Faupe 2014 at Copenhagen University

FAUPE Goal

New, Fast and effective screening techniques to identify breeding material with improved nutrient use efficiency (NUE) and tolerance to drought.

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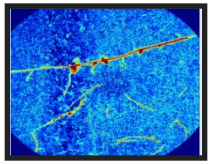
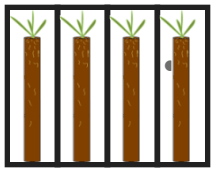
Overview FAUPE 2014

Field phenotyping of Spring Barley

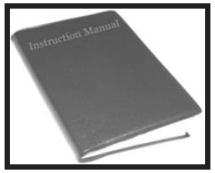
Test of soil sensors (Sensing root growth)



Testing new minirhizotron Camera technique



Test of new methods for tube root screening



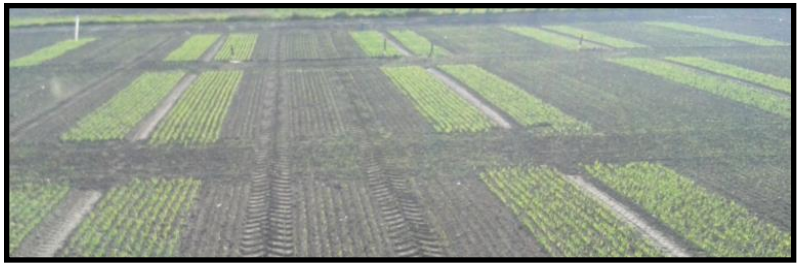
Development of protocol for imaging and sensing

Field phenotyping of Spring Barley

Faupe Field Trial 2014

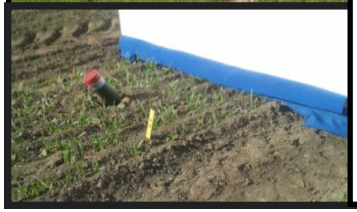
Objectives

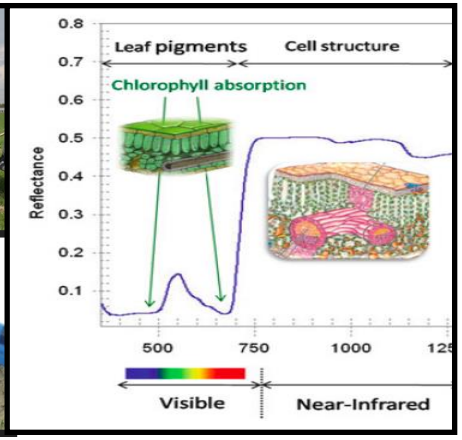
- Tests of methods and non-destructive measurements
- Preliminary relation to NUE and WUE
- How can non-destructive root and shoot phenotyping be combined



Experiment

- 2 spring Barley Varieties
- 3 Nitrogen Levels

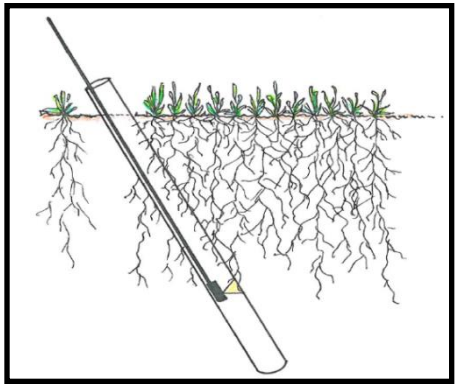




Non-destructive Phenotyping

- Multispectral canopy imaging
  With nine wavelengths

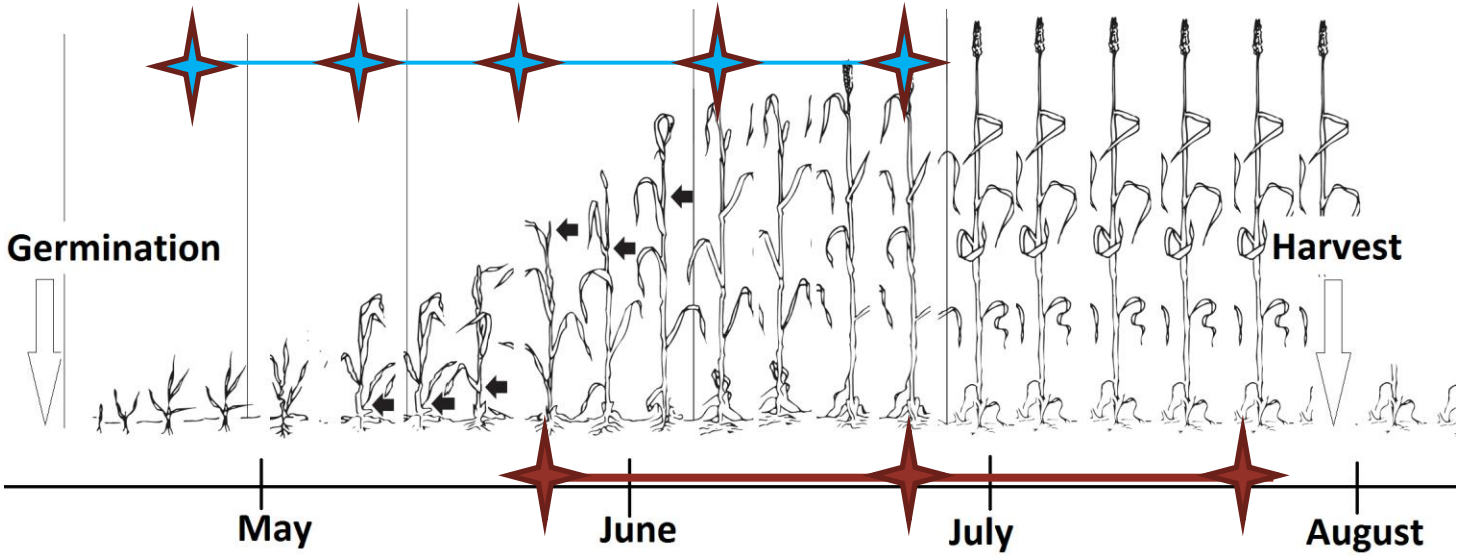
- Minirhizotron root imaging

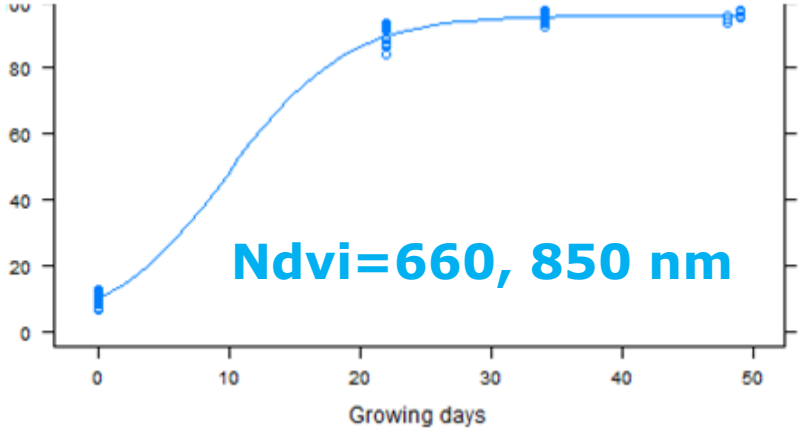


Measurements 2014

Canopy Phenotyping

Dry Summer
≈200 mm water deficit
Possible water stress during Grain Filling!





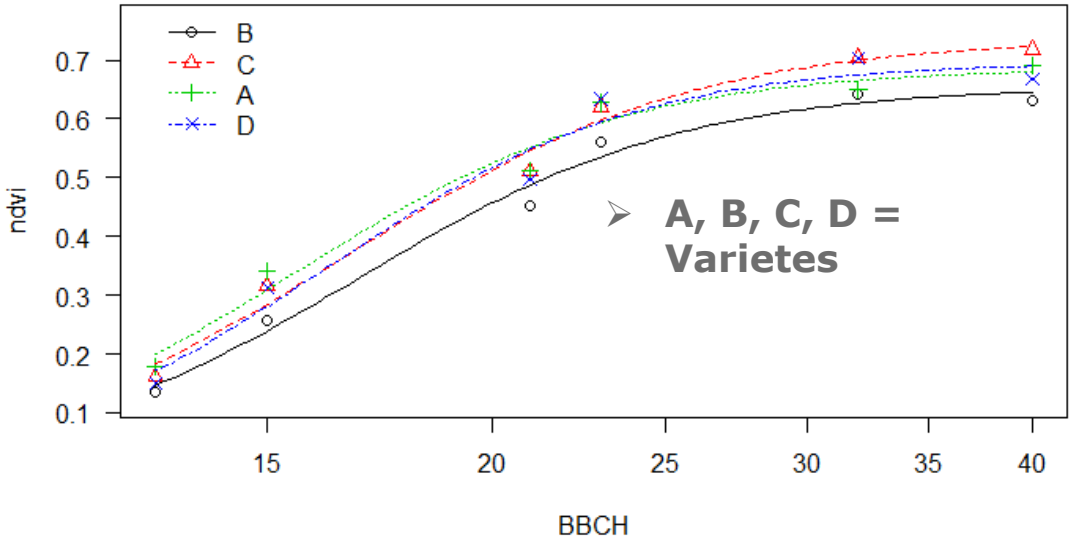
Canopy Phenotyping with Phenofield

Growth Rates:

- Early vigour
- Yield models
- Identify parameters important for NUE and drought tolerance

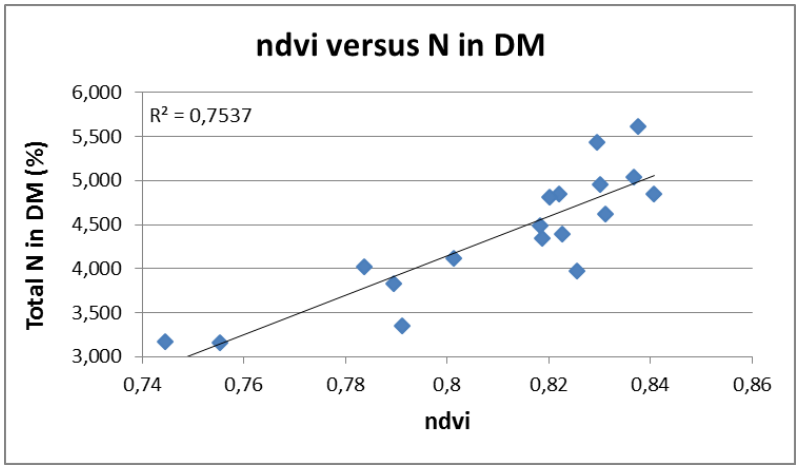
(E.g. Pang et al., 2014)

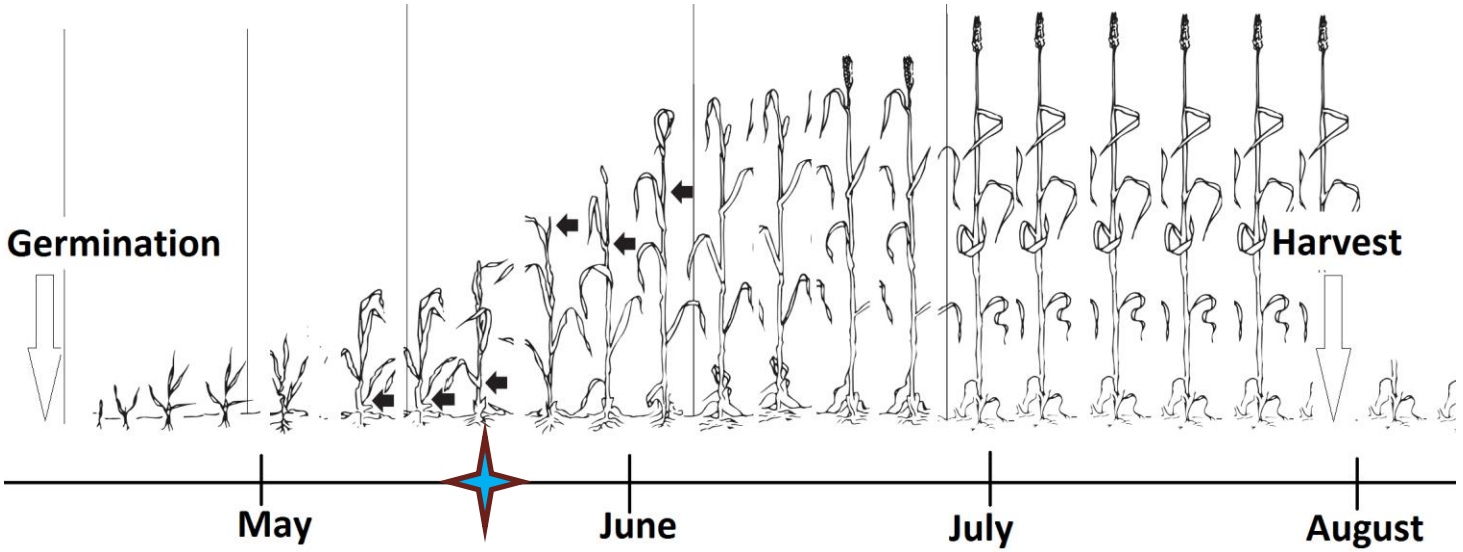
Spring wheat varieties, 100 kg N/Ha



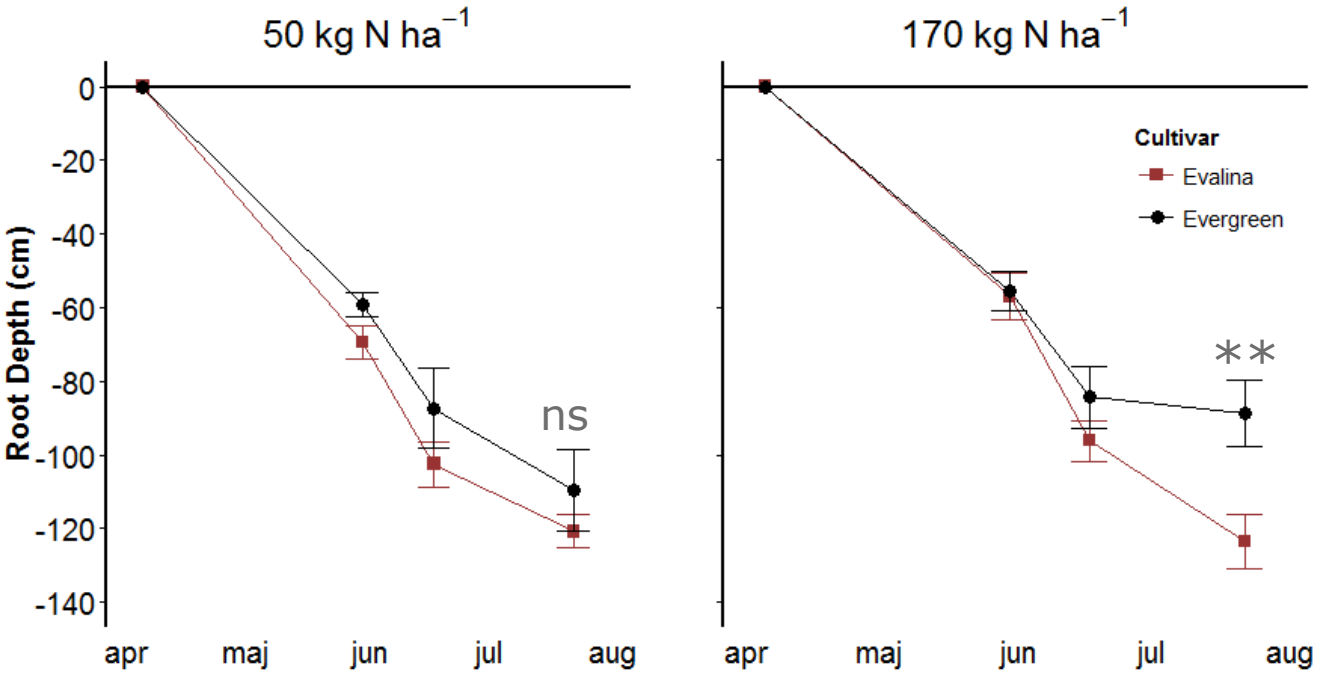
Canopy Phenotyping with Phenofield

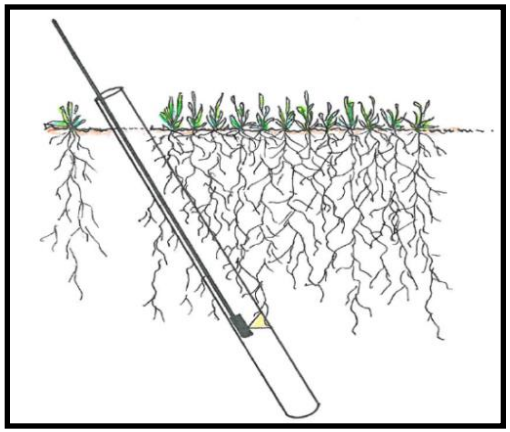
Nitrogen in plant material – NUE
Ndvi meassurement with two wavelengths





Root Phenotyping





Test of soil sensors (Sensing root growth)

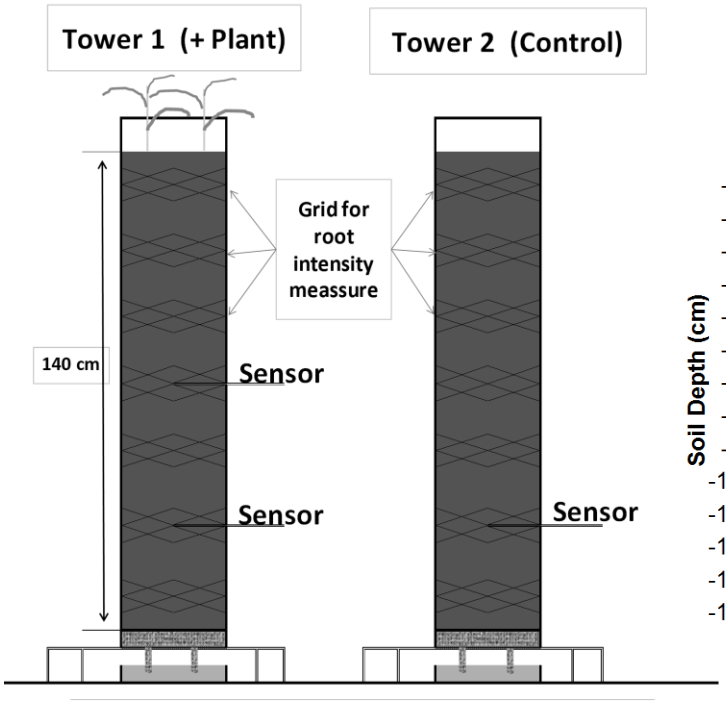
Sensing Root Activity

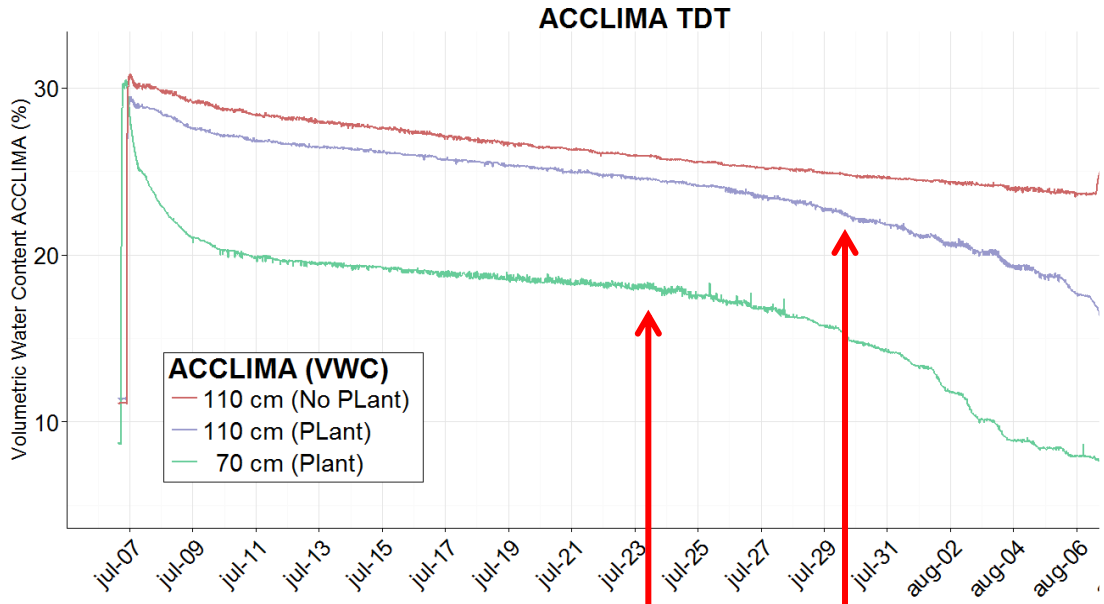
Objectives

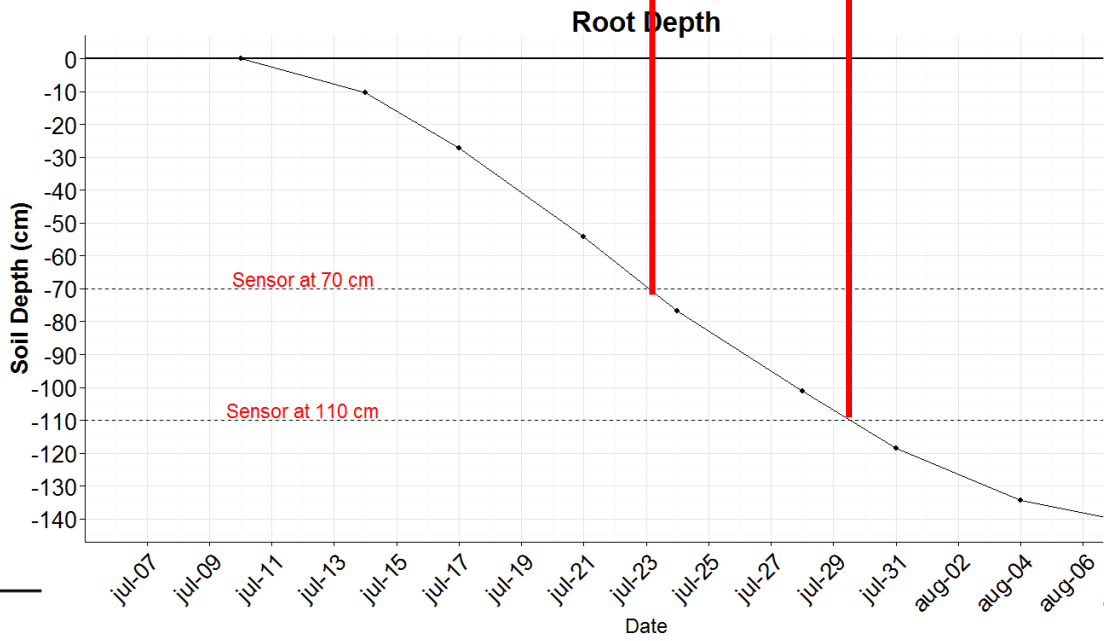
- Can Root Growth be evaluated by sensing the uptake of water or nutrients?
- Indirect measurements of root growth instead of time consuming visual evaluation
- Sensor test with maize and fodder radish in 140 cm columns

Water depletion curves

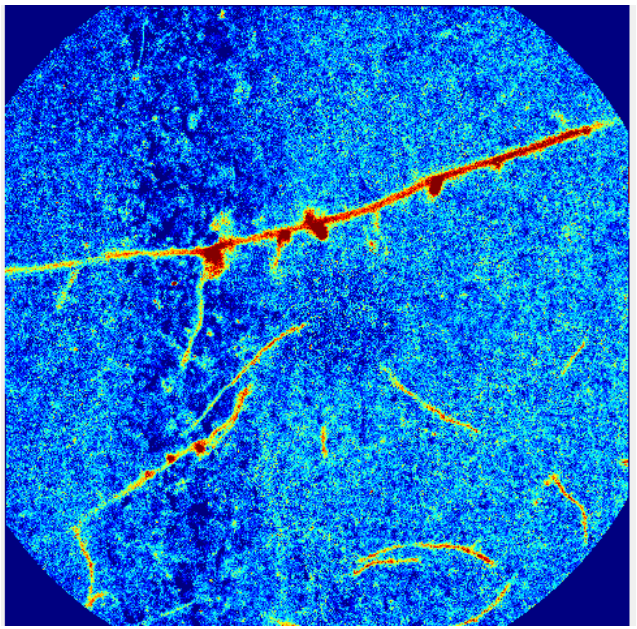
Acclima TDT Water Content



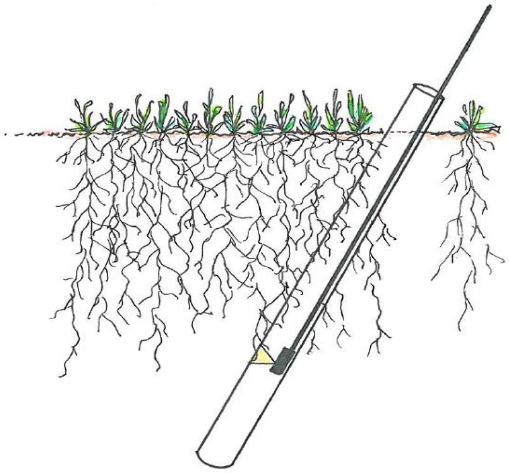




Testing new minirhizotron Camera technique

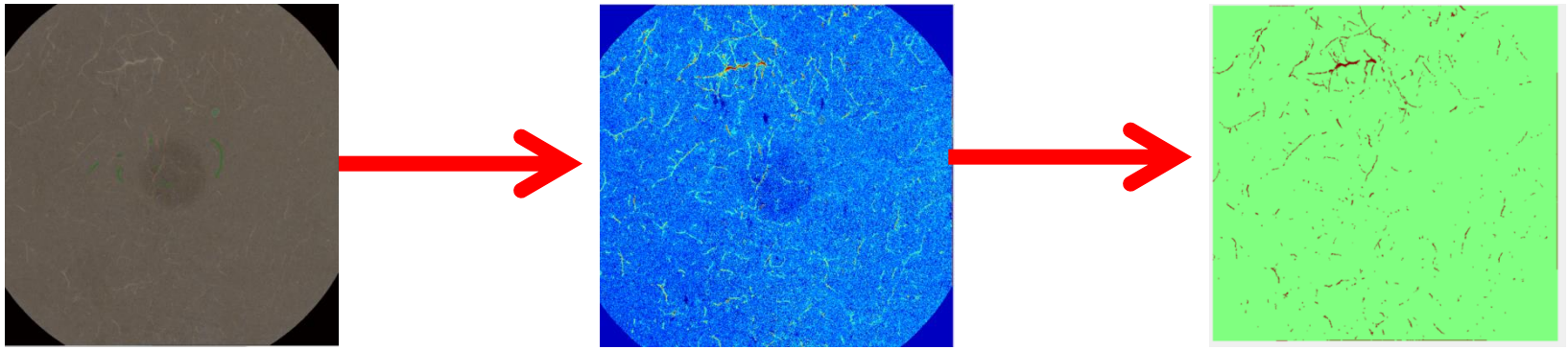


Development of new method for automated quantification of roots in minirhizotron studies

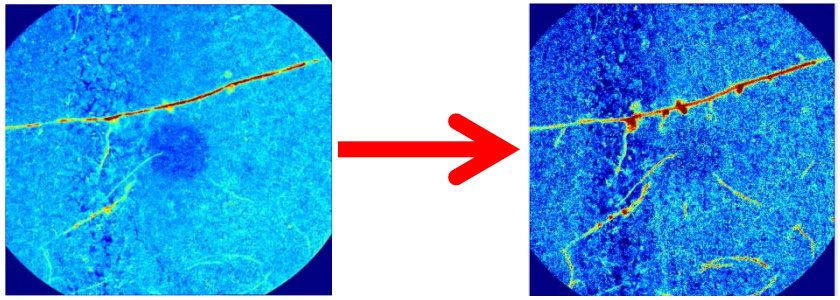


Testing multispectral image analysis on root pictures using the VideomterLab

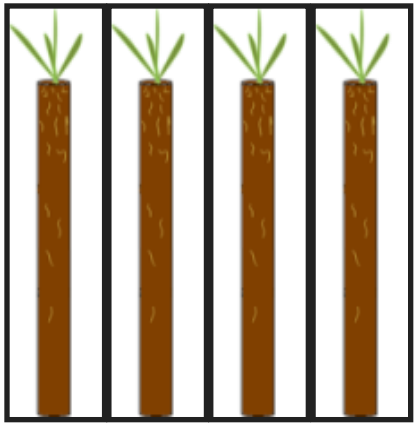
Normal RGB image **Multispectral image** **Binary image**



Algorithm training can improved root identification



Test of new methods for tube root screening



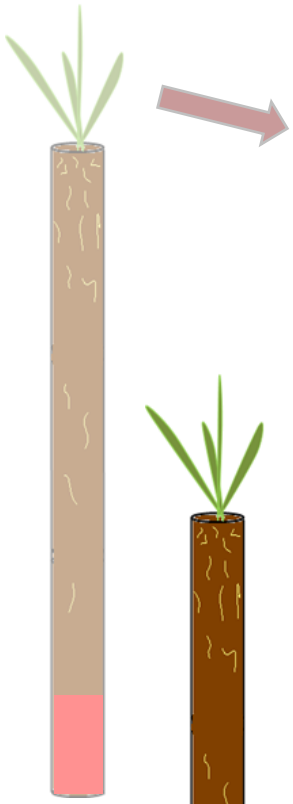
Root screening in tubes

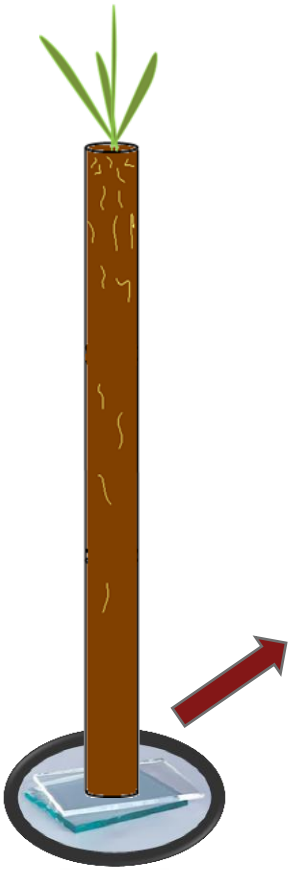
Objectives

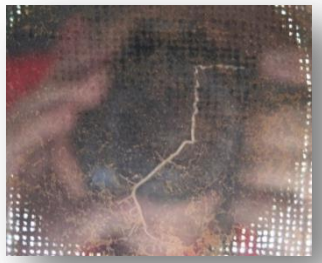
Faster and higher precision
than field testing

Methods tested with success

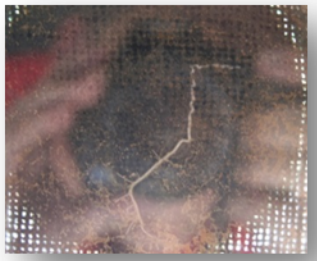
- Deep herbicide placement:
  - Fast roots ➔ early symptoms
  - Fastest roots ➔ longer exposure to herbicide ➔ more severe symptoms than slow roots
- Tubes standing on transparent plate:
  - Fast roots ➔ early bottom emergence

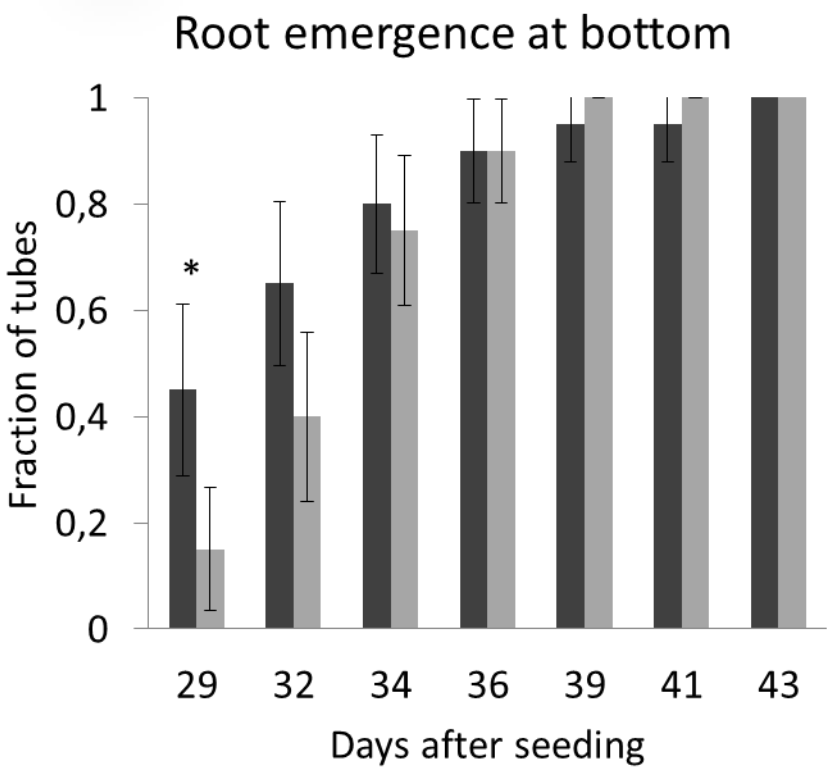


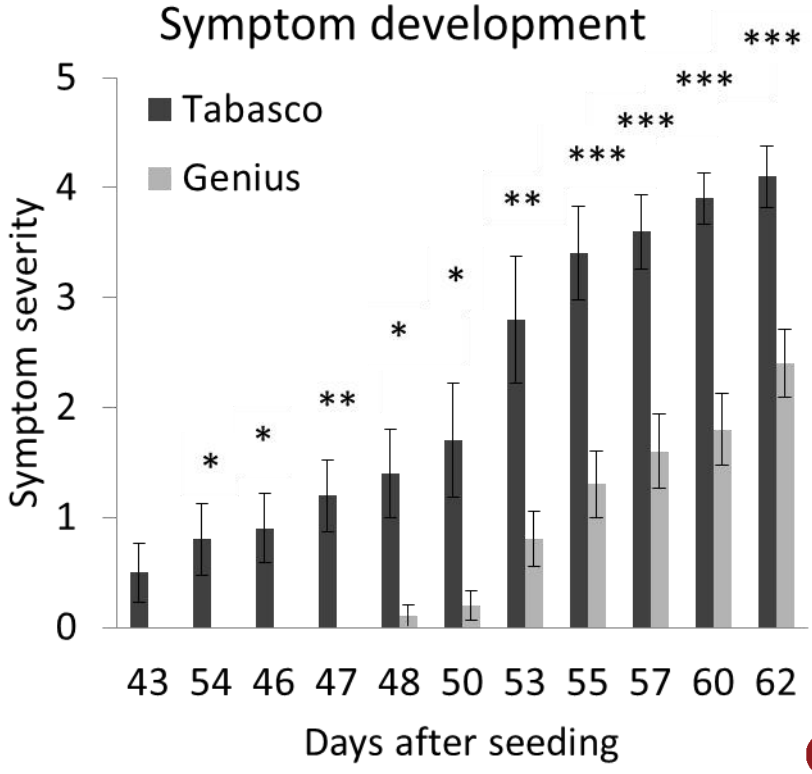




Results

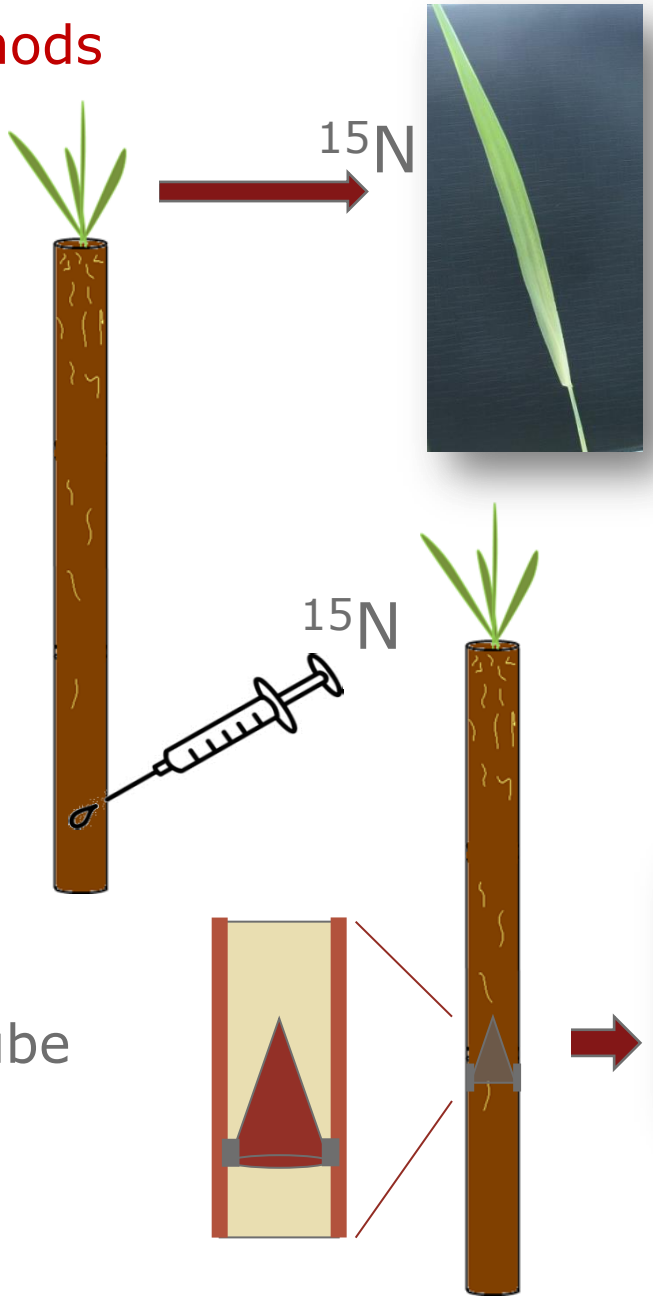



Root emergence at bottom
Fraction of tubes
1
0,8
0,6
0,4
0,2
0
*
29
32
34
36
39
41
43
Days after seeding


Symptom development
Symptom severity
5
4
3
2
1
0
Tabasco
Genius
*
*
*
**
*
*
**
***
***
***
***
43
54
46
47
48
50
53
55
57
60
62
Days after seeding

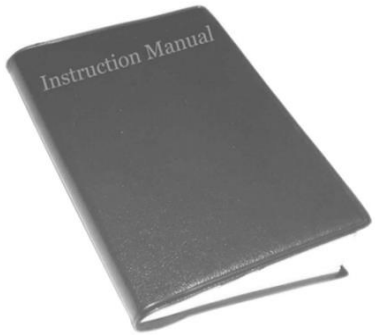
Other promising methods

- ^{15}N injection to soil



- Cone placed inside tube

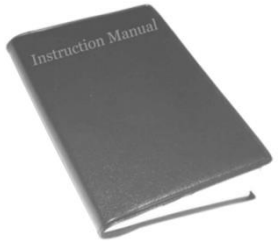
Development of protocol for imaging and sensing



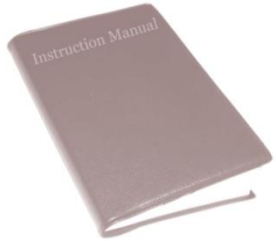
FAUPE will deliver several protocols for imaging and sensing:

When, What, How?

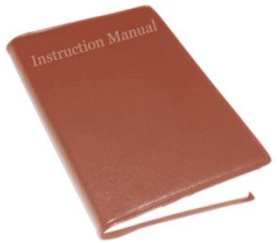
- **When to use the different methods**
  A timetable for phenotyping based on visible developmental stages



- **What can it measure**
  A guide to which traits that can be measured with the different imaging and sensing tools



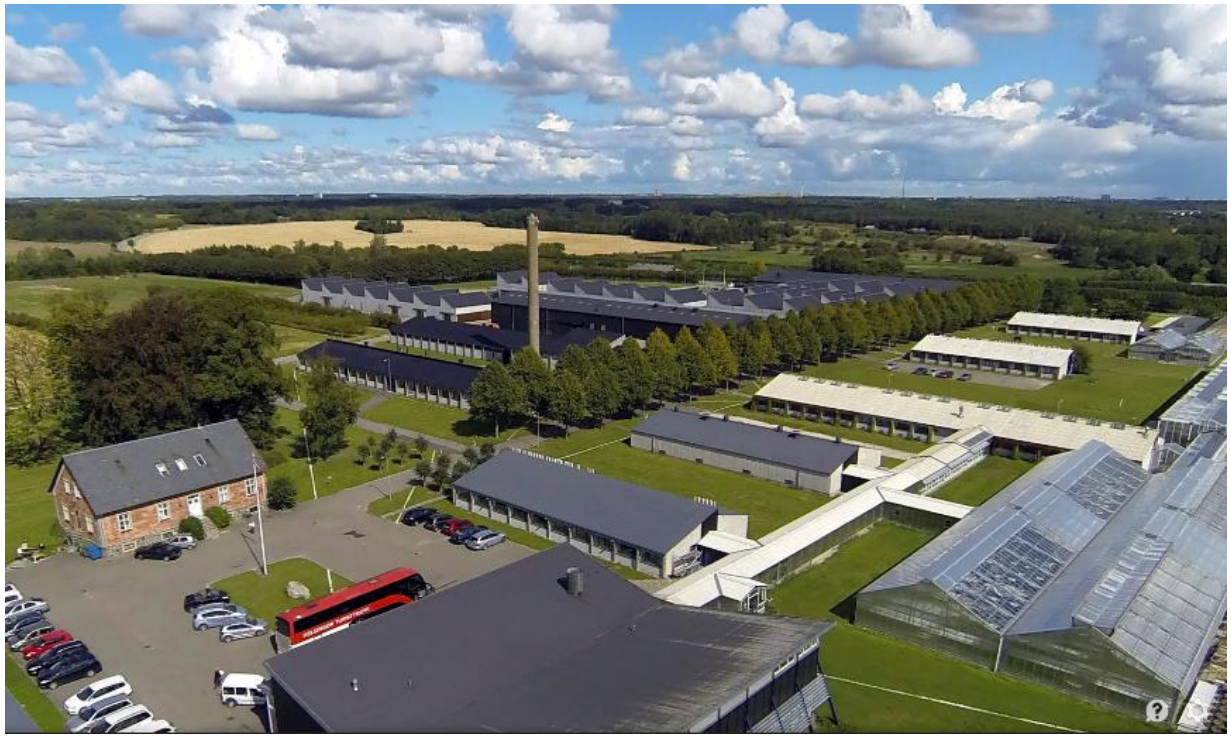
- **How to use it**
  A technical manual for the different imaging and sensing tools



When: A timetable for phenotyping based on visible developmental stages

→ Growth stage → ↓ Type of Measurement ↓		Seedling	Tillering	Flowering	Ripening	Maturity
In field: Root/soil	Imaging		+	+	+	+
	Sensing (nutrients and water)	+	+	+	+	+
In field: Canopy	Dynamic growth curves and vigour	+	+	+		
	Relative biomass N content	+	+	+		
In green house: Root	Root emergence at bottom plate		+	+		
	Herbicide uptake		+			

Thanks for your attention



FAQ

Milestones 2014

April: Setup of field trial with minirhizotrons for root phenotyping and where this can be combined with multispectral imaging for aboveground phenotyping . Simple experiment with spring barley and N levels, to create differences to study.

May: Setup tests with soil sensors (conductivity, TDR, others?) allowing datalogging of root activity in soil

October: Presentation of preliminary results from root v.s. aboveground phenotyping in barley experiment

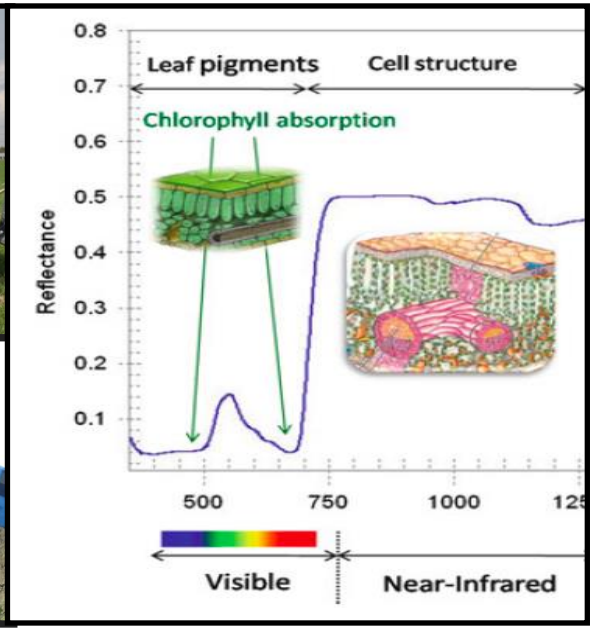
December: Sugestions for improved experimental setup for aboveground root phenotyping facility presented

December: Pilot test with multispectral imaging for detection of roots and root growth finished and presented

December: Present results on improved protocols/methods for root phenotyping and canopy phenotyping

Phenotyping 2014

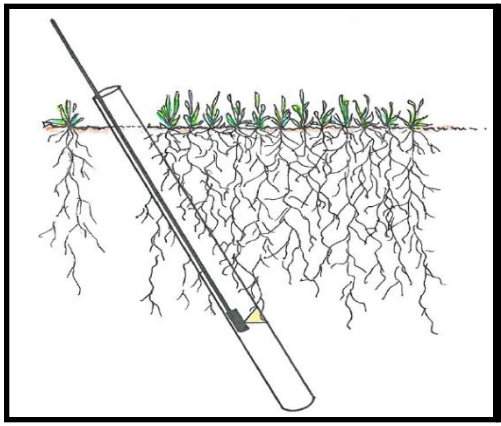
PhenoField Platform



- **Multispectral imaging**
- Non-destructive
  - Biomass,
  - photosynthetic capacity
  - Nitrogen Uptake

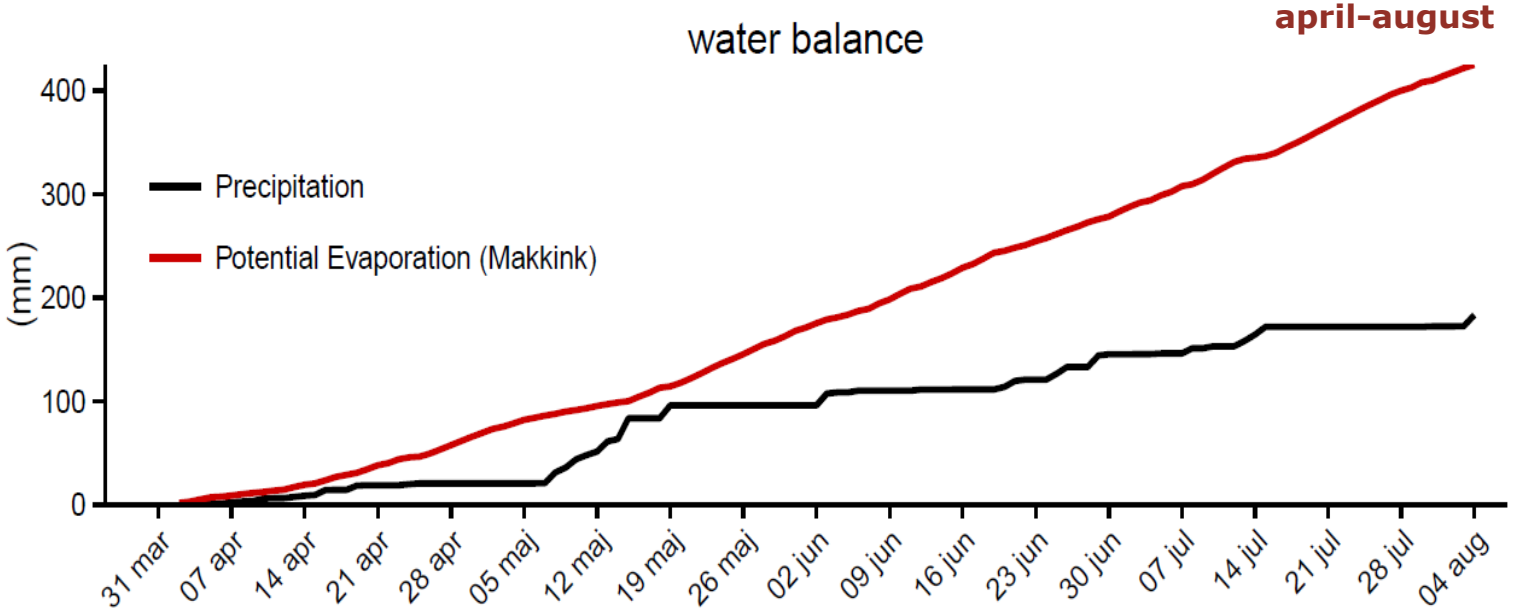
465 nm, 500 nm, 525 nm, 590 nm, 615 nm, 625 nm, **660 nm**, 740 nm and **850 nm**

- **Mnirhizotron study**
- Non-destructive
  - Root depth
  - Root intensity



The 2014 Season at Højbakkegård

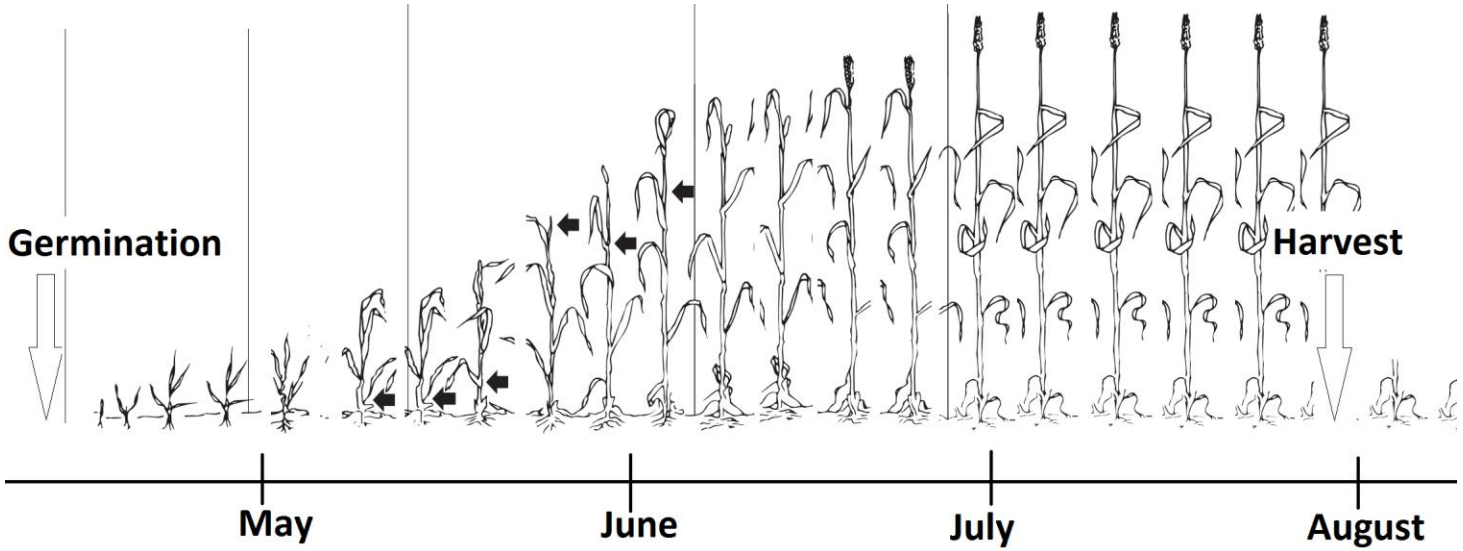
≈200 mm water deficit from april-august



Wet Period in May
80 mm Rain

Dry Summer
Possible water stress during Grain Filling!

Measurements 2014

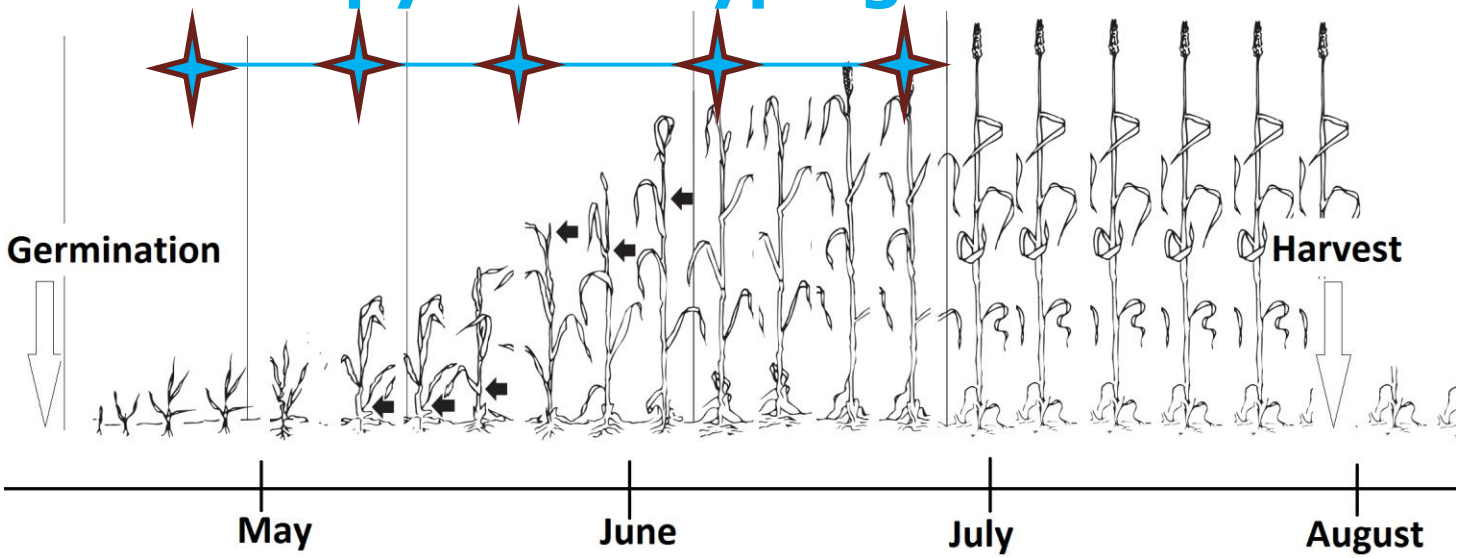


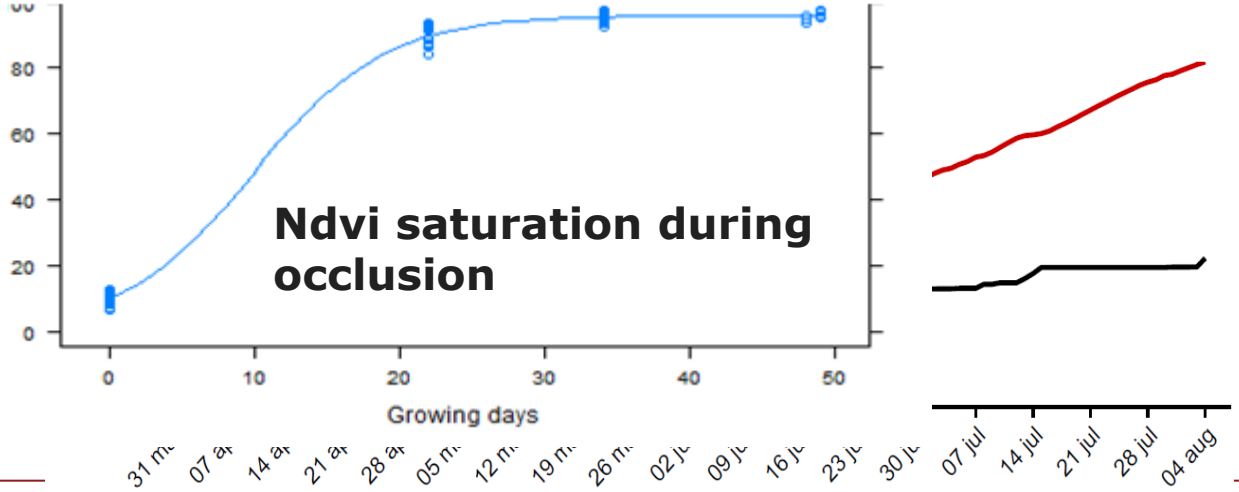
Measurements 2014

Wet Period in May
80 mm Rain

Possible W g Grain

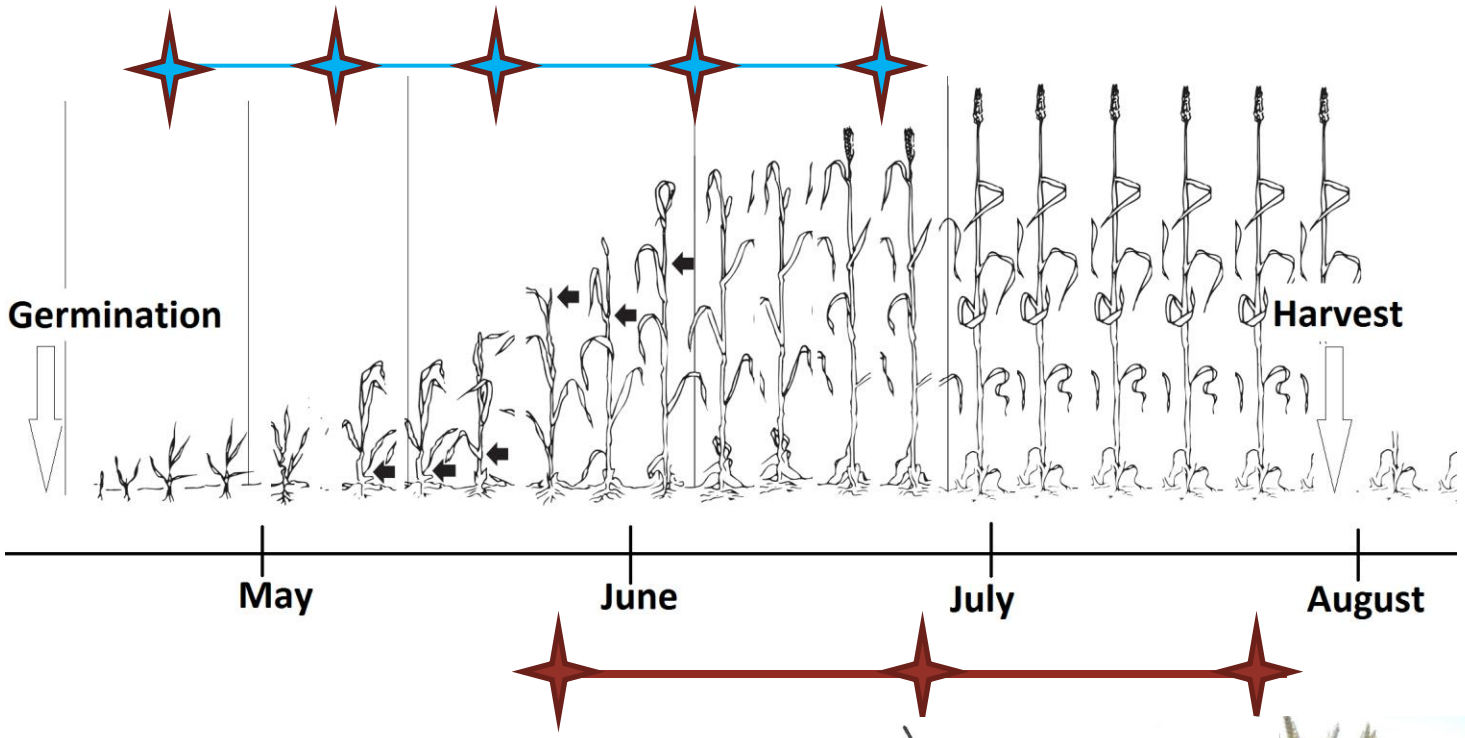
Canopy Phenotyping



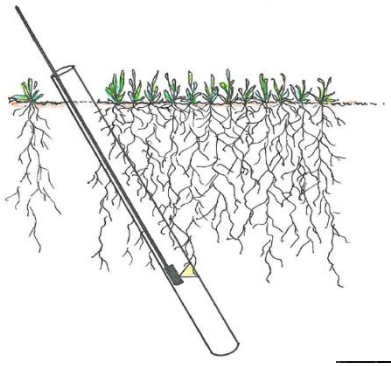


≈200 mm water deficit from april-august

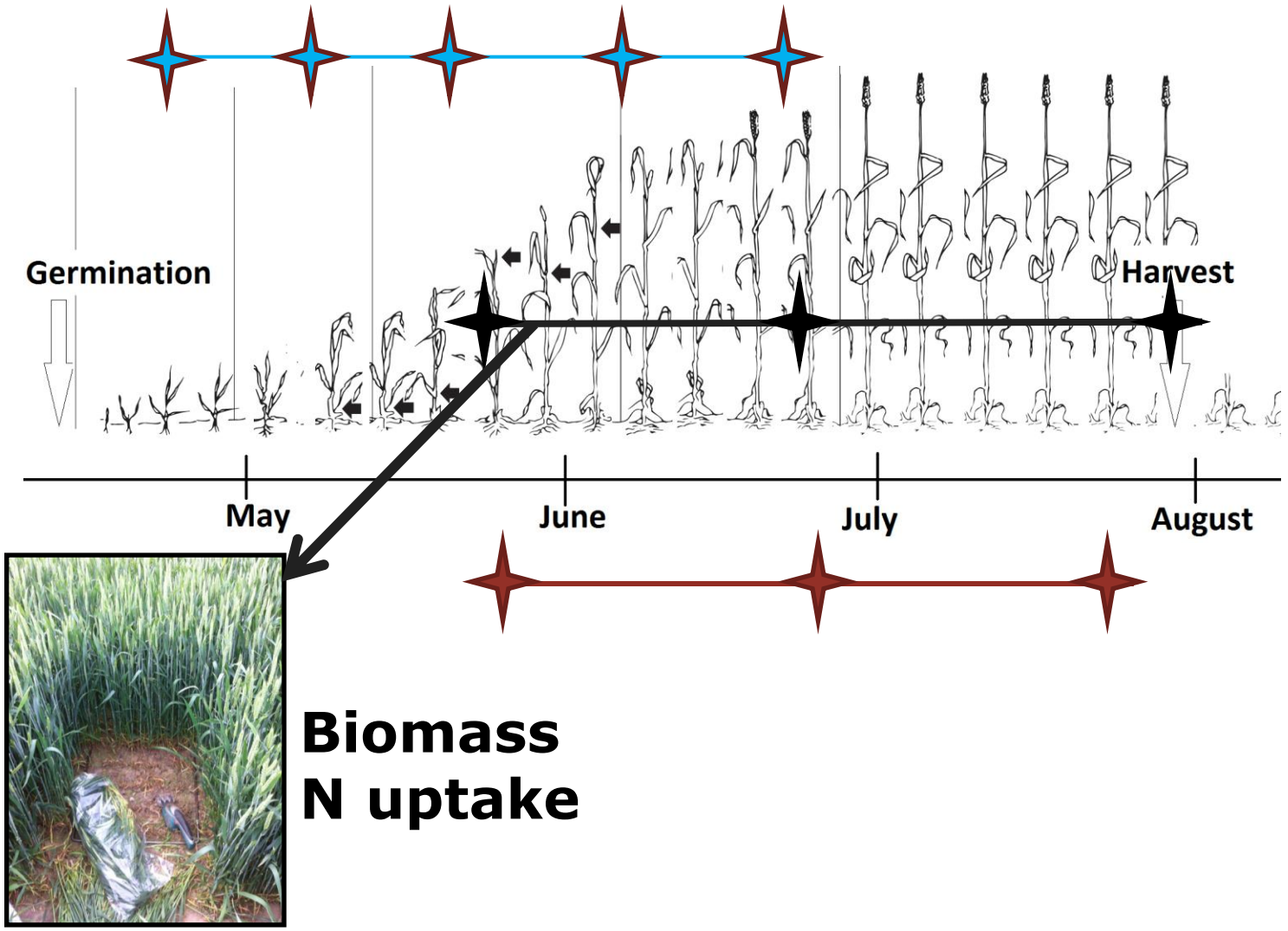
Measurements 2014



Root Phenotyping

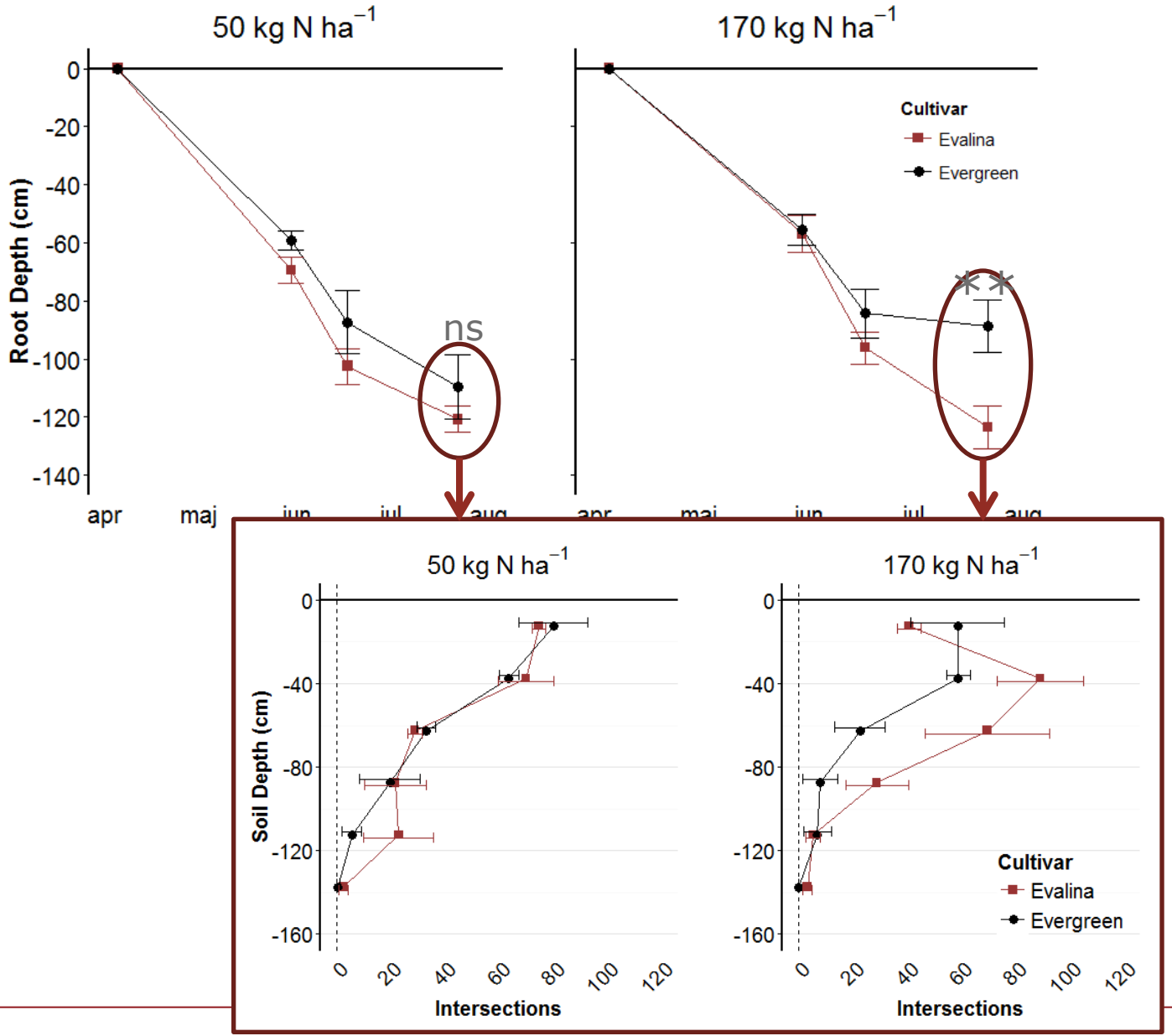


Measurements 2014

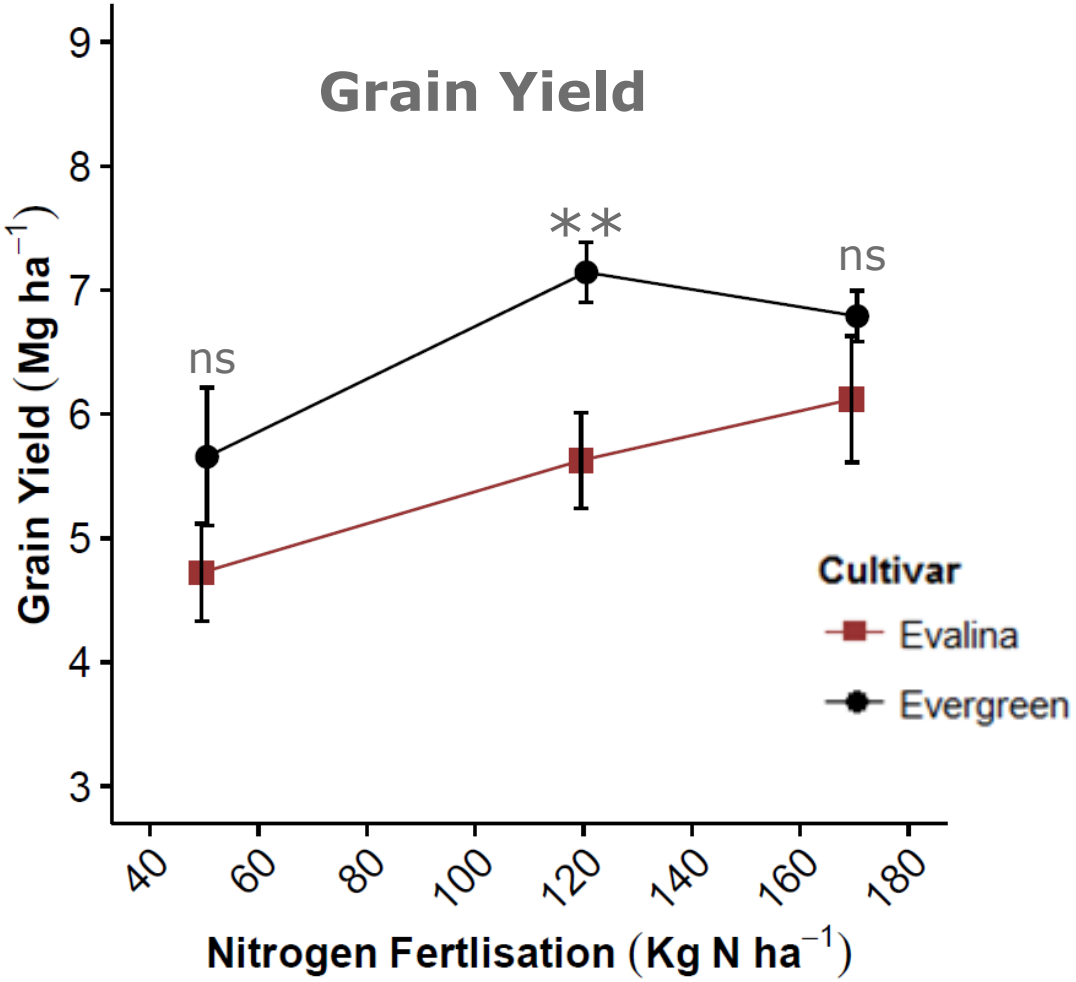


Biomass
N uptake

Root Phenotyping



Grain yield


Grain Yield
Grain Yield (Mg ha^{-1})
9
8
7
6
5
4
3
**
ns
ns
Cultivar
Evalina
Evergreen
40
60
80
100
120
140
160
180
Nitrogen Fertlisation (Kg N ha^{-1})

Wheat genotypes with high early vigour accumulate more nitrogen and have higher photosynthetic nitrogen use efficiency during early growth

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