Resistance breeding in winter wheat

A Work package in the bigger resistance project

Aim:

- Develop effective and reliable protocols for large-scale germplasm evaluation
- Identify novel genetic markers
- Transfer of protocols to the breeding program
- Key diseases - Fusarium Head Blight, Septoria tritici blotch

Team:

SLU: Researcher 1, Phd students 1, Postdocs 2

Aakash Chawade, Mustafa Zakieh, Firuz Odilbekov (now at LM), Admas Alemu

Lantmännen: Breeder 1

Tina Henriksson

Outcome:

Peer-reviewed scientific publications: **4**

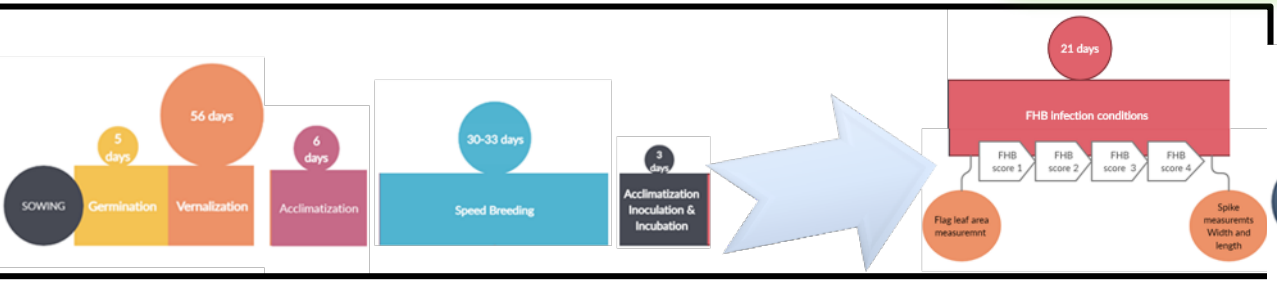
Relevance to industry: protocols, germplasm with resistance, genetic markers

STB

FHB

Next generation methods for advancing the genetic improvement of winter wheat against diseasesNext-generation

Fusarium head blight (FHB)
Adult stage plant tested



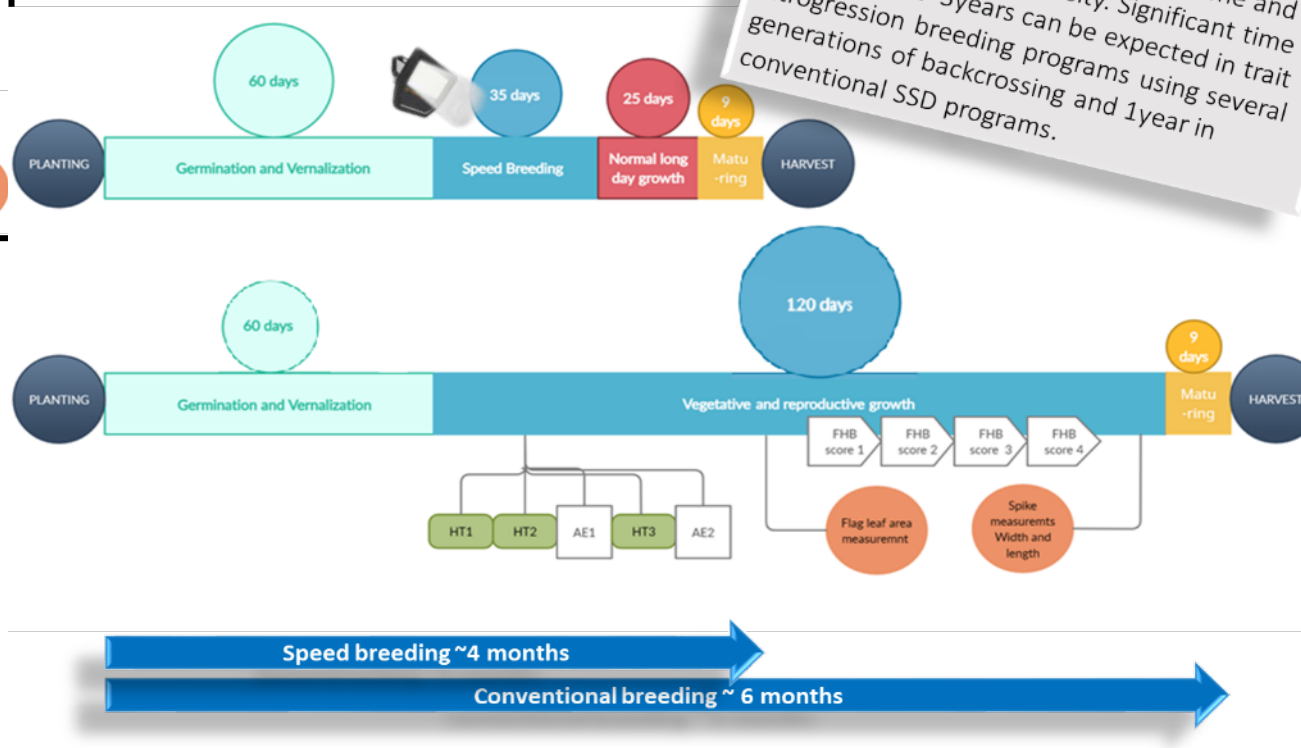
Timeline, characterizing WW for FHB utilizing SB growht conditions. Zakieh et al. (2021), *Frontiers in Plant Sci.*

Methodology utilizing Speed breeding for adult stage identification of resistance and mutl-triat evaluation

Method

- Energy and time effecient.
- Can be adapted for several pathosystems thus several disease resistance programs for speeding up marker identifcation and selection.

Crop genetic gain for disease resistance can accelerated by reducing generation time and increasing selection intensity. Significant time saving up to 2–3years can be expected in trait introgression breeding programs using several generations of backcrossing and 1year in conventional SSD programs.



Relevance of results to industry – resistance

- Protocol transfer to the industry and training of personnel
- Germplasm with resistance identified in industry material
- Genetic markers that are now routinely used in MAS
- New crosses that can be based on new knowledge and identified with MAS
- Exchange of knowledge between industry and academia for an increased understanding from both sides

Phenotyping (winter wheat, sugar beet)

Aim:

- Research focus on method development and studying physiological responses of plants to stress
- Started with just two DSLR cameras six years ago
- Developed core technical competence in hardware and software development
- Working towards integration in breeding programs

Team:

SLU: Researchers 2, Phd students 2, Postdocs 2
Aakash Chawade, Ramune Kuktaite, Fernanda Leiva, Alexander Koc, Ajit Nehe, Vishnukiran Thuraga

Lantmännen: Breeders 3
Tina Henriksson, Johan Lundmark, Pernilla Vallenback

DLF Beet Seed: Breeder 1 – Simon Jeppson

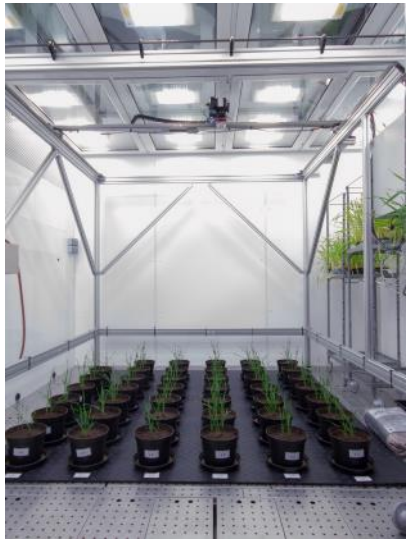
Outcome:

Peer-reviewed scientific publications: **6**
Relevance to industry: new traits, imaging system
Germplasm characterized

2018

2019

2021



2022

Phenocave: Automated, standalone and affordable phenotyping system for controlled growth conditions

An indoor platform to monitor and evaluate different plant characteristics under abiotic stress, using either RGB, NDVI (modified lens), Multispectral and Hyperspectral cameras.

Tested with two case of studies: Wheat and sugar beet

Cameras supported


RGB

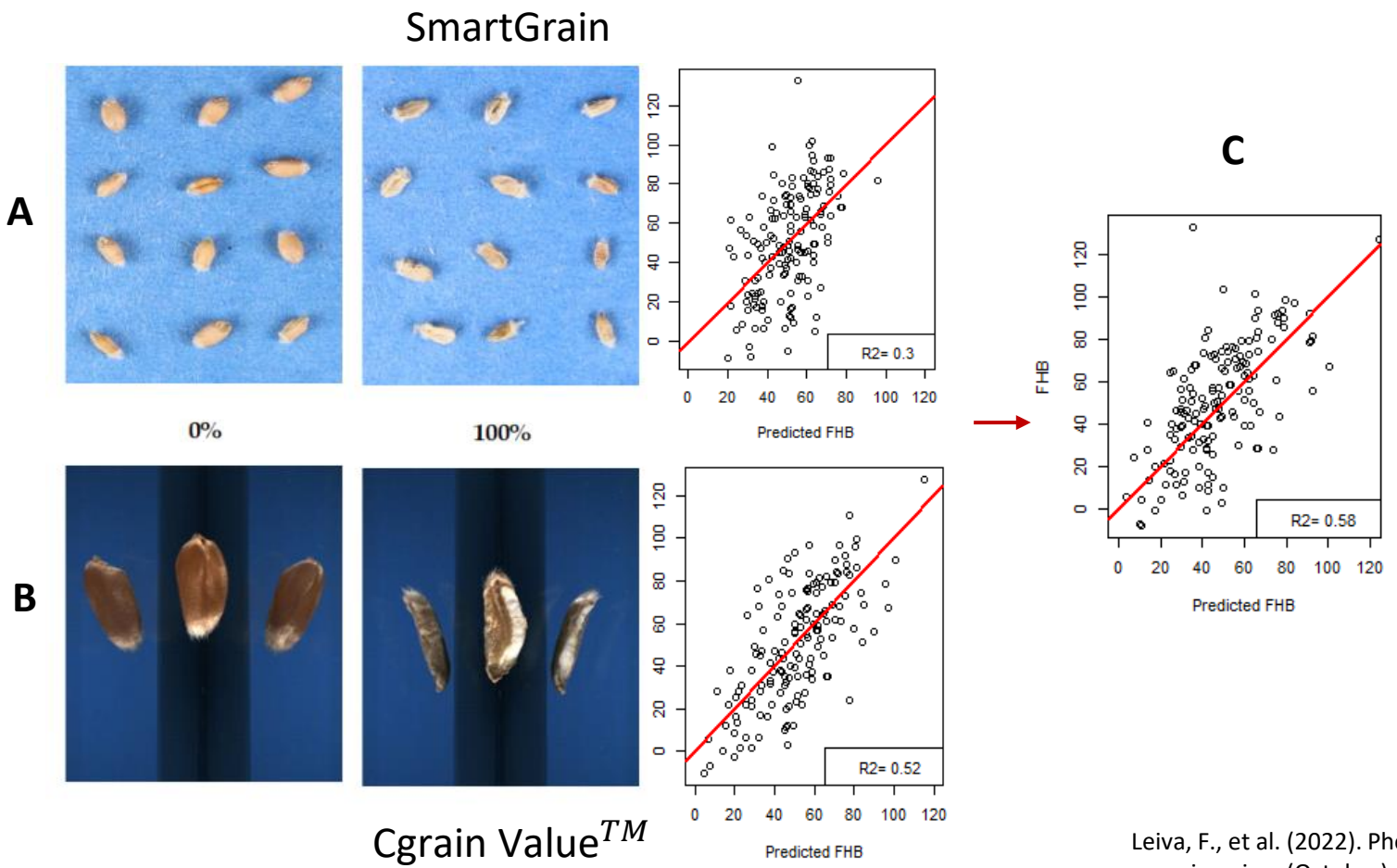

MSI


HSI

Leiva, F.,et al. (2021). Phenocave: An Automated, Standalone, and Affordable Phenotyping System for Controlled Growth Conditions. *Plants*, *10*(9), 1817. https://doi.org/10.3390/plants10091817

Phenotyping Fusarium Head Blight (FHB) from seed morphology using RGB imaging

A method to predict FHB through morphological traits using the free software SmartGrain (A), a cost-benefit instrument Cgrain Value^{TM} (B), and the combination results traits from both of them (C).



Importance

- Asymptomatic spikes can yet produce infected grains.
- This method can accelerate the identification of disease-free seeds.
- Avoid bias between scorers, time-consuming, and non-reproducibility.

Applicability

- Low-cost image acquisition and free software for SmartGrain.
- Cgrain Value^{TM} is placed in Svalöv which means that can be easily implemented in breeding programs.

Leiva, F., et al. (2022). Phenotyping Fusarium head blight through seed morphology characteristics using RGB imaging, (October), 1–13. https://doi.org/10.3389/fpls.2022.1010249

Relevance of results to industry – phenotyping

- Identification of new traits that can be detected by drones and different cameras
- Imaging systems that can be used for different kinds of traits
- Germplasm characterized easily and quickly that is much more “even” and equal for a large material
- Better use of existing equipment
- Many more observations can be made and better-quality of results obtained
- Quicker systems

Cgrain equipment in Svalöv

Low-cost GS (winter wheat, green pea, sugar beet)

Aim:

- Developing GS models for the breeding programs by utilizing real-world & complex datasets
- Deep integration with breeding programs by utilizing real-world & complex datasets
- Key traits: disease resistance, yield, grain quality
- Integration with resistance and phenotyping projects
- Developing bioinformatics pipelines

Team:
SLU: Researcher 1, Postdocs 2
Aakash Chawade, Admas Alemu, Aditi Bhandari

Lantmännen: Breeders 3 - Alf Ceplitis, Firuz Odilbekov, Lorena Batista
Findus: Breeder 1 - Agnese Brantestam
DLF Beet Seed: Breeders 2 – Per Snell, Catja Selga

Outcome:
Peer-reviewed scientific publications: **1** (green pea)**,** Under review **1** (Winter wheat)
Relevance to industry: New methods for GS, low-cost method evaluation, genetic markers

Better Barley

Project just started

Aims:

- Developing GS models for the barley breeding program by utilizing real-world & complex datasets
- Deep integration with breeding programs by utilizing real-world & complex datasets
- Developing bioinformatics pipelines
- Key traits: grain yield, maturity, disease resistance

Team:

SLU: Researchers 2, Industry Postdoc 1

Ramesh Vetukuri, Aakash Chawade, Johanna Åstrand (SLU & Lantmännen)

Lantmännen: Breeders 3

Alf Ceplitis, Firuz Odilbekov, Lorena Batista

Expected outcomes:

Relevance to industry: New methods for GS in barley, genetic markers

Relevance of results to industry – Genomic selection

- Methods for design of reduced marker sets for GS
- GS prediction models for FHB & other traits in winter wheat
- GS prediction models for traits important to barley breeding for Northern Scandinavia
- Information on large-effect markers for key traits in wheat & barley
- Efficient knowledge transfer through active participation in LM breeding program