BioSC
Bioeconomy Science Center

P³roLucas

Optimization of plant performance and products for lupin cascade use

Boost Fund 2.0

GFL Jahrestagung 2025 - Dr. Marco Löhrer

RWTH AACHEN UNIVERSITY

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JÜLICH Forschungszentrum

P³roLucas

aims at promoting the protein crop plant lupin by:

CG1 - RWTH Aachen University
Molecular Plant Physiology

Prof. Dr. Ulrich Schaffrath
Dr. Marco Löhrer


- **improving production by smart use of biostimulants:** protection against biotic- and abiotic stresses and yield increase

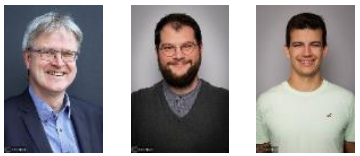
CG2 - IBG-4, FZ Jülich

Prof. Dr. Björn Usadel
Dr. Anika Wiese-Klinkenberg
Dr. Sebastian Beier
Mansi Singh

- **increasing knowledge and facilitating research**: consolidation and generation of genomic- and transcriptomic resources (*L. mutabilis* genome sequencing)

CG3 - IBOC - Bioorganic Chemistry, HHU Düsseldorf and IBG-1, FZ Jülich

Prof. Dr. Jörg Pietruszka
Dr. Thomas Classen
Philipp Sowa



- **implementing a cascade use approach**: use of hitherto unused alkaloids (up to now regarded as unwanted) in chemical industry

CG4 - Chair of Agricultural and Food Market Research, ILR, University of Bonn

Prof. Dr. Monika Hartmann
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Jeanette Klink-Lehmann
Bodo Rehm

- **investigating reception of concept:** assessment of producer's acceptance of biostimulants in legume cultivation

L. angustifolius

L. mutabilis

Biologicals/Biostimulants

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Molecular Plant Physiology

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- in **P³roLucas** we test commercially available as well as novel biostimulants as a (partial) alternative/addition to breeding approaches and traditional "PSM" to protect lupin from stresses and to improve plant performance
- **goal**: provisioning of biostimulants that induce positive effects in selected narrow-leafed lupin elite cultivars under field conditions

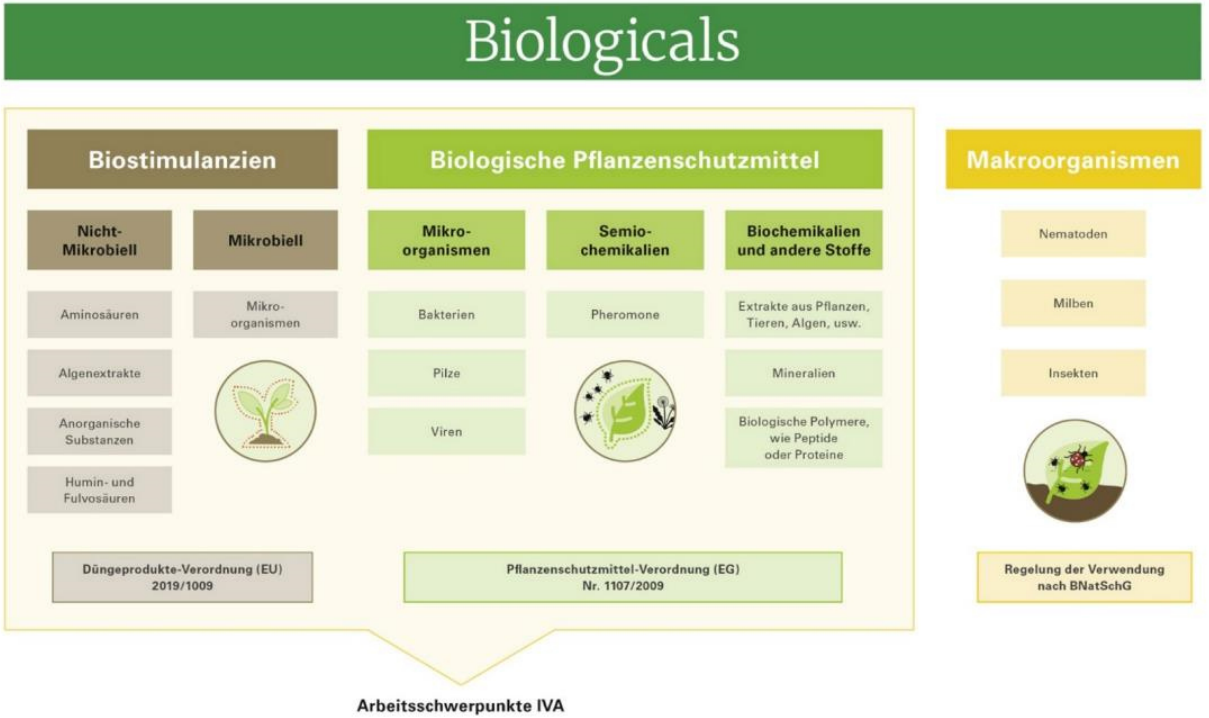
„biostimulants"
(„biologicals", „plant strengtheners"):

natural substances (from e.g. soil/environment or plant-derived/microorganism-derived) or microorganisms that improve growth and nutrient uptake of plants and protect against abiotic stresses

(in Germany regulated by „Düngemittelverordnung")

If biostimulants also protect against biotic stress, they are treated as plant protection products!

(in Germany regulated by „Pflanzenschutzmittelrecht")



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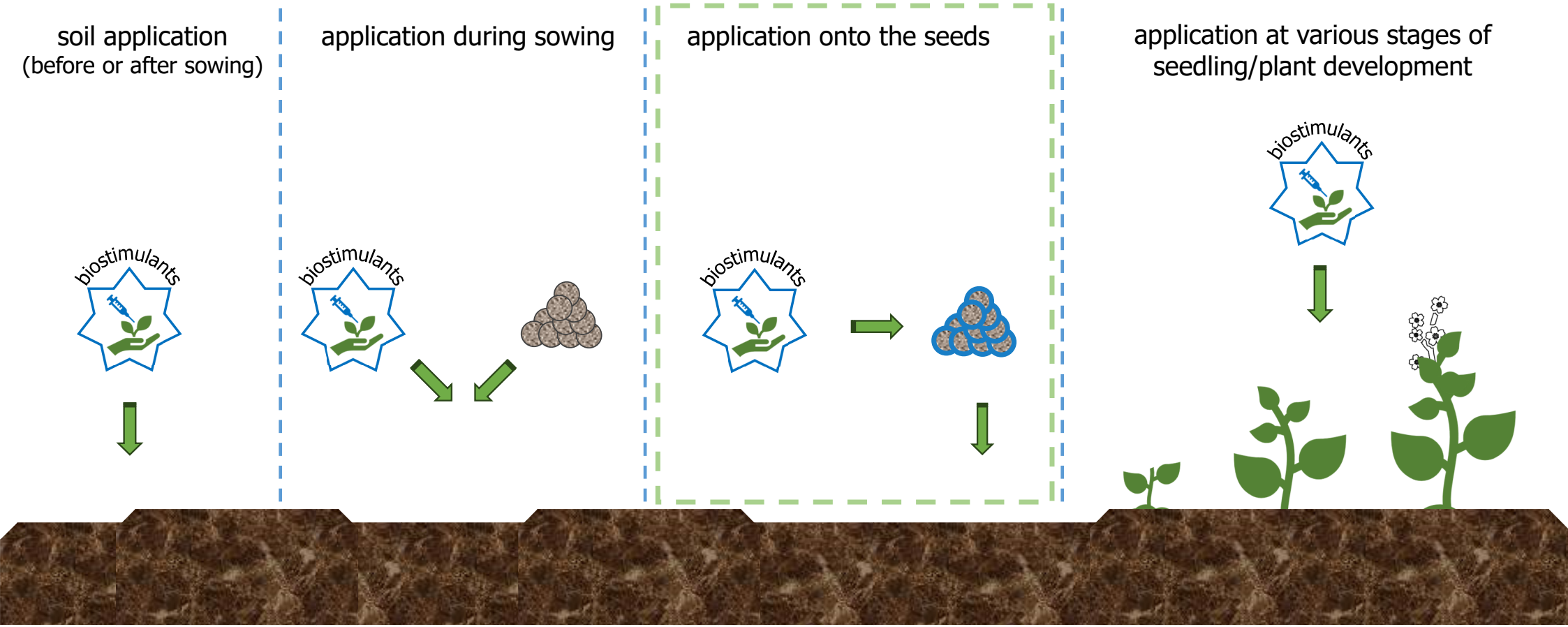
Biological/Biostimulant application



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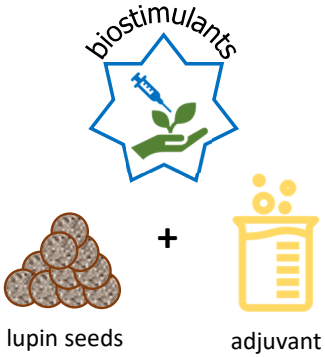
seed treatment

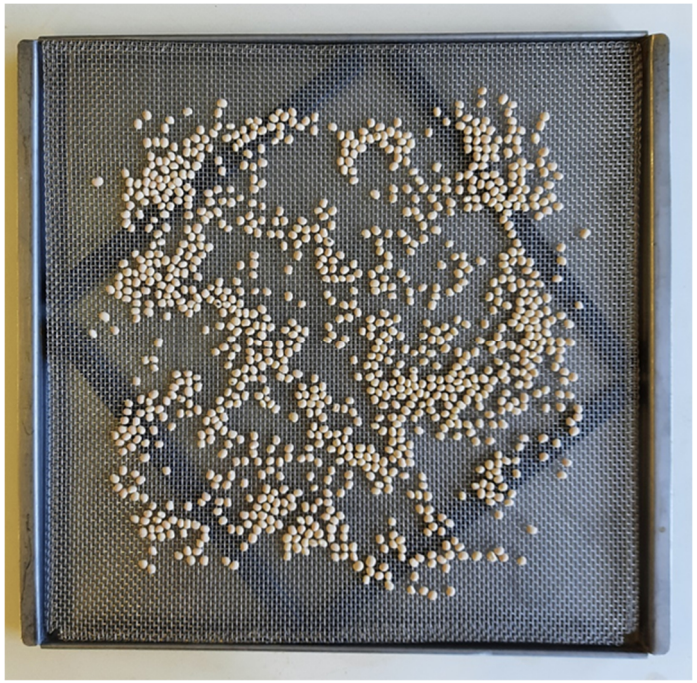


short co-incubation
or coating process
incl. seed priming*

biostimulant and adjuvant

only adjuvant („seed priming“)

untreated control



drying

*=hydration treatment; controlled imbibition and induction of the pregerminative metabolism; stopped before dessication tolerance is lost and before radicle emerges

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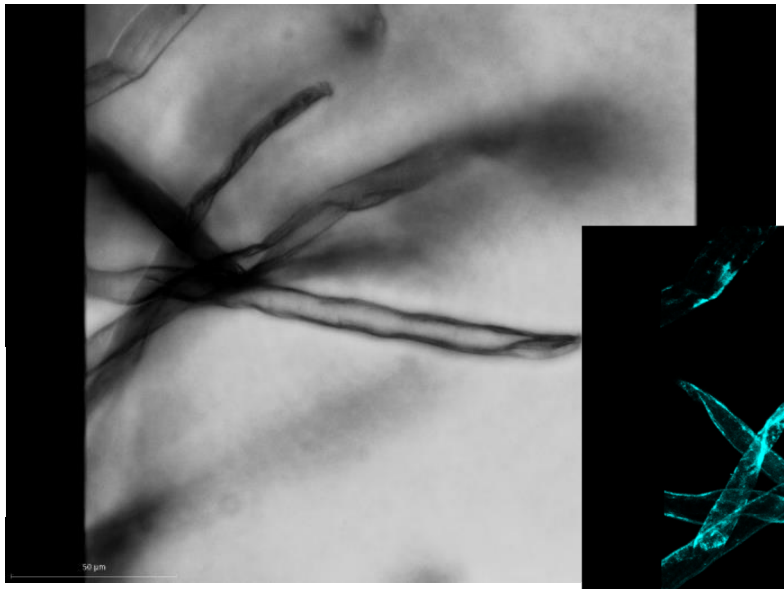
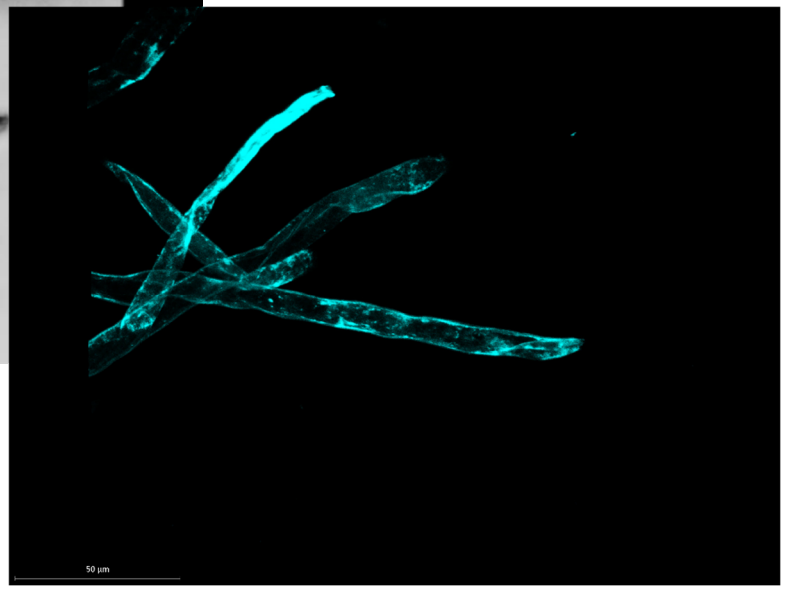
Where do we find the bacteria after treatment?



control treatment

CLSM



treatment incl. „seed-priming“ followed by drying of seeds

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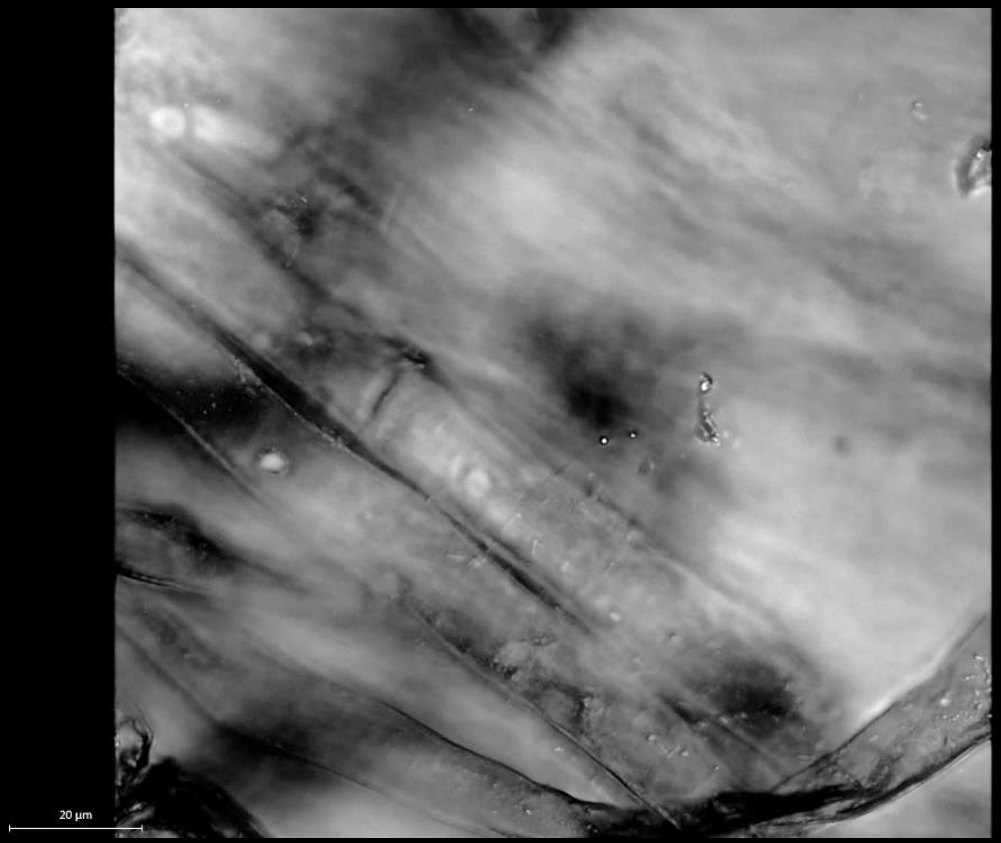
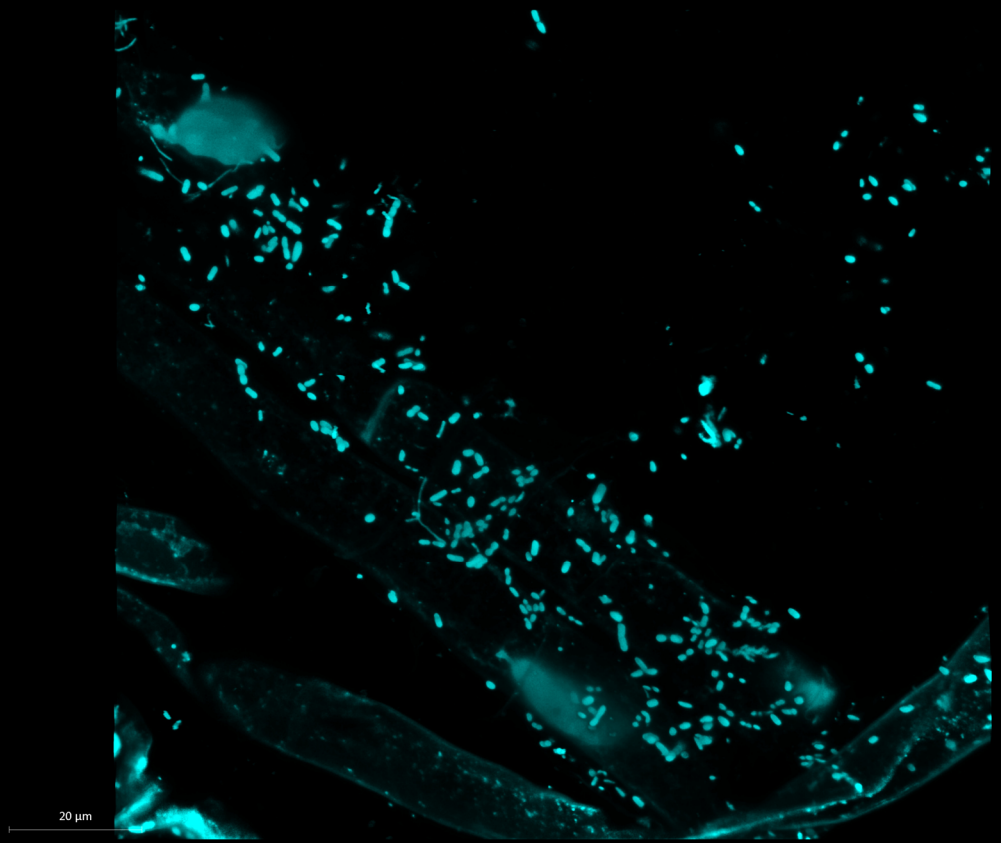
living bacteria are found at the root and the root hairs after seed-treatment





L. angustifolius seeds treated with bacterial biostimulant

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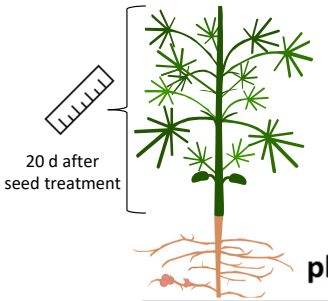
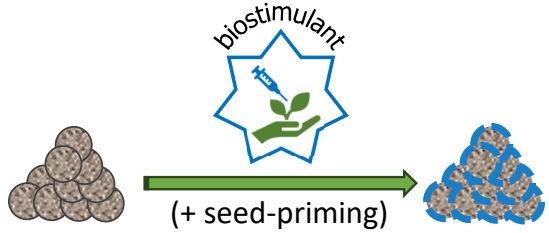
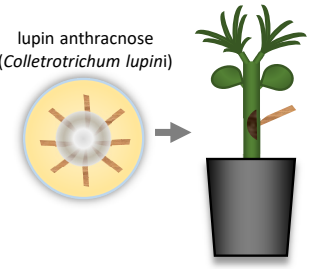
Molecular Plant Physiology

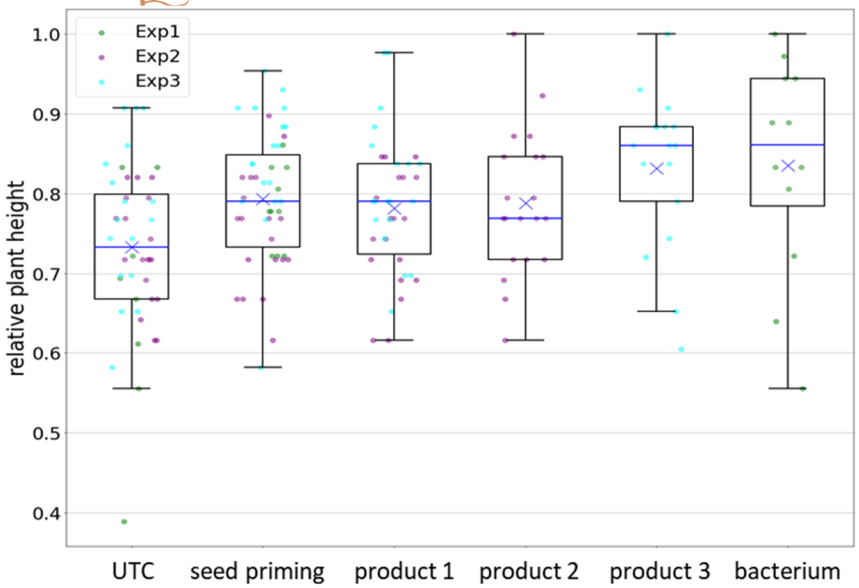
Biological/Biostimulant Treatment and Seed-priming improve Lupin Performance



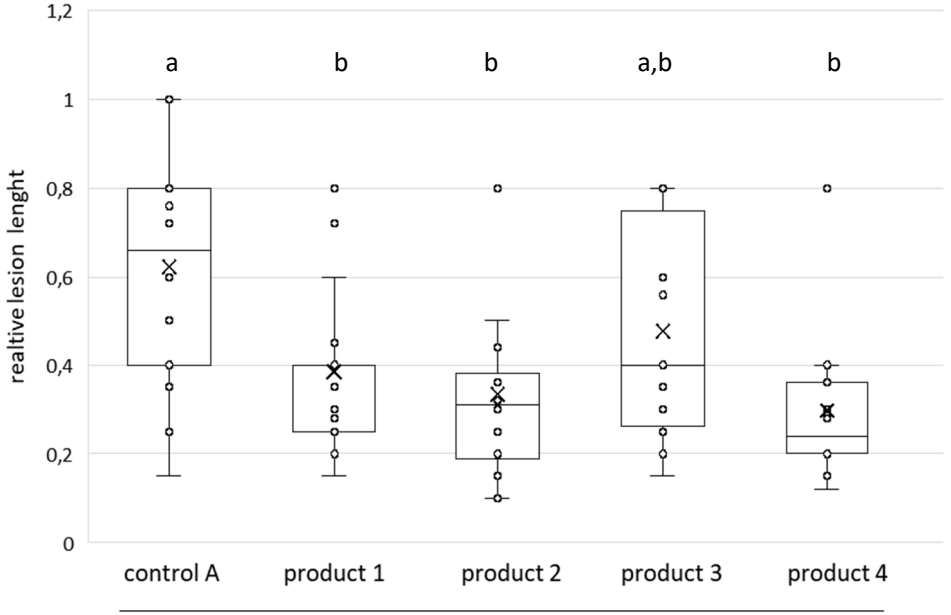




plant growth-promoting effect



resistance induction



two independent# biological exp., one-way ANOVA, Tukey Post-Hoc Test, α = 0.05

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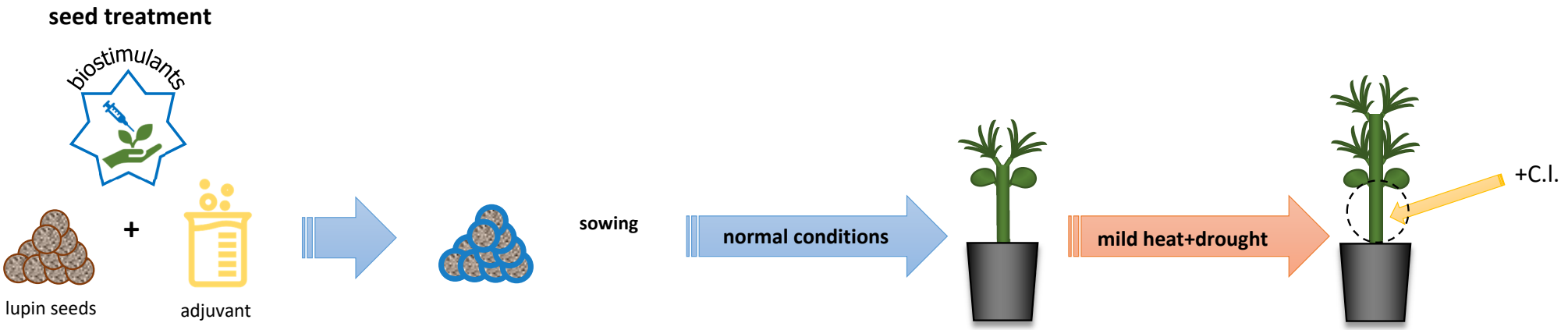
Molecular Plant Physiology

stress experiments

☞ Do biostimulants/biologicals only work under certain conditions?



treatment, drying and pre-germination

scoring of disease symptoms 21 d after seed treatment

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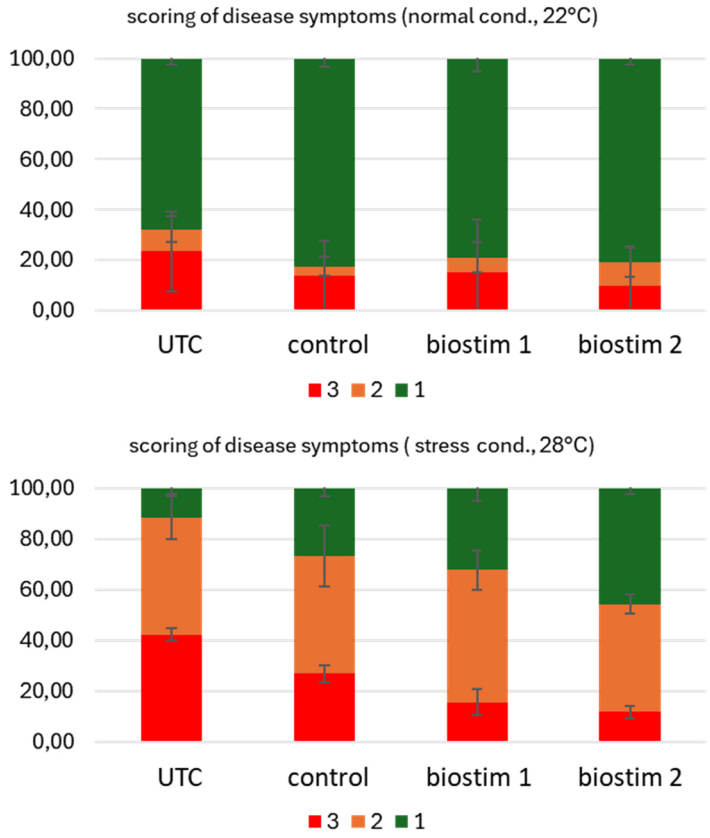
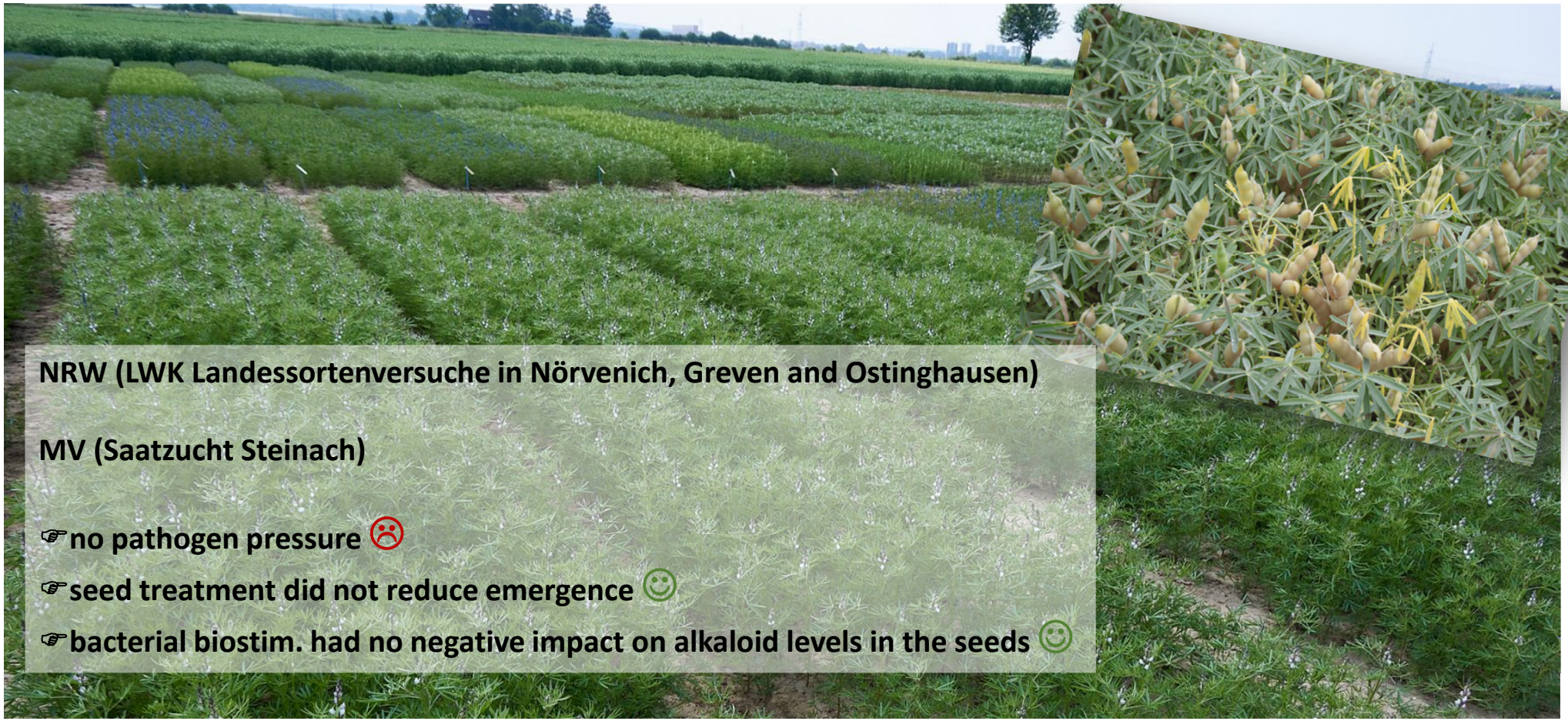
stress conditions enhance effect



☞RNAseq experiment together with CG2

first field trials in 2024



NRW (LWK Landessortenversuche in Nörvenich, Greven and Ostinghausen)

MV (Saatzucht Steinach)

- ☞ **no pathogen pressure** ☹
- ☞ **seed treatment did not reduce emergence** ☺
- ☞ **bacterial biostim. had no negative impact on alkaloid levels in the seeds** ☺

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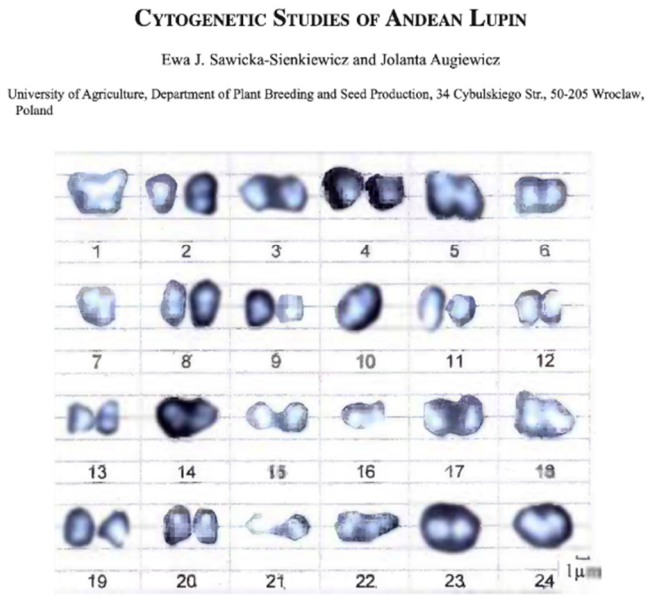
L. angustifolius

L. mutabilis

De novo genome assembly of *Lupinus mutabilis*

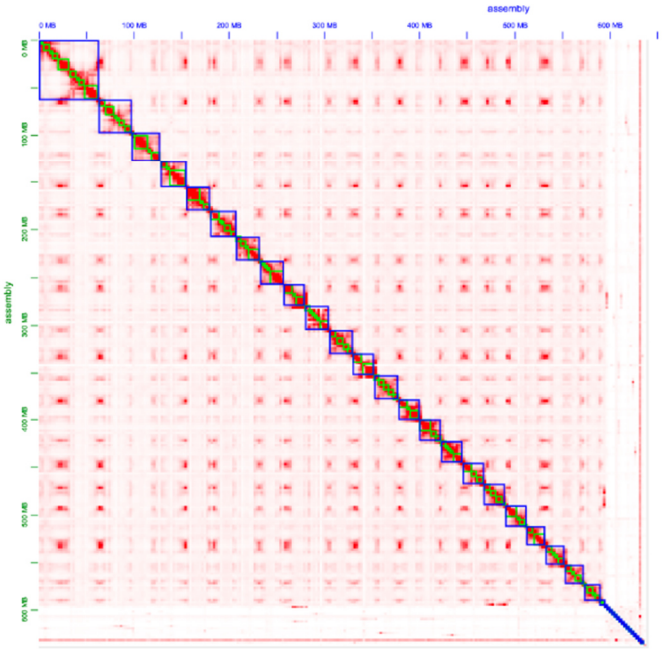


CYTOGENETIC STUDIES OF ANDEAN LUPIN

Ewa J. Sawicka-Sienkiewicz and Jolanta Augiewicz

University of Agriculture, Department of Plant Breeding and Seed Production, 34 Cybulskiego Str., 50-205 Wroclaw, Poland

- *Lupinus mutabilis* has a diploid genome (2n=48)



Genome Statistics

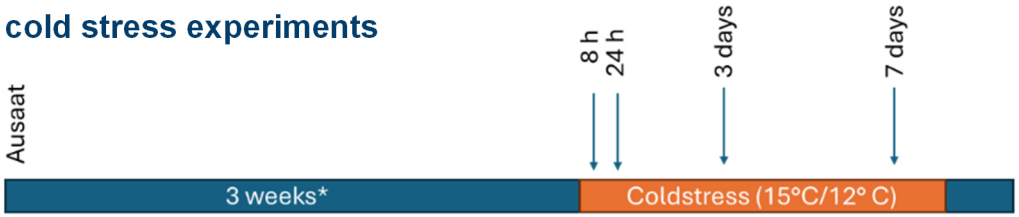
	ONT	ONT and Hi-C
Sequencing coverage	115 x	160 x
Contigs	226	169
Genome size	636 Mb	636 Mb
N50 length	7. 95 Mb	24 .06 Mb
N90 length	2. 03 Mb	19 .09 Mb

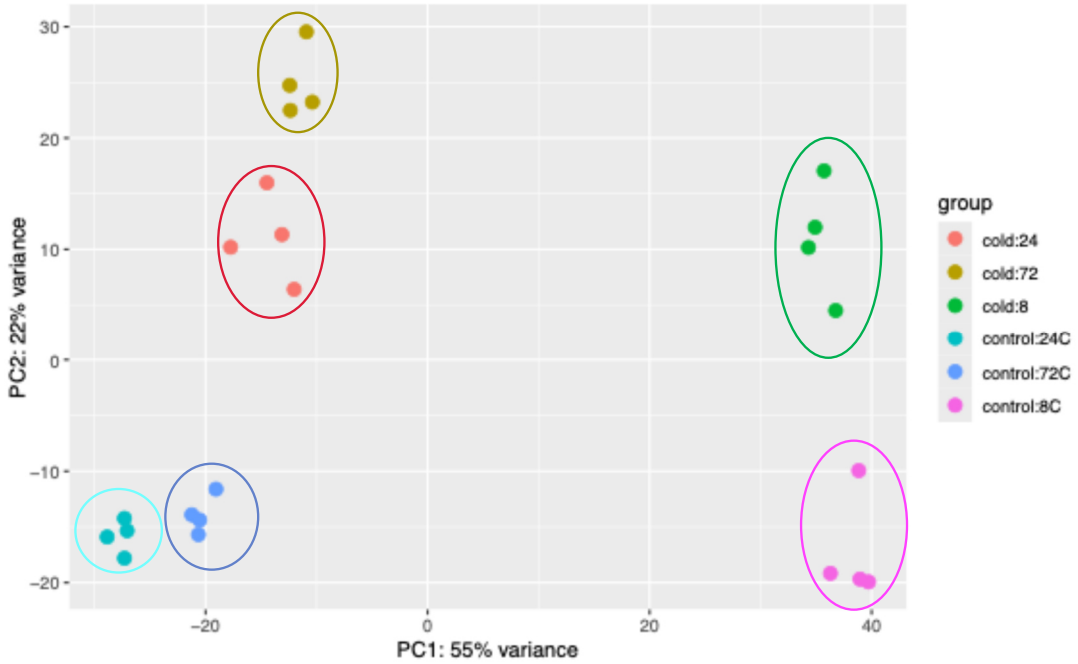
Annotated protein coding sequences	**Mercator Annotated sequences (A)**	**Mercator Occupied Bins (O)**	**Classified sequences (C)**	**Bins available (B)**
38,415	34,635 (90.16 %)	5992 (96.29 %)	21188 (55.16 %)	6223

Helixer was used for genome annotation and further proteins were classified with Mercator

Climate adaptation of *Lupinus mutabilis*

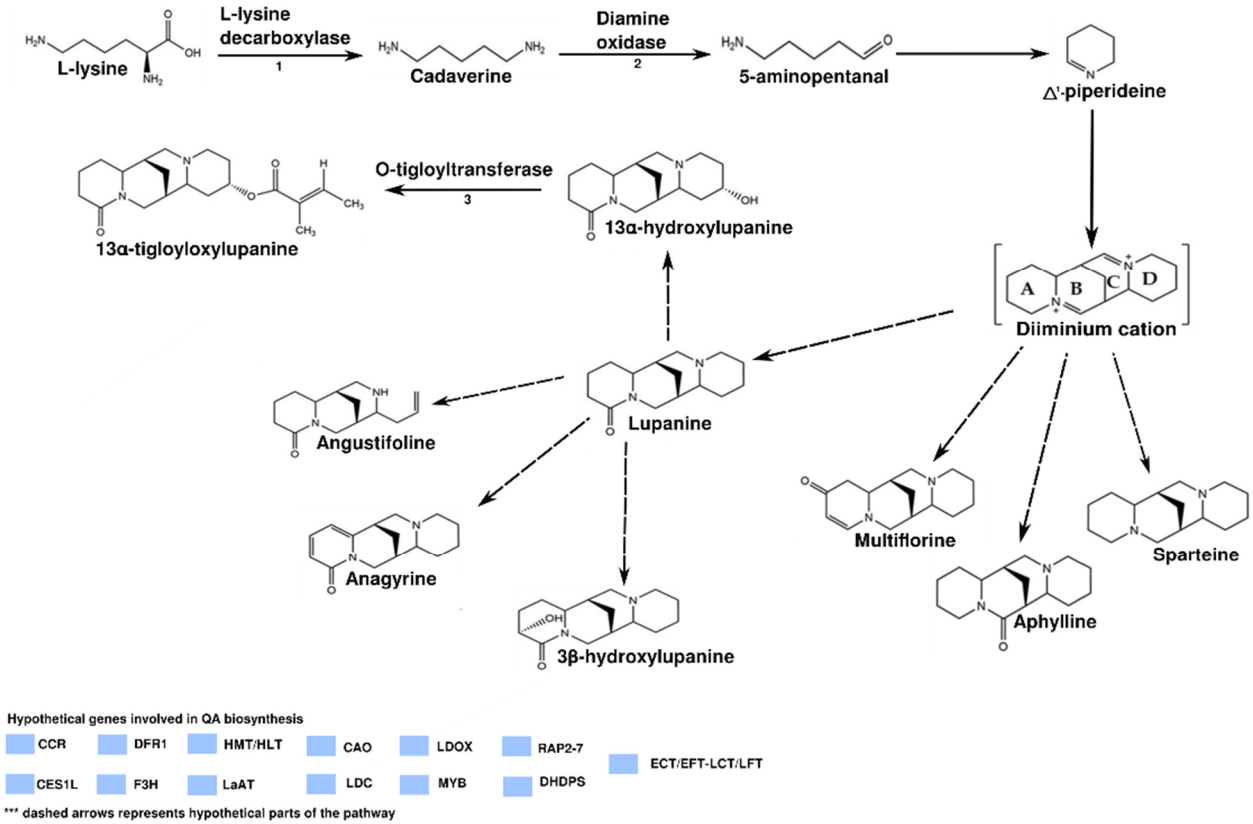
cold stress experiments





- 4 replicates each time point.

Integration of QA biosynthesis pathway into Mercator



MapMan Site of Analysis

https://mapman.gabipd.org/

mercator4 protein function mapping

- Quinolizidine alkaloid (QAs) biosynthetic pathway in lupins now available with Mercator4 v6.0.

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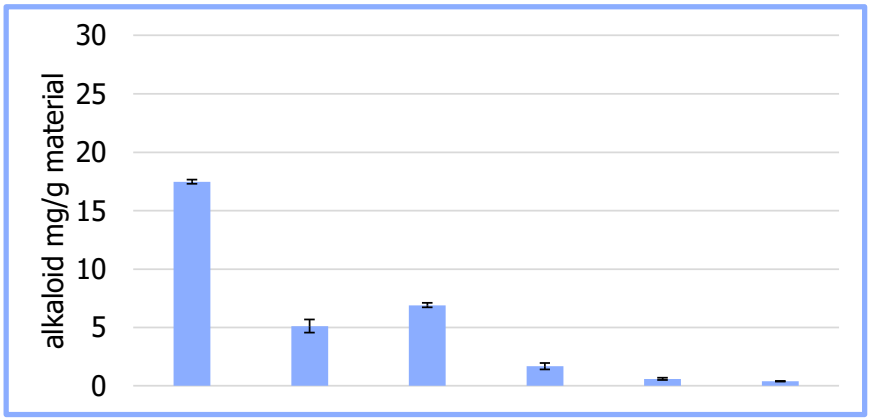
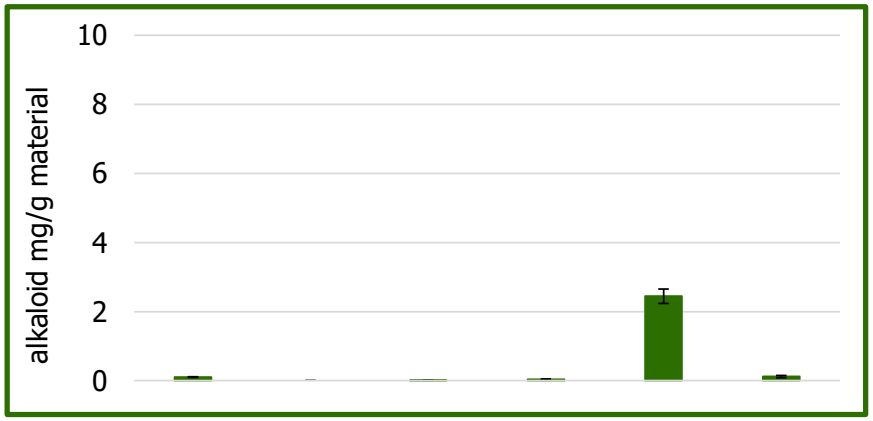
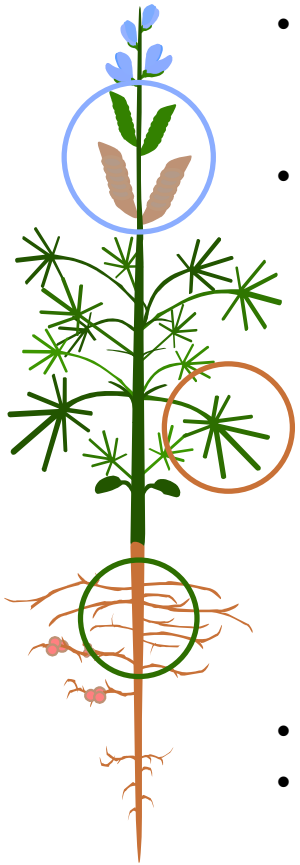
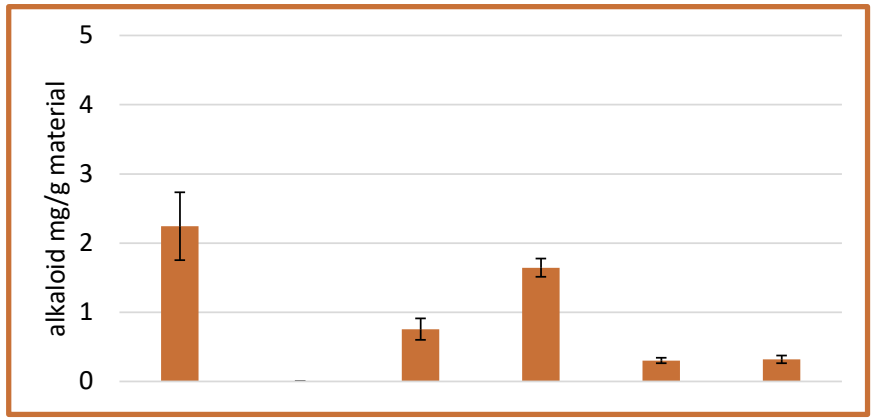
Quinolizidine alkaloids (QA)







- QA alkaloids are derived from lysine and present everywhere in the plant (synthesized in green tissues)
- seeds have highest alkaloid content



- alkaloid abundance and composition tissue specific
- changes in abundance and composition can also be caused by stress (link to WP1) ☞ reliable extr. process

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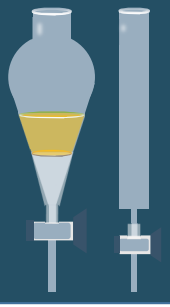
Expertise in WP3

extraction, isolation and identification of QA

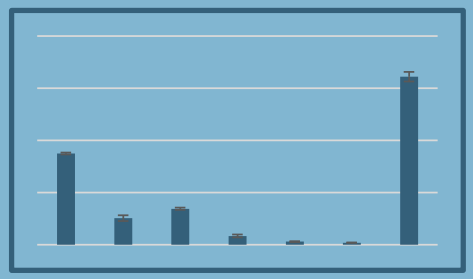


GCMS
NMR
HPLC
LCMS

establishing a natural compound side stream

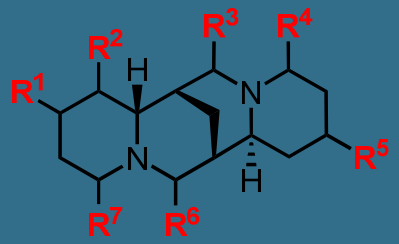
identifiying value and use of alkaloids

high-through-put detection of alkaloid profiles



stable detection of 8 major and ~30 minor alkaloids

valorization and modification of QA



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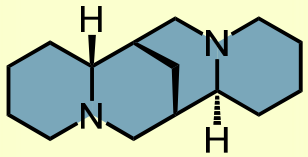
Spotlight on a valuable compound



IN THE PIPELINE | CHEMICAL NEWS

Sparteine and Other Fine Chemical Shortages

16 JUN 2010 • BY DEREK LOWE • 2 MIN READ • COMMENTS

https://www.science.org/content/blog-post/sparteine-and-other-fine-chemical-shortages

c&en TOPICS MAGAZINE COLLECTIONS VIDEOS JOBS

SYNTHESIS

Where has all the sparteine gone?

No one seems to know why a chemical widely used in organic synthesis briefly disappeared and still remains scarce

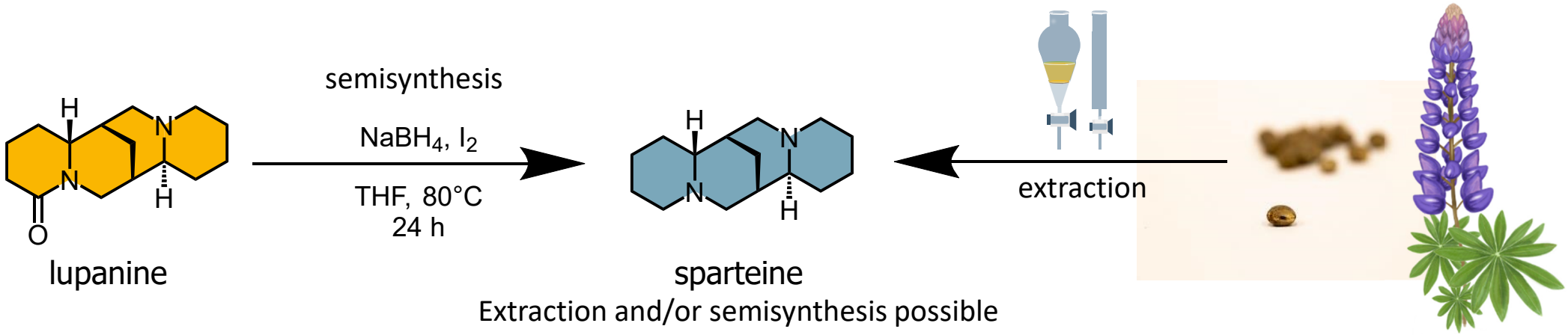
by Stephen K. Ritter

April 24, 2017 | A version of this story appeared in Volume 95, Issue 17

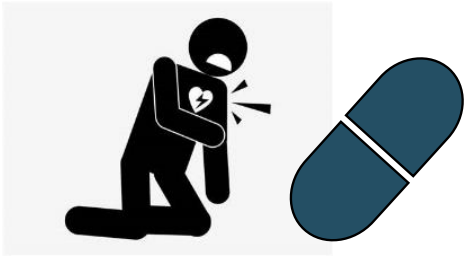
Chemical and Engineering News, Vol. 95, Issue 17, Stephen K. Ritter

- Bisquinolizidine ring system without additional moieties
- expensive and almost impossible to synthesize de-novo

Spotlight on some valuable compounds

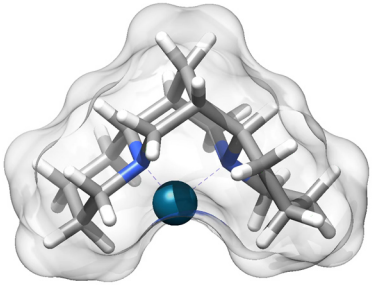


Extraction and/or semisynthesis possible



direct pharmaceutical use e.g. antiarrhythmic agent

Esteves *et al., Journal of Cleaner Production* **2020**, *277*, 123349



ligand in enantioselective catalysis (application could be demonstrated in frame of the project)

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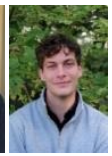

- **investigating reception of concept:** assessment of producer's acceptance of biostimulants legume cultivation

L. angustifolius

L. mutabilis

P³roLucas – CG4

WP4: Farmers` acceptance of combined innovation (narrow-leafed lupin varieties and biostimulants)

Chair of Agricultural and Food Market Research, Institute for Food- and Resource Economics, University of Bonn

Prof. Dr. Monika Hartmann

Jeanette Klink-Lehmann

Bodo Rehm

Bodo Rehm (bodo.rehm@ilr.uni-bonn.de)

Dr. Johannes Simons

Main objective: Evaluate farmers` acceptance and use of a combined innovation consisting of **narrow-leafed lupin varities** and dedicated **biostimulants**

Study 1
Expert interviews with farmers and other actors to gain insights into adoption drivers

Study 2
Online survey with farmers to quantify findings from study 1

Study 3
Experiment with farmers to assess influence of information provision

Acknowledgements

Thank you for your attention!

loehrer@bio3.rwth-aachen.de

- Prof. U. Schaffrath and Dr. M. Löhrer (project coordination)

  Molecular Plant Physiology (Biology III), RWTH Aachen University
- Prof. Björn Usadel, Dr. Anika Wiese-Klinkenberg and Mansi Singh

  IBG-4, FZ Jülich
- Prof. J. Pietruszka, Dr. T. Classen and Philipp Sowa

  IBG-1, FZ Jülich and IBOC - Bioorganic Chemistry, HHU Düsseldorf
- Prof. M. Hartmann, J. Klink-Lehmann and Bodo Rehm

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- Saatgut Steinach GmbH & Co KG

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of North Rhine-Westphalia