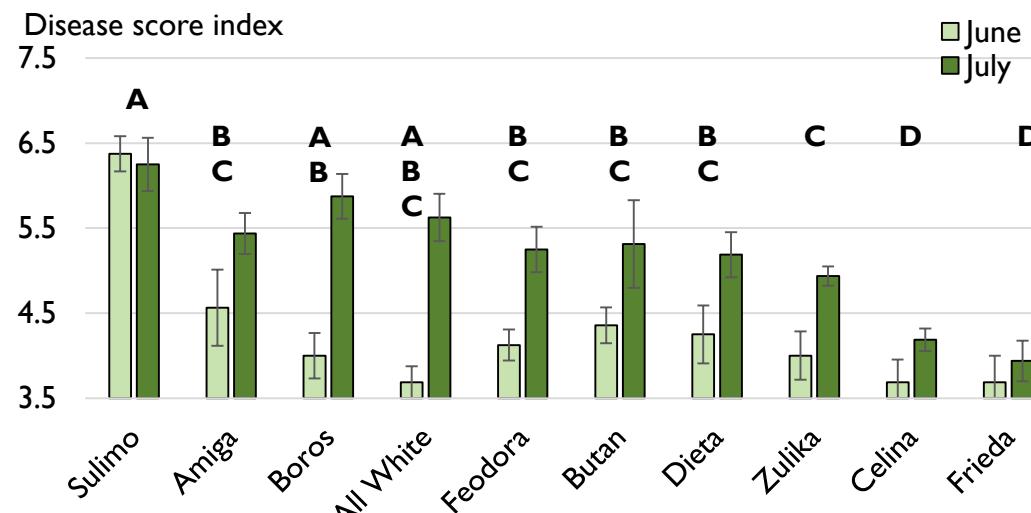
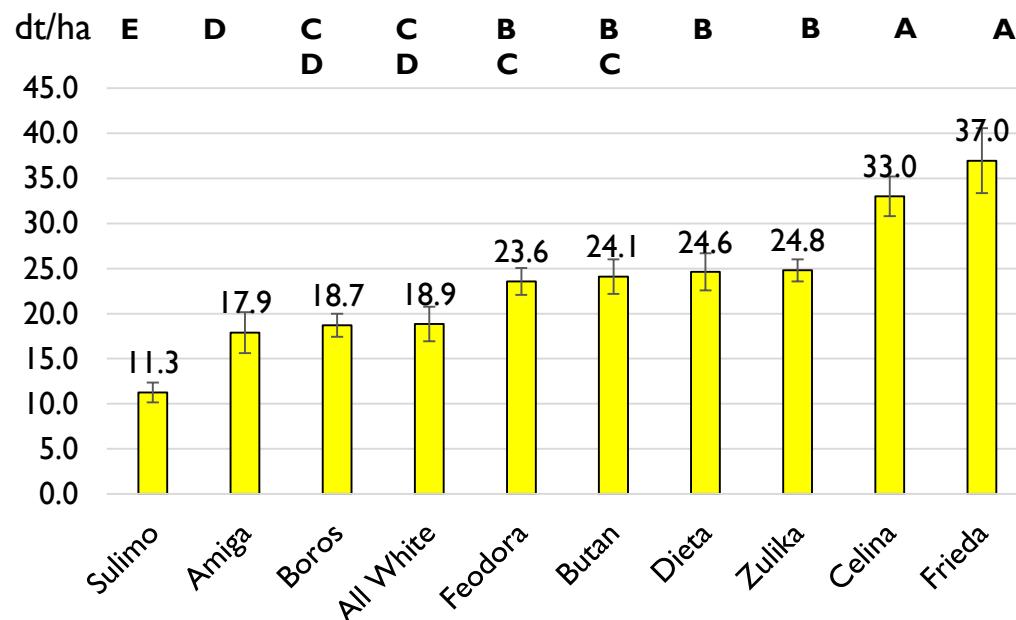
Anthracnose in white lupin

- main obstacle in Switzerland
- fungal agent: *Colletotrichum lupini*
- total yield loss possible
- transmission: seed, rain splash
- under wet conditions $> 25^{\circ}\text{C}$
- major reason for stagnating cultivation
- only quantitative resistance
- In Europe only 2 resistant varieties
(Frieda, Celina (DE))



Cultivar trial 2022

2 sites, 4 rep



Pre-breeding: Screening of genetic resources

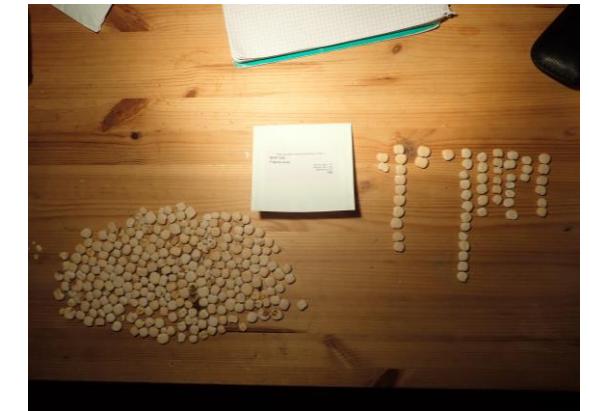
every year since 2015:

- 100-200 new accessions
- single rows in mini-plots
- between infection rows of susceptible cultivar «Amiga»
- relative disease scoring
- 100-200 selected single plant progenies from previous years
- challenge: up to 15% cross pollination possible
- → isolate selected plants from insects!



Crossings and pedigrees

- Selection of resistant (bitter, late) and sweet parents
- sowing of crossing partners at staggered intervals
- crossings in the greenhouse
- F 1 – F 5: insect tunnel
- single plant selection starting mostly in F 4 (some sweet plants selected earlier)
- seed evaluation



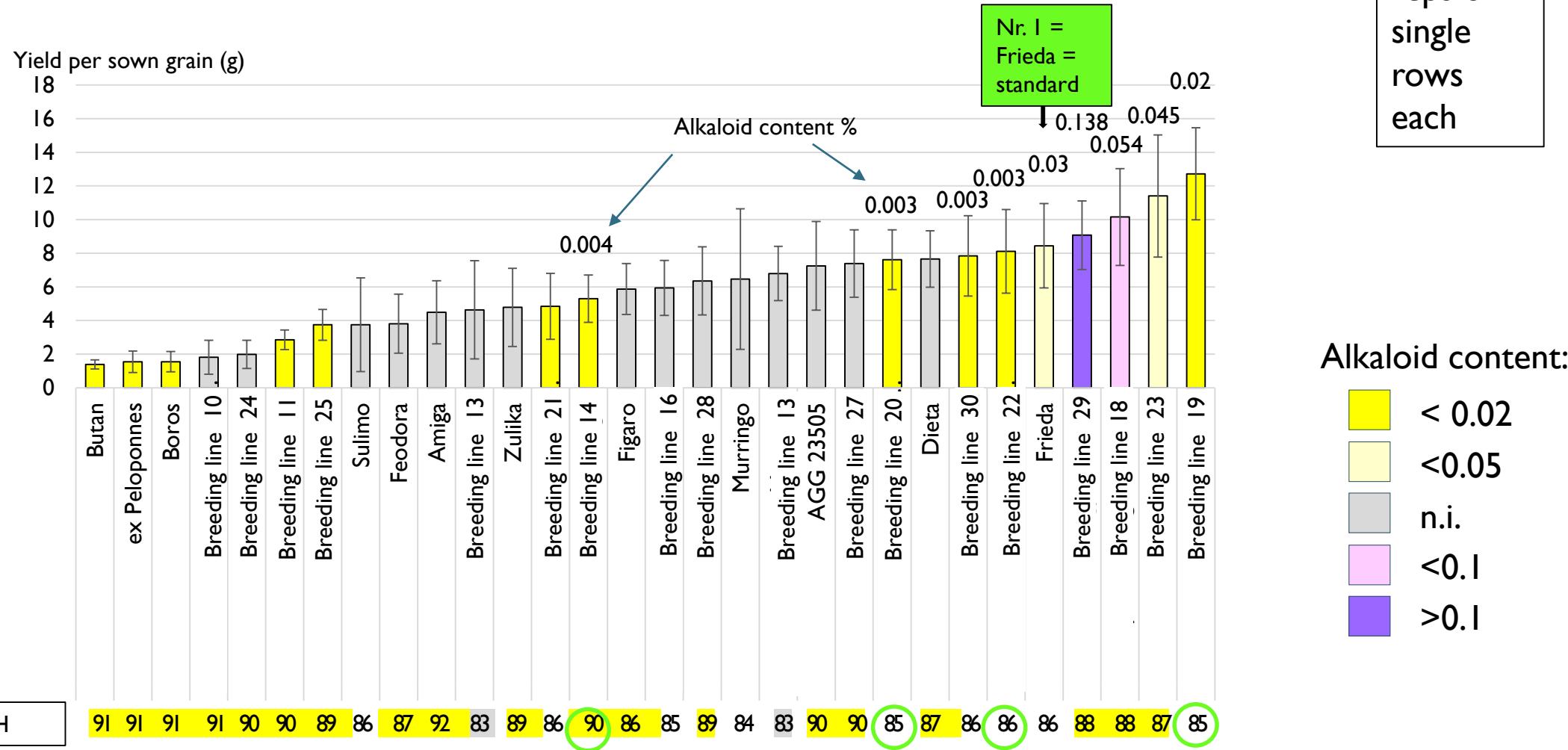
Testing: A - Ring Trial

- In Co-operation with gzpk
- Advanced breeding lines (F4 and older)
- Commercial cultivars
- Between infection rows
- 3 sites with 2 replicates each
- = Data from 6 single rows per breeding line



A - Ring Trial Results 2022

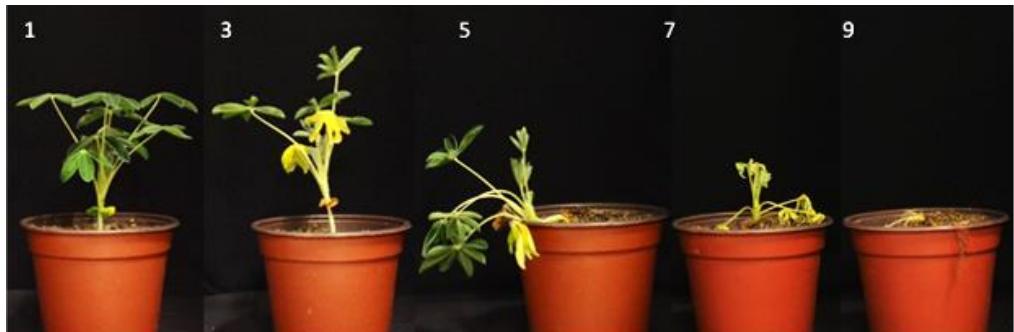
Searching
for
resistant,
sweet
AND early
lines



2023: 4 candidates from ring trial plus 2 sister lines =
6 candidates for first yield evaluation in miniplots

Disease scoring of F5/F6 lines after artificial inoculation

- controlled conditions, climate chamber
- 14-day-old plantlets
- stem wound inoculation with spore suspension
- repeated disease scoring over 14 days
- standardized area under disease progress curve
- Data used
 - I. for selection
 - for marker development

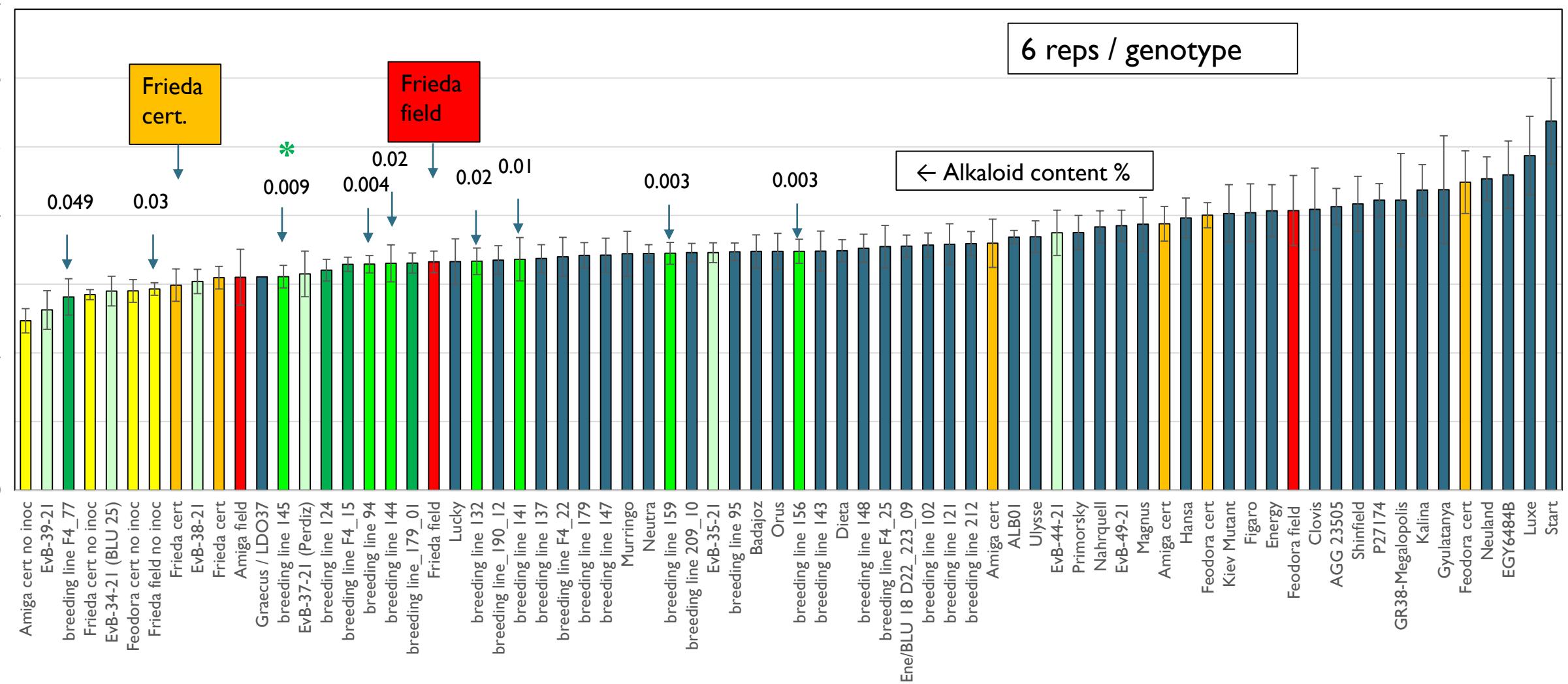


Alkemade et al. 2020

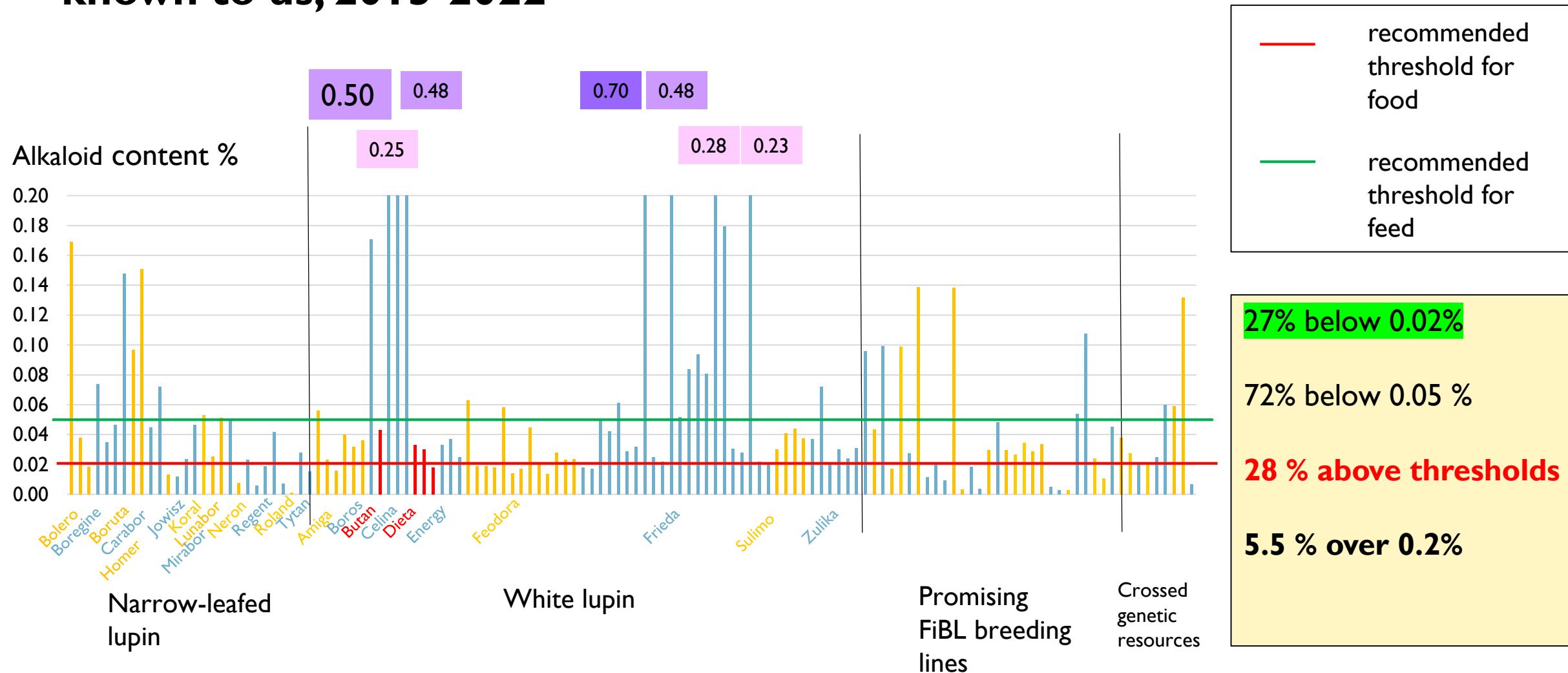
Disease scoring of F5/F6 after artificial inoculation

Mean (sAUDPC)

Best line F5: 0.05 % alkaloids
 Best stable line: 0.009 %
 → in miniplots of 1m² in 2023



All 128 alkaloid analyses of lupins cultivated in Switzerland known to us, 2015-2022

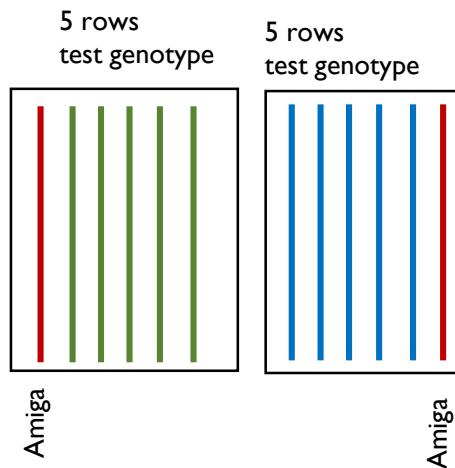


White and Blue Lupin samples from FiBL and gzpk trials and from farmers;
analyzed in different labs

B - Miniplot Trial 2023

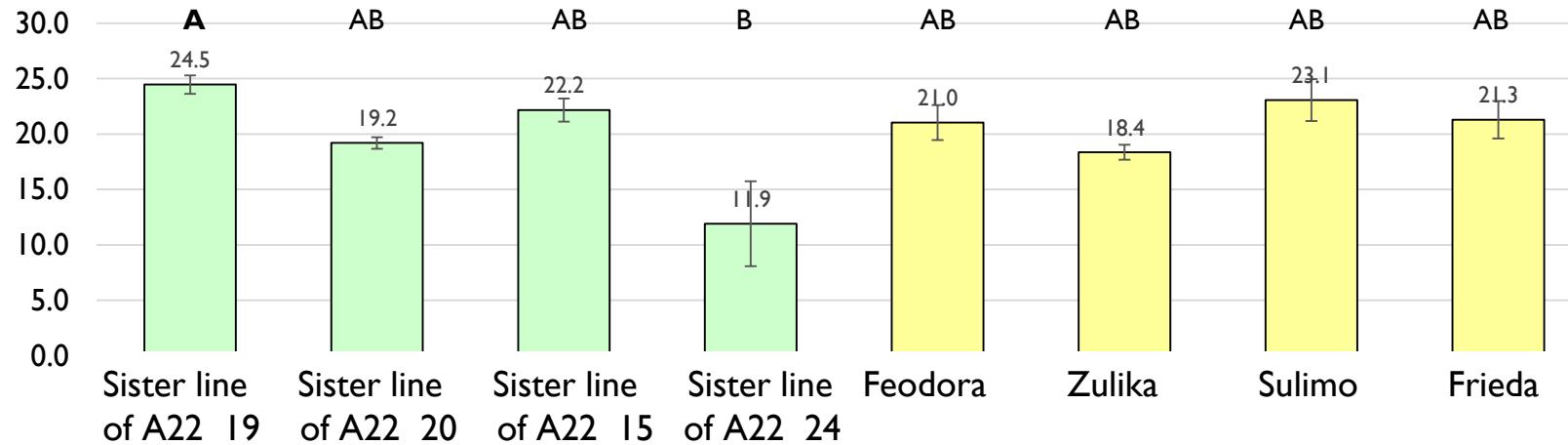
Layout:

- 40 6-row plots with one infection row of Amiga
- augmented design with 8 incomplete blocks of 5 entries,
- in each block Frieda as check variety,
- 11 entries replicated 2 times, 10 entries 1 time
- On 2 sites

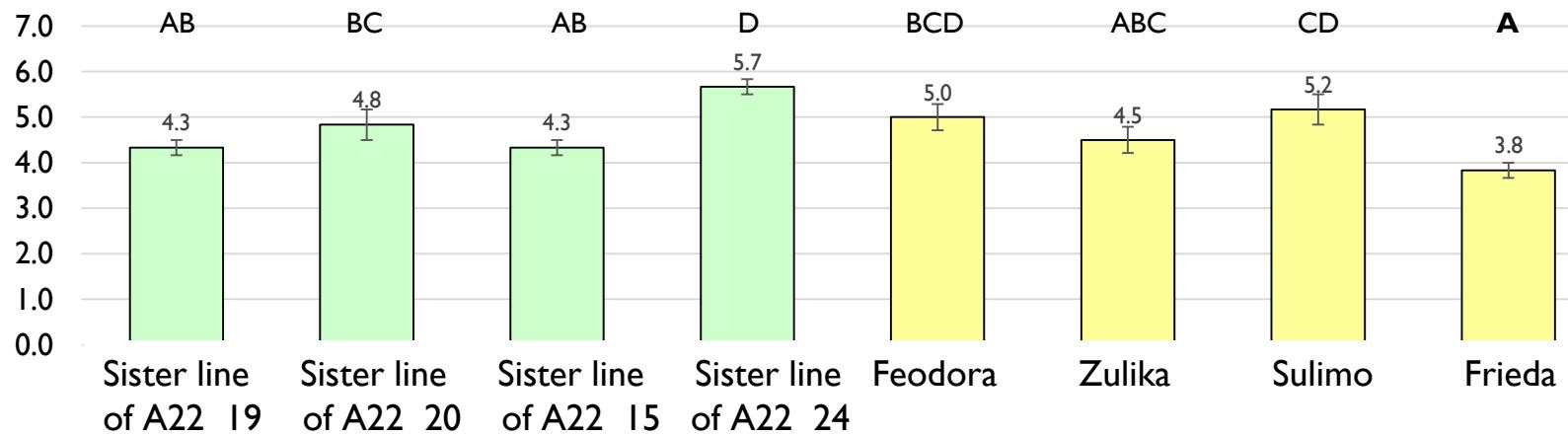


Miniplot Pre-Trial 2022

(Mean of 3 Replicates)



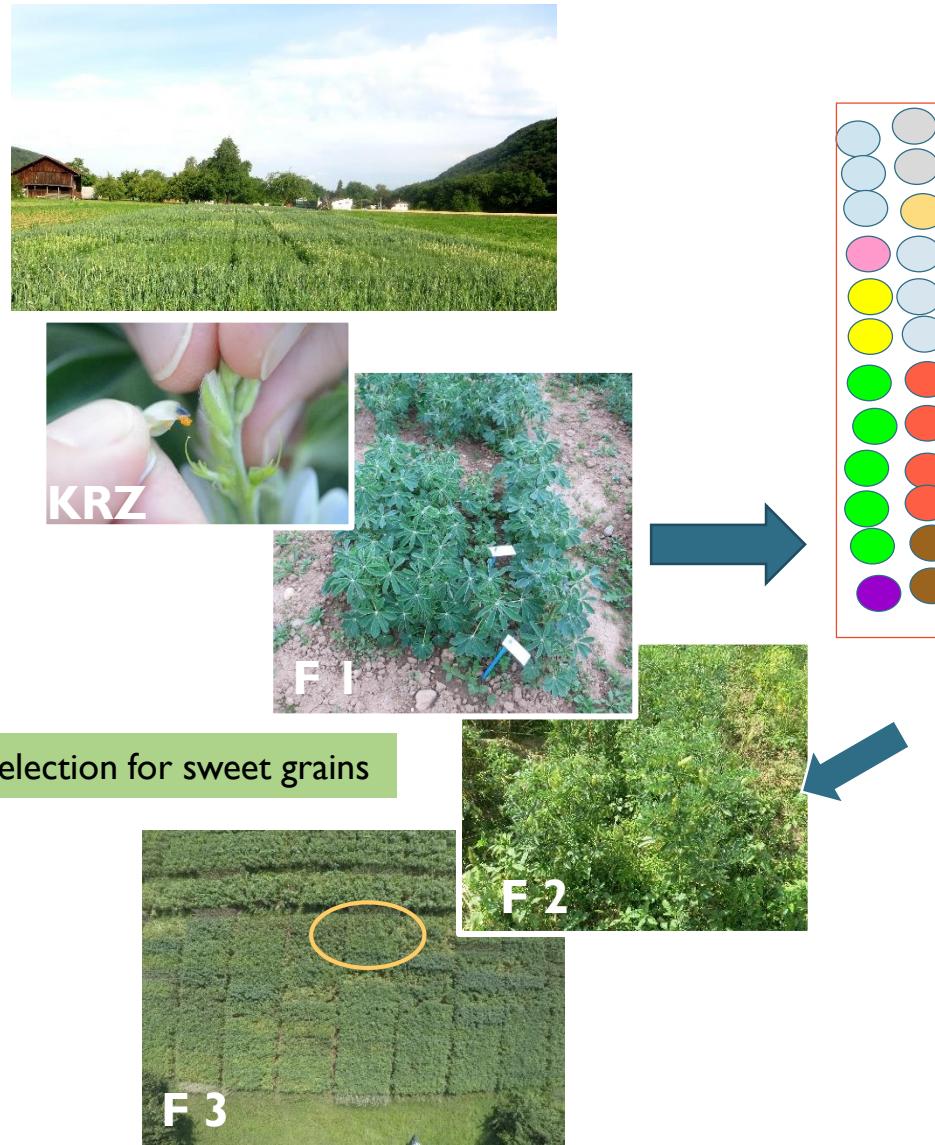
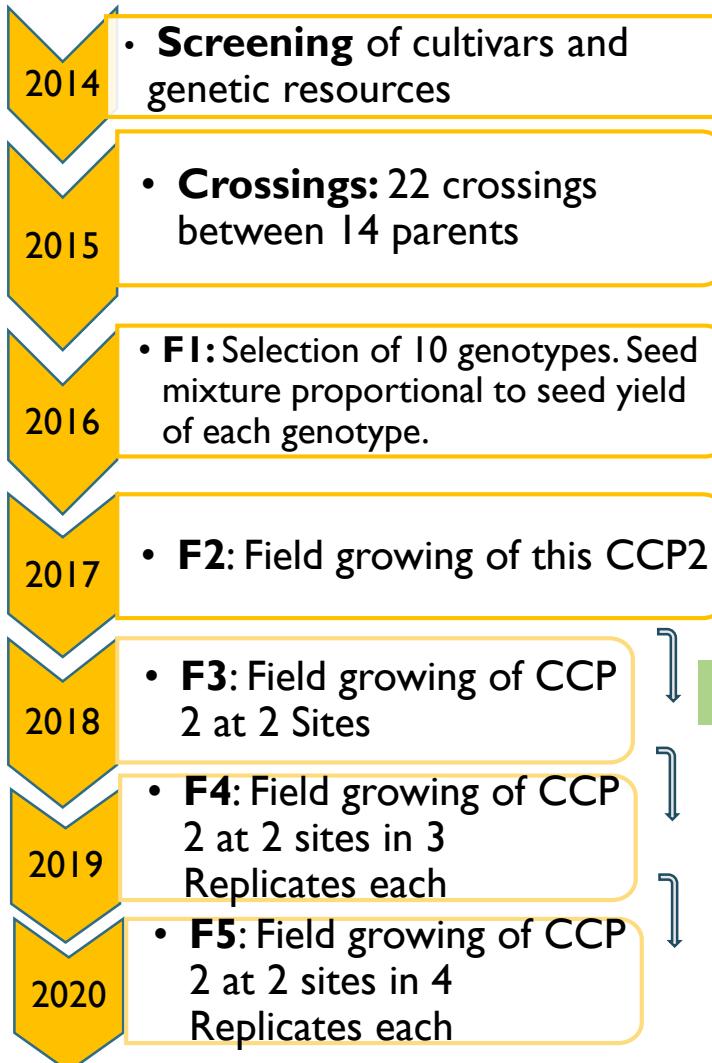
Yield, dt/ha



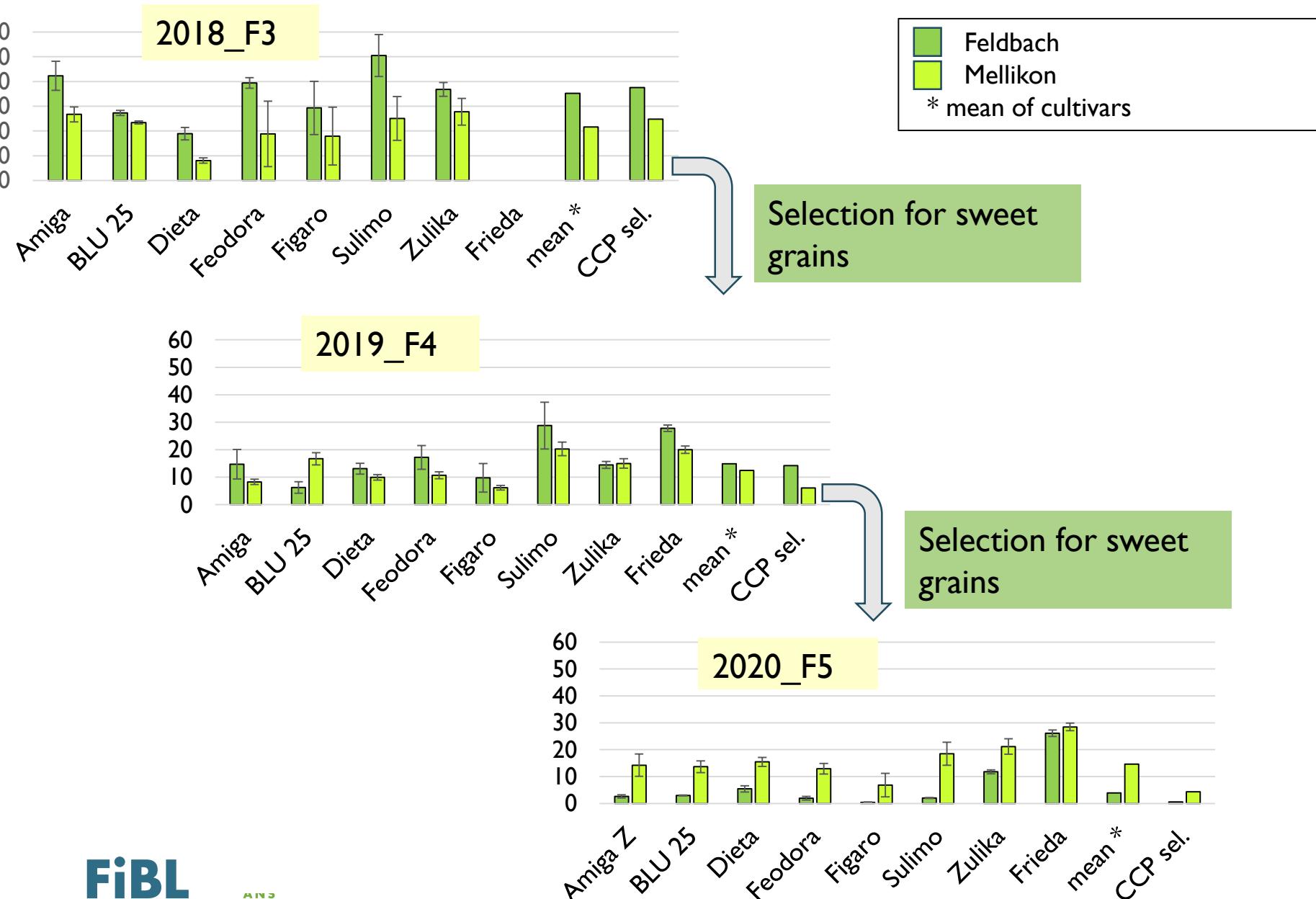
Anthracnose score
21.07.22

I = no symptoms
9 = all plants are dead

Parallel approach: Forming a Composite Cross Population (CCP)



CCP within cultivar trial, two sites, 2018-2020

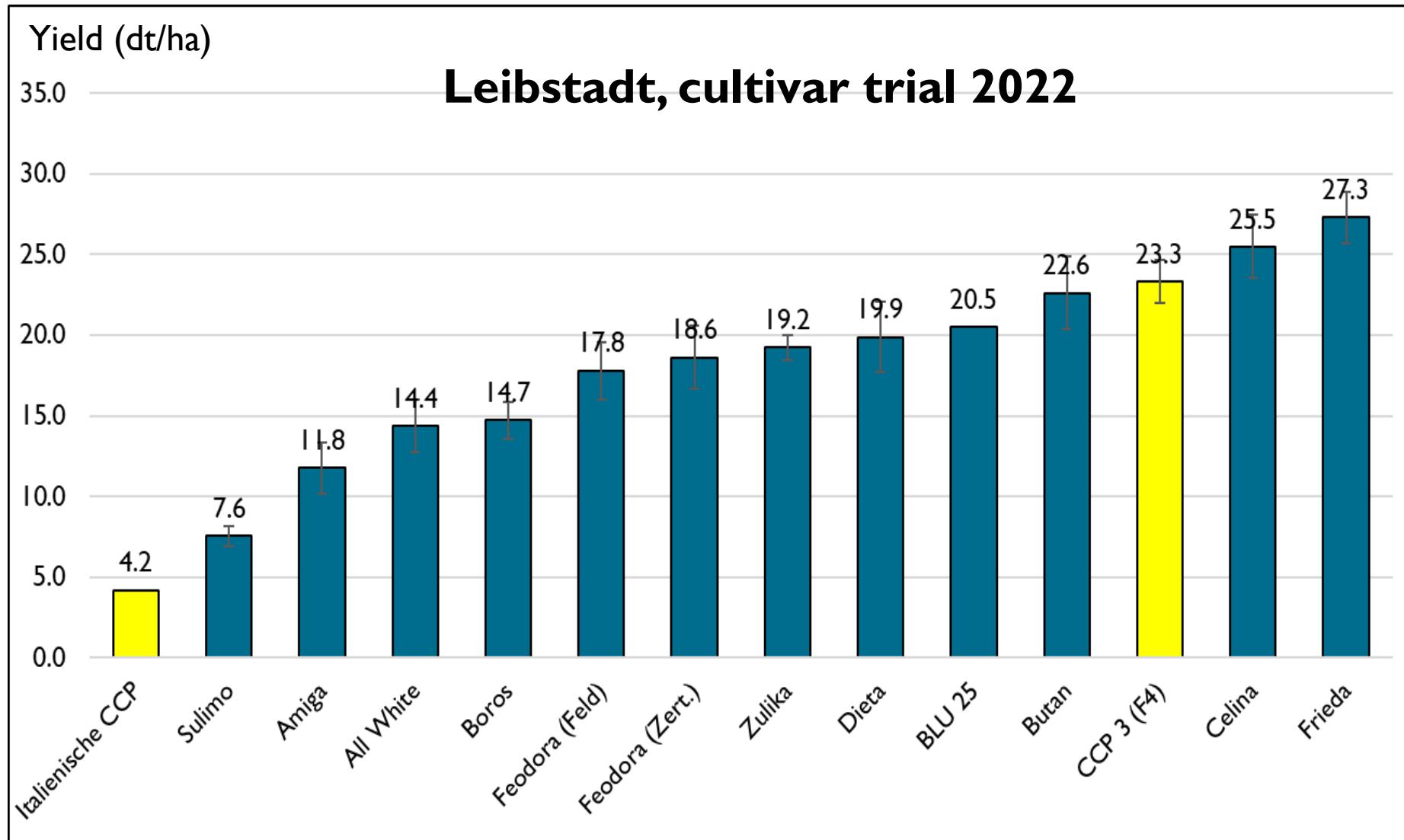


Conclusions:

- not enough anthracnose resistance in parental lines
- selection for sweetness must occur before population is formed

New CCP formed in 2022

- F4 plants
- 5 resistant parents involved
- 4 commercial cultivars involved
- Starting from 5 sweet mother plants
- 130 seeds sown in 3 plots on one site
- Yield compared with cultivar trial result
- Isolated propagation
- In 2023, F5 fully integrated in cultivar trial



And if we perhaps succeed with registration of new cultivar(s)?

Then there should be a market demand for them!

That is the task in WP 5 of LUPINNO SUISSE...



	Objectives, workpackages	Lead by
1	Pre-Breeding of White Lupin for anthracnose resistance	FiBL
2	Pre-Breeding of White Lupin for low alkaloid content	FiBL
3	Developing a breeding programme for commercial white lupin cultivars	FiBL and gzpk
4	Cultivar trials	FiBL and gzpk
5	Identifying the market potential, networking	FiBL

Working groups

FiBL plant
breeding group



Getreidezüchtung
Peter Kunz (gzpk)



FiBL consumers
and food group



WP 5, Identifying market potential and networking

Evaluation of the market potential for lupin in CH

Consumer survey in CH
Dec. 2022

Raw material mediation

Support to food processing trials

Alkaloids in lupins fact sheet (online July 23)

Estimation of the production costs

Contribution to Action Group «Proteins4Future» of Swiss Food Research Network, June 1st, 2023

Feb 23: workshop at FiBL Lausanne (French speaking)

Set-up of a network

Jan 22: online-Stakeholder workshop (German speaking)

Setup of website «Swiss LegumeHub» (online July 23)

Identification of the needs & opportunities for lupin value chain

Participation in Swiss «Protein Power Network», 4 meetings/year, list of contacts, workshops, member list

Co-organisation of Swiss grain legume day

Many thanks for multiple support over 10 years!

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Breeding team!! Crops team! FiBL team...
Torsten Arncken



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra



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Contacts



FiBL Frick

White lupin breeding project

+41 62 865 72 37

christine.arncken@frib.org



gzpk

Pea and lupin breeding

+41 55 264 17 89

m.kamp@gzpk.ch



FiBL Frick

Deputy leader, breeding group

+41 62 865 72 94

mariateresa.lazzaro@frib.org



gzpk

grain legume group leader

+41 55 264 17 89

s.kussmann@gzpk.ch



FiBL Frick

Research associate, food quality and processing

+41 62 865 04 22

ivaina.braendle@frib.org



FiBL Frick

Food quality and processing expert

+41 62 865 04 27

ursula.kretzschmar@frib.org

FiBL online



www.fibl.org



www.bioaktuell.ch



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