



Phenotyping meeting
30th September 2024

Wheat, RGB images for length measurement and counting

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This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under Grant Agreement No 817970.



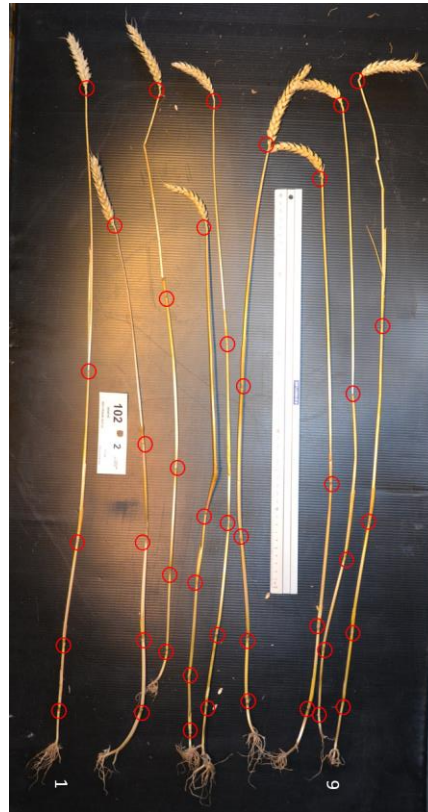
Assessment of organ lengths on wheat plants, in laboratory, using RGB images

Acquisition

40 RGB images



Annotated RGB images



Results

Process with ImageMeter

1	102	Parcelle
42		Plateau Tal - 1 Nœud
85		1 er - 2 eme Nœud
133		2 eme - 3 eme Nœud
217		3 eme Nœud - Dern. Nœud
352		Dern Nœud - Base Epis
76		Epis
905		TOT

Reference



Annotation of point of interest: tillering plateau, nodes, base of the ear)

Measurement of organ lengths: stem, between nodes, ears

Counting the number of orange wheat blossom midge larvae on wheat ears, in laboratory, using RGB images



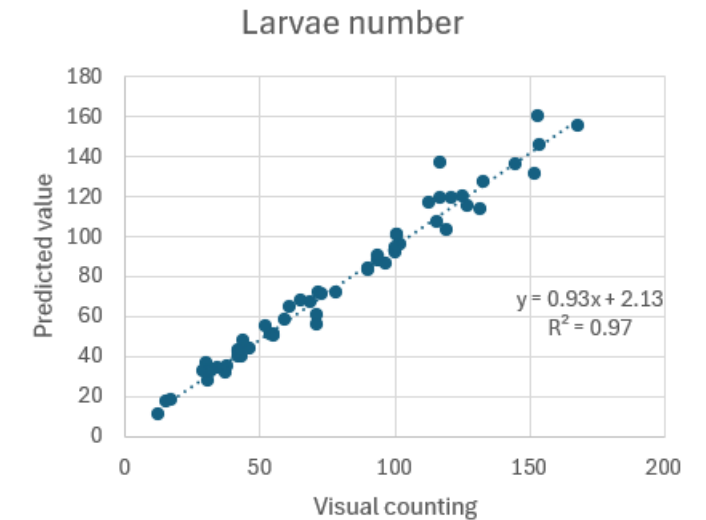
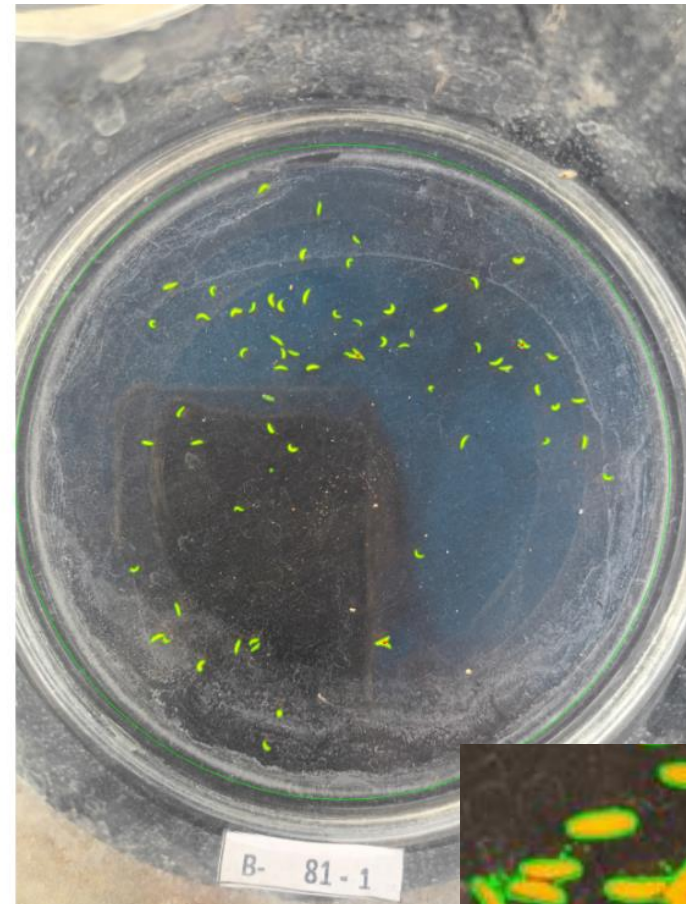
Acquisition

RGB images

Segmentation based on the color

Results

Validation on 54 samples



Larvae/ear for each variety

	Visual counting	Rank	Pred value	Rank
Var 1	5	1	5	1
Var 2	13	2	14	2
Var 3	24	3	23	3
Var 4	28	4	27	4
Var 5	28	5	28	5
Var 6	31	6	28	6
Var 7	40	7	38	7

Expected applications for DUS, VCU or performance testing

indicate here which use is foreseen and what will be the benefits to use this tool

▶ RGB images for measuring lengths (CRA-W)

- ▶ Collection of 10 plants by plot, image acquisition in lab, annotation of point of interest (tillering plateau, nodes, base of the ear) and use of ImageMeter software
- ▶ The work to assess the length traits can be performed from computer in time-shift, sometimes in better conditions for the operator.
The required time should be more or less the same.
Storage of images useful when doubtful results

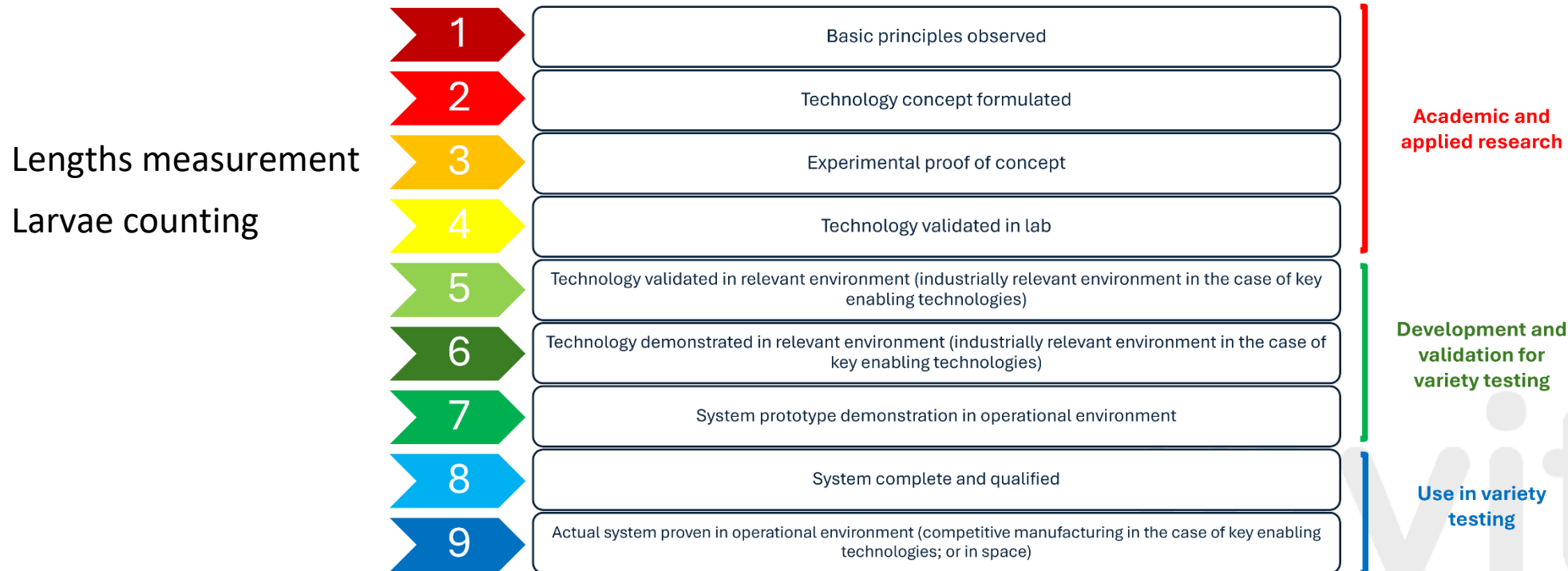
▶ RGB images for counting larvae (CRA-W)

- ▶ Collection of larvae by water cleaning in a plastic box for 30 ears by variety, image acquisition in lab and differed processing in office
- ▶ Counting time highly reduced.
Storage of images useful when doubtful results

invite

Readiness of the tool

please place the star on the TRL of the tool reached in INVITE project



"Technology readiness levels (TRL); Extract from Part 19 - Commission Decision C(2014)4995" (PDF). ec.europa.eu.

Further steps for an application by OEs or PROs

indicate here the further steps/developments needed, obstacles to overcome, for an application by EOs or PROs

▶ RGB images for measuring lengths (CRA-W)

- ▶ Automatic process to annotate the points of interest (tillering plateau, nodes, base of the ear)
- ▶ Advantage: The required time for the full process should be shorter. In the same time other DUS traits could be assessed as the ear size, the ear shape, the number of spikelets, the presence or not of the awns, the awns length.

▶ RGB images for counting larvae (CRA-W)

- ▶ Development of deep learning model to solve the issue in a much more robust way
- ▶ Validation on a full trial in greenhouse in 2025

invite



THANK YOU
FOR YOUR ATTENTION



Phenotyping meeting
30th September 2024

Wheat, detection of Fusarium Head Blight

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Juan Herrera, Simon Treier, Agroscope, CH

David Rousseau, Hadhami Garbougé, Univ. Angers, FR

Dan Rustia, Joseph Peller, WUR, NL



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4 technological approaches

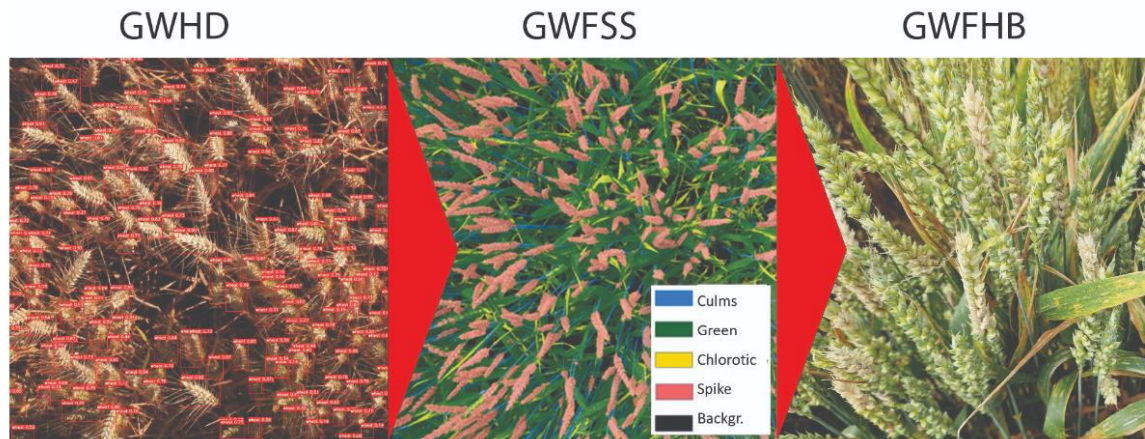
- ▶ RGB images in field (GEVES, AGROSCOPE, CRA-W)
- ▶ Handheld fluorometer in field (AGROSCOPE)
- ▶ Multispectral Visible NIR imaging in laboratory and in field (GEVES)
- ▶ Hyperspectral NIR imaging in laboratory and in field (CRA-W)

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Detection of FHB on wheat ears in field using RGB images



- ▶ +/- 3000 RGB images acquired by Agroscope, CRA-W, GEVES
- ▶ Contribution to Mobile-based Rapid Phenotyping (MoRPH) developed by WUR
 - ▶ In addition to the module on tomato
- ▶ Contribution to the GWFHB: **G**lobal **W**heat **F**usarium **H**ead **B**light



<https://www.global-wheat.com/gwfss.html>



Detection of FHB on wheat ears in field using fluorescence



Acquisition

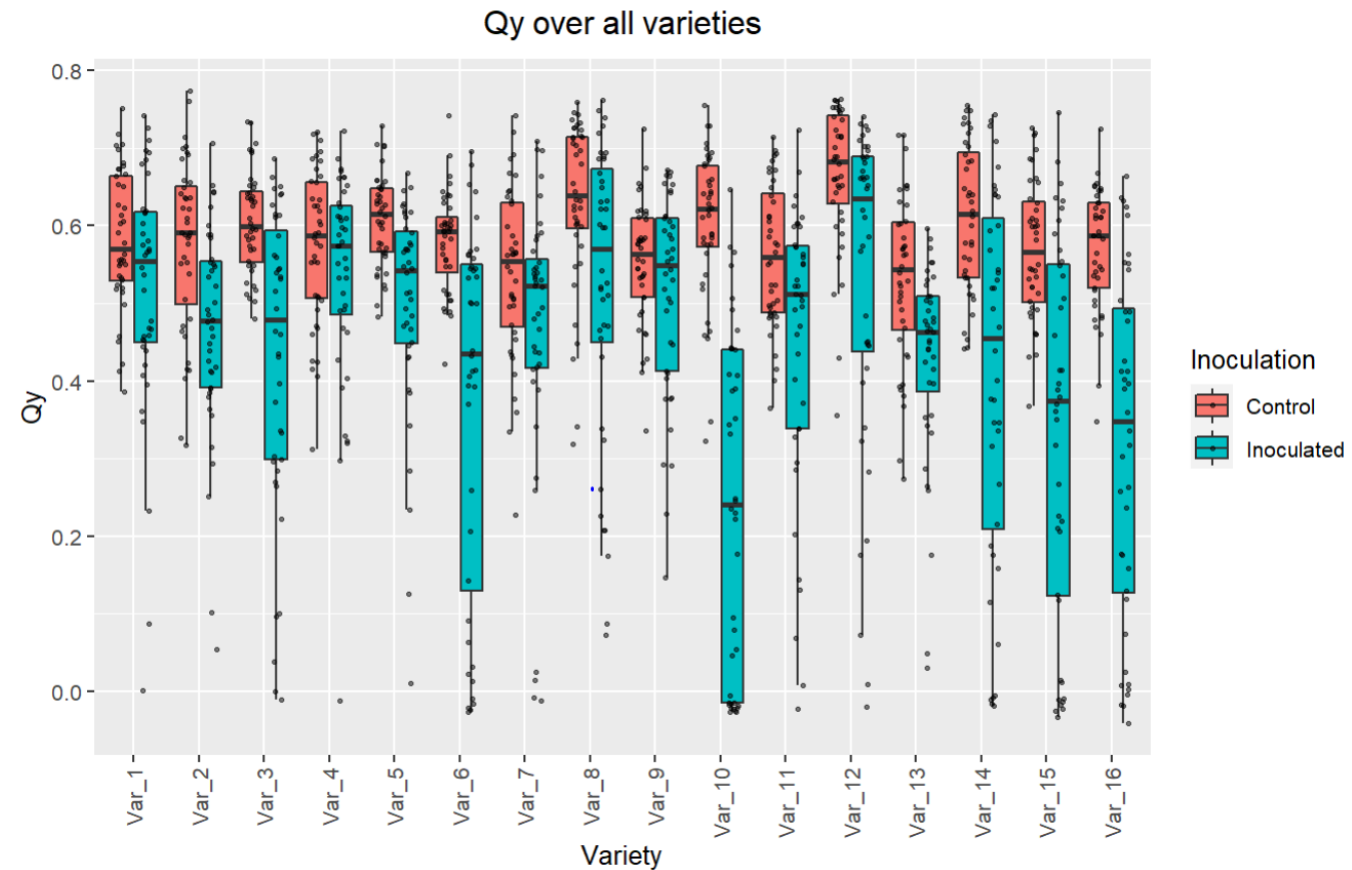
Fluorescence measurements (+/-2000) in the field at day (no dark adaptation)



Index	2	3	4	5	6	7
Time	10:27:54 29.3.2018	10:28:29 29.3.2018	10:31:45 29.3.2018	10:35:52 29.3.2018	10:22:44 3.4.2018	10:23:11 3.4.2018
	49° 20.3871' N 16° 28.6279' E	49° 20.3538' N 16° 28.6755' E	49° 20.2923' N 16° 28.6290' E	49° 20.2557' N 16° 28.5246' E	Qy 0.67	Qy 0.04
	Qy 0.72	Qy 0.65	Qy 0.27	Qy 0.67	Fo Backgr 378 Fo Flash 3330	Fo Backgr 897 Fo Flash 976
	Fo Backgr 299 Fo Flash 4885	Fo Backgr 378 Fo Flash 2711	Fo Backgr 89 Fo Flash 1069	Fo Backgr 438 Fo Flash 3110	Fo Backgr 398 Fo Flash 9331	Fo Backgr 864 Fo Flash 946
	Fm Backgr 299 Fm Flash 17138	Fm Backgr 418 Fm Flash 7058	Fm Backgr 52 Fm Flash 1436	Fm Backgr 418 Fm Flash 8544		
Value						

Results

QY results for measurements on spikes in the field showing a very large variability in relation to strong infections



Detection of FHB on wheat ears in laboratory using VIS-NIR multispectral imaging CMS4

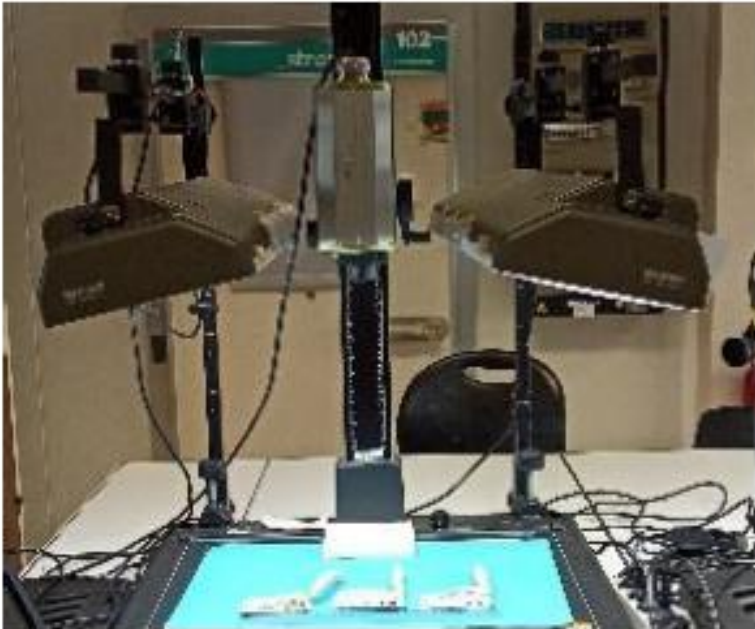


Acquisition

Multispectral imaging system
CMS4



- 4 spectral channel
- 4.2 Mpx global spatial resolution



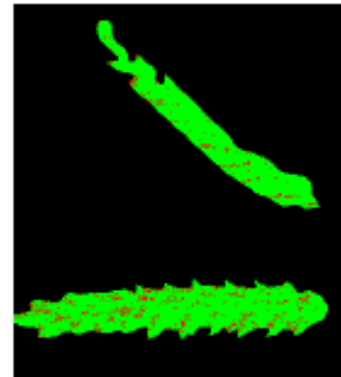
Annotated and predicted images

Observation

Bagged tree model
prediction

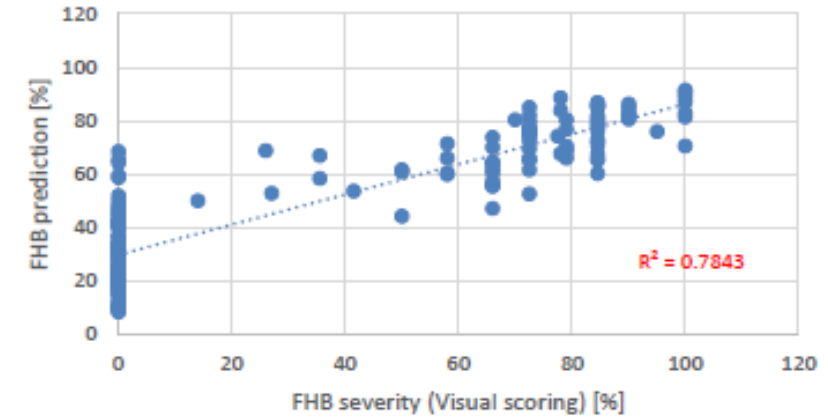


100 %
FHB



0 %
FHB

Results

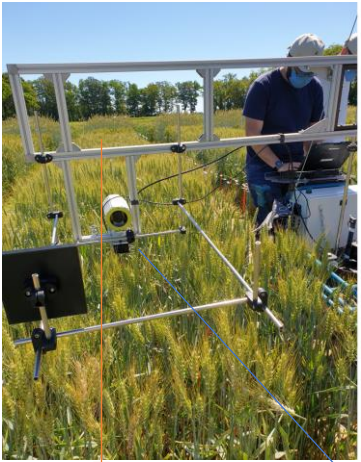


Detection of FHB on wheat ears in field using VIS-NIR multispectral imaging CMS4 in frontal view



1. Imaging acquisition

Multispectral CMS4 & RGB Sony system using pedestrian vectors



2. Annotations

Annotations of the 1st row of ears



Segmentation

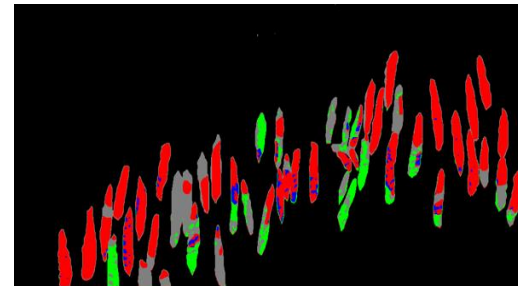
U-NET

3. Creation of 2 algorithms :

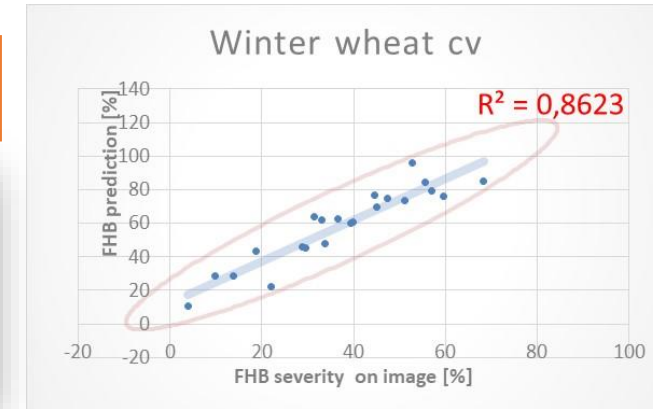
Ear segmentation (U-NET)



Fusarium quantification prediction (Machine learning)



4. FHB prediction results



- Usable for assesment of FHB cv resistance
- 😊 **High correlation with annotations:** in case of good acquisition conditions & high FHB pressure
- ▶ 😞 Camera CMS4: high price ≈ 20 k€, fastidious acquisition (2 to 10min), complicated annotation

Fusarium annotations



756 wheat images on 7 sites



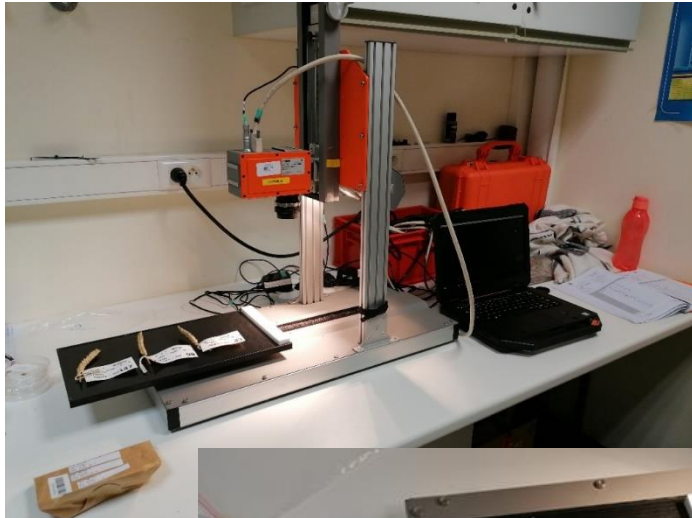
RGB

Detection of FHB on wheat ears in laboratory using NIR hyperspectral imaging



Acquisition

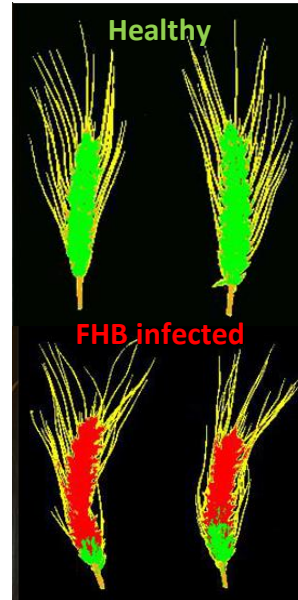
Hyperspectral imaging system
Specim FX17 (900-1700 nm)



MODEL VALIDATION (PLSDA)



NIR-HSI predicted images



Results

Predicted results by ear

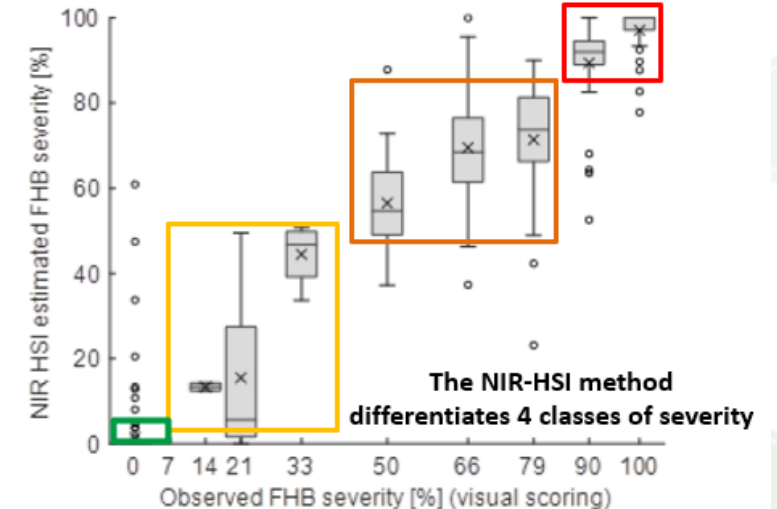
Infected or not	Actual class	
	FHB-infected	Healthy
Predicted as FHB-infected	152	13
Predicted as Healthy	2	141

Sensitivity: 98,7%



Specificity: 91,6 %

Severity



Detection of FHB on wheat ears in field using NIR hyperspectral imaging in vertical view



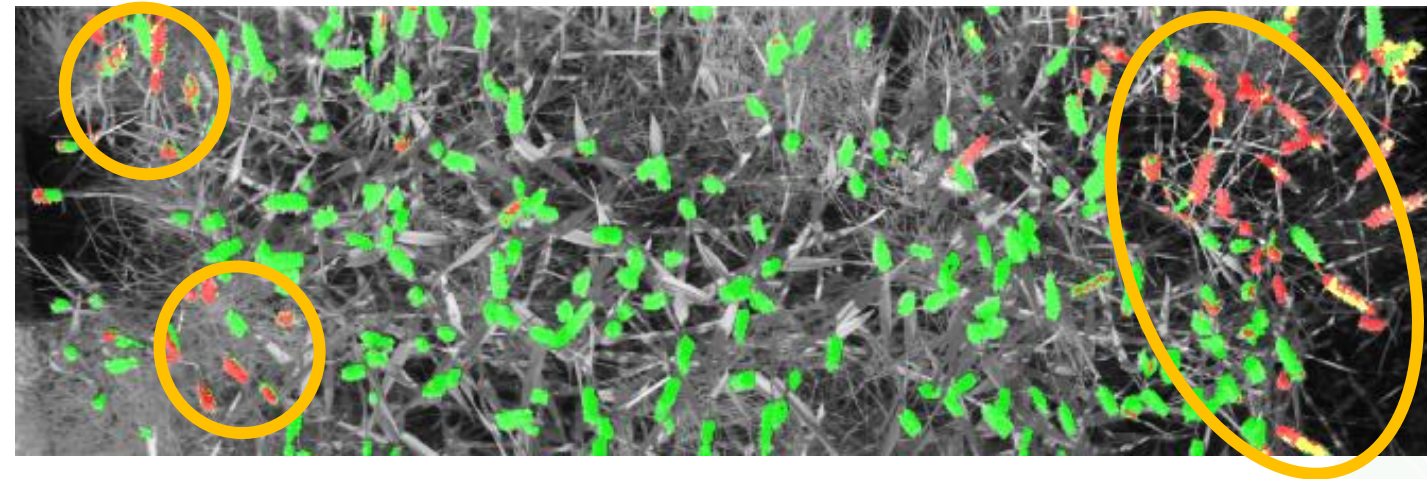
Acquisition

Hyperspectral imaging system with translation stage (+/- 100)



Results

Predicted images



- Healthy
- FHB infected
- Take-all infected

Date	✗ FHB		✗ Take-all		✓ Overall stress	
	RMSE	R ²	RMSE	R ²	RMSE	R ²
28-06-22	0,7	0,08	4,1	0,39	2,0	0,85
04-07-22	0,6	0,26	7,8	0,56	4,2	0,87
14-07-22	0,5	0,42	5,4	0,79	1,8	0,98

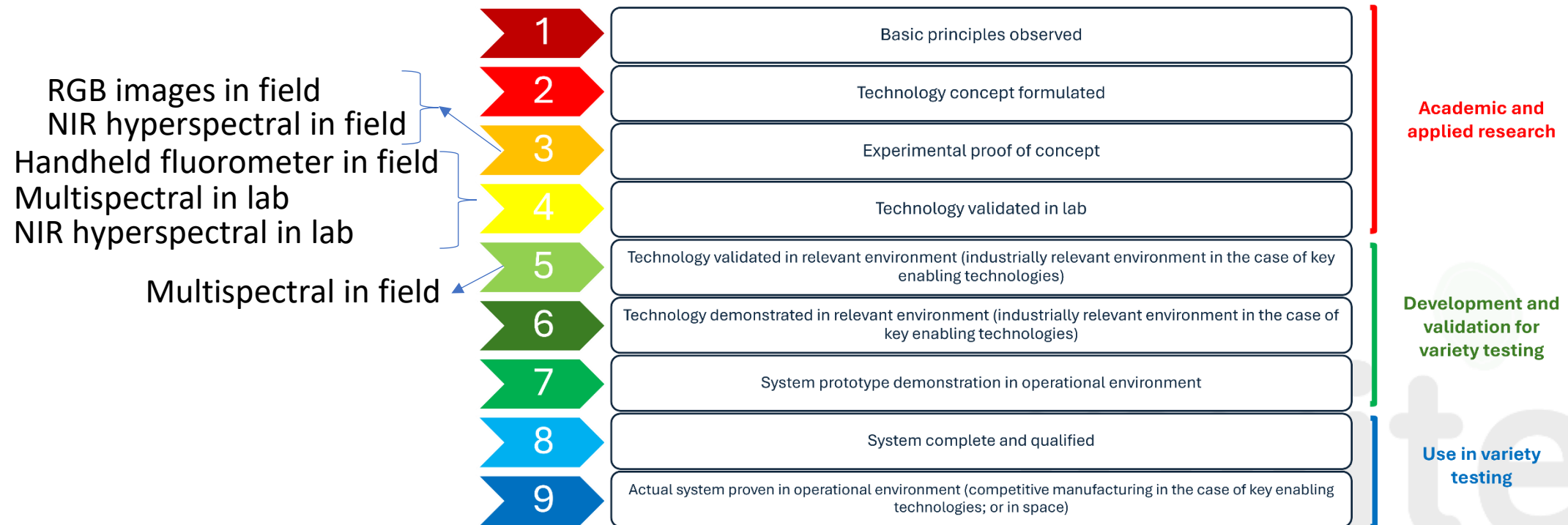
The method can assess the overall stress of the ears but ...
It is not specific enough to differentiate two diseases with similar symptoms.

Expected applications for DUS, VCU or performance testing

indicate here which use is foreseen and what will be the benefits to use this tool

- ▶ RGB images in field (GEVES, AGROSCOPE, CRA-W)
 - ▶ Random image acquisition on plots and using of the MoRPH App for FHB disease identification
 - ▶ Application window: when the ears are yet green
 - ▶ Low cost device
- ▶ Handheld fluorometer in field (AGROSCOPE)
 - ▶ Collection of point measurements of wheat ears with induced infections and controls without infections.
 - ▶ Application window: Disease monitoring at different growing stage
 - ▶ Time consuming for symptoms scoring
- ▶ Multispectral Visible NIR imaging in laboratory (GEVES)
 - ▶ Random collection of 100 ears by plot, image acquisition in lab and differed processing in office
 - ▶ Application window: when the ears are yet green
- ▶ Multispectral Visible NIR imaging in field (GEVES)
 - ▶ Image acquisition on the 1st row of ears and differed processing in office
 - ▶ Application window: when the ears are yet green
 - ▶ High correlation with annotation in case of good acquisition conditions & high FHB pressure
- ▶ Hyperspectral NIR imaging in laboratory (CRA-W)
 - ▶ Random collection of 100 ears by plot, image acquisition in lab and differed processing in office
 - ▶ Application window: Independent of the maturity stage of the ears
- ▶ Hyperspectral NIR imaging in field (CRA-W)
 - ▶ Image acquisition on 1 m² by plot and differed processing in office
 - ▶ Application window: Independent of the maturity stage of the ears
 - ▶ Useful for selective harvest

Readiness of the tool



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Further steps for an application by OEs or PROs

indicate here the further steps/developments needed, obstacles to overcome, for an application by EOs or PROs

- ▶ RGB images in field (GEVES, AGROSCOPE, CRA-W): semi-automatic annotation,
 - ▶ Improvement of image acquisition (perspective view),
 - ▶ New sensors low cost (mobile phone)➤ PHENET
- ▶ Handheld fluorometer in field (AGROSCOPE)
 - ▶ Assess its potential application under natural infections in a variety testing network to improve the comparability among campaigns, sites and operators➤ PHENET
- ▶ Multispectral Visible NIR imaging in laboratory (GEVES)
 - ▶ Proof of concept validated in lab but too long for using in routine and high price
- ▶ Multispectral Visible NIR imaging in field (GEVES)
 - ▶ Semi-automatic annotation➤ PHENET
- ▶ Hyperspectral NIR imaging in laboratory (CRA-W)
 - ▶ Prediction in real time➤ QUALISPECTRA
- ▶ Hyperspectral NIR imaging in field (CRA-W)
 - ▶ Specificity, Acquisition speed, natural light control, prediction in real time
 - ▶ Transfer to spray boom adapted to imaging acquisition➤ QUALISPECTRA, PHENET





THANK YOU
FOR YOUR ATTENTION