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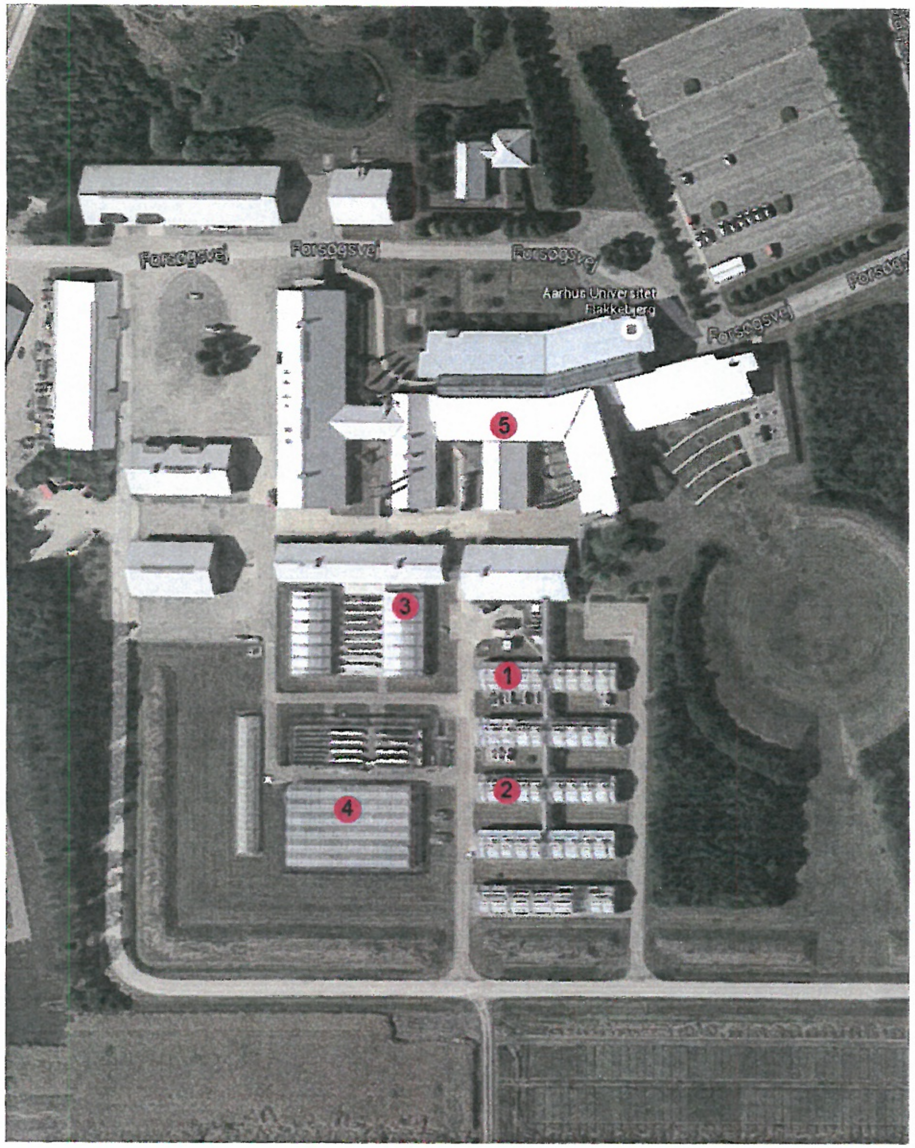
INSTITUT FOR MOLEKYLÆRBIOLOGI OG GENETIK

Program for besøg af
Uddannelses- og forskningsminister
Esben Lunde Larsen

AU Flakkebjerg
tirsdag den 2. februar 2016



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Program

Kl. 16.45	Velkomst v/Dekan Niels Chr. Nielsen, Aarhus Universitet
Kl. 17.00	Rundvisning

1. Global Rust Reference Centre v/professor Mogens Hovmøller - fremvisning af forsøg i væksthus v/post doc Chris Khadgi Sørensen
2. Pesticidresistens v/seniorforsker Solvejg K. Mathiassen - fremvisning af forsøg med vindaks i drivhus v/ph.d.-studerende Marielle Babineau
3. Afgrøders bioteknologi v/adjunkt Kim Hebelstrup
4. Korns konkurrenceevne overfor ukrudt v/professor Per Kudsk - fremvisning af semifieldforsøg v/ph.d.-studerende Antje Reiss
5. Dansk frø – en global spiller v/seniorforsker Birte Boelt - fremvisning af frø, græs, babyleaf v/ph.d.-studerende Simon Abel

Kl. 18.00	Middag
Kl. 18.30	Åbent Møde: Viden, vækst og værdi for jordbrugssektoren Velkomst ved Knud Vincent, Venstre Slagelse og dekan Niels Chr. Nielsen Indlæg ved institutleder Erik Østergaard, Institut for Molekylærbiologi og Genetik om Crop Innovation Denmark Indlæg ved institutleder Erik Steen Kristensen, Institut for Agroøkologi om målrettet regulering af kvælstof og pesticider Indlæg ved Uddannelse og Forskningsminister Esben Lunde Larsen Efterfølgende debat.
Kl. 20.00	Afslutning ved Knud Vincent

Researchers to develop new "super-wheat"

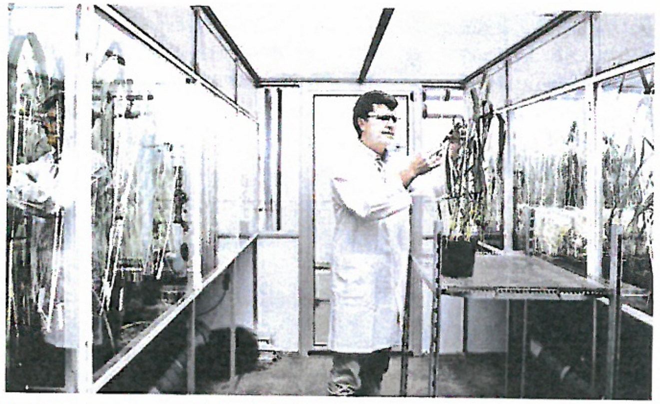
Post doc Chris Khadgi Sørensen & Professor Mogens Hovmøller

Department of Agroecology, Faculty of Sciences and Technology, Aarhus University, Forsøgsvej 1, DK-4200-Slagelse, Denmark

E-mail: chris.sorensen@agro.au.dk & mogens.hovmoller@agro.au.dk

By Jan Aagaard, journalist, Winter – spring 2016 No. 05 | Focus Denmark, 79

New ideas, technologies and products are essential if the world is to successfully tackle the challenge of producing enough food for 2.4 billion additional people in 2050. Denmark's agriculture and food sector holds a leading position globally and is renowned for its strong focus on research, innovation and product development.



Crop research Professor Mogens Støvring Hovmøller is part of a team that develops new, more resistant strains of wheat.
Foto: Sara Galbiati

Wheat is one of the world's most important crops, feeding billions of people, yet attacks by a range offungal diseases can negatively impact both yield and quality. Therefore, plant breeders from Danish Agro Group's seed breeding company Nordic Seed have teamed with researchersfrom Aarhus University and a number of international partners to develop new, more resistant strains of wheat.

The aim is to develop various new highyield, multi-resistant wheat strains, i.e. strains resistant to a range of fungal diseases.

"Breeding high-yield and disease-resistant grain crops is vital to reducing cultivators' dependence on pesticides. The big challenge is finding resistance to all of the important fungal diseases in wheat and ensuring that these resistances remain intact through the years," says Professor Mogens Støvring Hovmøller from the Aarhus University Deparrment of Agroecology.

Evolution of herbicide resistance in Danish farms

Ph.D. Student Marielle Babineau

Department of Agroecology, Faculty of Sciences and Technology, Aarhus University, Forsøgsvej 1, DK-4200-Slagelse, Denmark

E-mail: marielle.babineau@agro.au.dk

Herbicide resistance in agricultural weeds is a major problem causing non-negligible yield losses meaning more expenses for farmers and less food worldwide. My project aims to better understand the micro evolutionary changes involved in the evolution of herbicide resistance in the weed species loose silkybent (*Apera spica-venti*) in Denmark. Weed populations have been collected at three locations in Denmark (Odense, Nibe, and Herning) at farms where resistance to herbicide has been confirmed in a preliminary test. Weeds were collected around the resistance "hot spot" in concentric circles (see map), of hundred meters and even several kilometers, in order to have a response gradient of populations with different genetic and phenotypic responses to herbicide. These populations are being screened for their susceptibility to five different herbicides (ALS, ACCase, PSII, root growth inhibitor, and shoot growth inhibitor) allowing us to identify cross and multiple resistance. The target genes of herbicide are also sequenced to identify resistance-endowing mutations allowing categorizing the type of resistance (metabolic versus target-site). This project will also identify the genes that are significantly differently expressed between susceptible and resistant populations in order identify crucial genes in the evolution of herbicide resistance in loose silkybent. These genes will help us to identify which metabolic pathways the plant uses to survive herbicide. Once those "resistance genes" have been identified, the fitness cost of the populations carrying those genes will be assessed. The presence of a fitness cost to herbicide resistance could allow the farmers to better manage and control herbicide resistant weeds. For example, if herbicide resistance weeds germinate less in colder conditions, farmers could sow spring sown crop earlier and avoid having them compete with weeds.

We will associate gene expression profiles, resistance level, resistance mechanism, and fitness of the different gradient populations. This correlation will allow us to establish a potential chronology in the evolutionary steps taken by loose silkybent in Denmark to become herbicide resistant.

Sampling map of farm near Odense for 2014.

Field number 7 where loose silkybent is problematic because of herbicide resistance.

Bioengineering in crops: New agricultural products for the food, ingredient and material industry

Assistant professor Kim Henrik Hebelstrup

Department of Molecular Biology and Genetics, Faculty of Sciences and Technology, Aarhus University, Forsøgsvej 1, DK-4200-Slagelse, Denmark

E-mail: kim.hebelstrup@mbg.au.dk

Plants can be used as natural factories for the production of biofriendly plastics and food fibers made from tailor-made starches.

Common agricultural crops such as wheat, barley and maize do not only form the basis of bread, beer and livestock feed. They also have the potential for producing carbohydrates designed for specific purposes like bioplastic. At Aarhus University Flakkebjerg we are investigating the possibilities for designing crops with new, high-value and purpose-built products.

Challenges – two examples

- Current crop carbohydrates are too easily digestible, which make them unhealthy with respect to quick sugar release. Molecular plant bioengineering can be used to develop new crop varieties with a more healthy profile in relation to sugar release and carbohydrate uptake in the body.
- Plastic materials based on fossil fuels are mostly not biologically degradable. This leads to an increasing problem with accumulation of plastics in the environment. Bioplastics made from renewable crop products can be designed to be biologically degradable.

Solution

Plants produce different types of carbohydrates, including starch. Starch can replace petroleum-based plastics and are used for environmentally-friendly bioplastics. However, the quality of the bioplastic is very dependent on the composition of the carbohydrates. The ambition is to expand the plant production of the new, specialised types of carbohydrates suitable for particular types of plastic. These plants do also possess more healthy types of carbohydrates and will therefore also be valuable as food.

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Molecular biology is the key

The naturally biologically machinery for synthesis of carbohydrates in plants is a complex network of biomolecules that are orchestrated to produce materials that are not necessarily optimal for the agro-processing and food industry. We work on understanding these basic molecular networks in the living plants, and develop new genetic tools, which is a prerequisite for obtaining new crop varieties.

Starch granules – the major component of flour. Here magnified 5000x by electron microscopy.

Collaborations

This research is done in collaboration with Copenhagen University, Scandinavian starch manufacturing industries and international research institutions.

Weed suppressive effect of wheat, triticale and rye-relative contribution of above- and belowground interactions

Ph.D. Student Antje Reiss, Senior Scientist Inge S. Fomsgaard, Senior Scientist Solvejg K. Mathiassen & Professor Per Kudsk

Department of Agroecology, Faculty of Sciences and Technology, Aarhus University, Forsøgsvej 1, DK-4200-Slagelse, Denmark

Email: antje.reiss@agro.au.dk

Field with winter rye (left) and winter triticale (right), surrounded by winter wheat

Problem

- Weeds account for a potential yield loss of 34% worldwide (EC Oerke, 2006)
- Current weed management practices are primarily based on the use of herbicides
- Herbicides are the main pesticide contaminant of ground and surface water
- Herbicide resistance is an increasing problem and no new herbicide modes of actions are being introduced by the agrochemical companies

Solution: Development of more integrated weed management strategies exploiting the weed suppressive effect of the crop itself.

Scentless Chamomile

Blackgrass*

Hypotheses

- Both competition for nutrients, water and light and allelopathy contribute to weed suppression.
- The relative contribution of competition and allelopathy to weed suppression depends on the crop species and the growth stage.

Aim: Quantification of the relative importance of competition and allelopathy and in weed suppression.

Species in focus

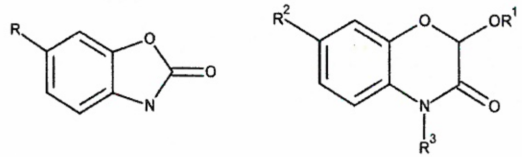
- Cereals: 4 winter wheat, 4 winter triticale and 4 winter rye varieties
- Weeds: Blackgrass and scentless chamomile

Objectives

Characterisation of the **competitive properties** of wheat, triticale and rye in filed experiments by measuring e.g. crop height and ground cover before canopy closure in a field experiment.

Characterisation of the **allelopathic properties** of wheat, triticale and rye by collecting exudated allelochemicals via silicone tubes inserted into plant boxes. This is a novel method making it possible to investigate chemical fluxes of benzoxazinoids in the root zone throughout the growing season without disturbing the root environment.

Silicone tube micro extraction



Structure of the chemical group of benzoxazinoids

Separation of allelopathic effects from competition by comparing the results of the field and plant box experiments of the 12 varieties

- **Co-operation:** The field experiment is replicated by Sejet Planteforædling.
- **Perspectives:** This project will provide basic information for developing a breeding program of cereal varieties with innate weed suppressive properties.

*http://www.stuff.co.nz/business/farming/agribusiness/10491137/Hunt-resumes-for-feared-black-grass-weed.

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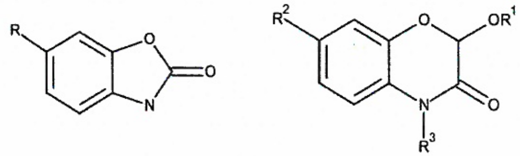

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genetic control of seed production, for example with our colleagues at AU Flakkebjerg's Department of Molecular Genetics and Biology.

As part of the vision we have for the Danish seed industry, all steps from planning, implementing and discussing research activities always involve Danish seed companies and farmers. All research innovations are freely disseminated; there is of course a significant interest by seed companies and farmers whose quest for higher yields is often facilitated by these innovations.

Moreover, internationally, grass seed production is restricted to three major areas: Denmark, New Zealand and Oregon, USA. Here at AU-Flakkebjerg we have extensive collaborations with the small number of scientific and research staff internationally - take for example Birte and Simon, a Dane and a Kiwi both represented at AU-Flakkebjerg. This strength and unity between the international research groups will only be further reinforced when Simon returns to New Zealand later this year to commence a research position in grass and clover seed production.

Simply put, our research aims at higher yields, optimising inputs and increasing farm income and industry export while promoting sustainable practices.

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