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DATA CHRACTERIZATION OF BARLEY HEB-25 THROUGH HYPERSPECTRAL IMAGING AND MACHINE LEARNING

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AIM

In regard to field characterization of a large NAM population containing wild barley DNA introgressions, the *Agrover*, a **multimodal sensor system** was newly developed in 2015 to support high-throughput phenotyping of plant development in field trials by means of hyperspectral and RGB data.

AGROVER FIELD TRIALS 2016 – 2018

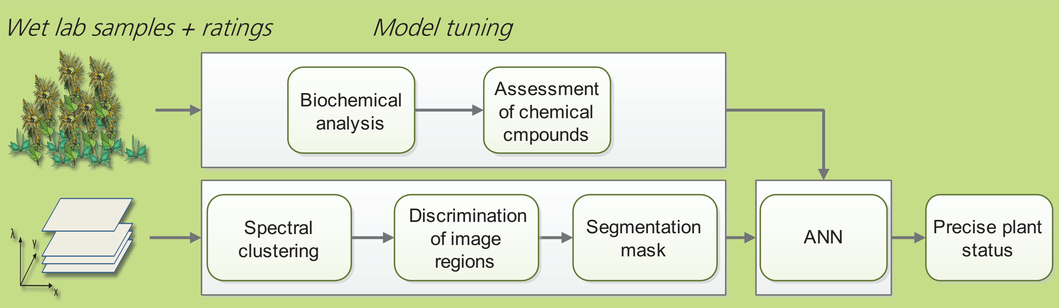
HEB-25 field trials started in 2016 with two nitrogen fertilization treatments and were re-designed to a fungicide treatment experiment in 2017 and 2018 in Halle, while nitrogen was continuously tested in Merbitz. **Hyperspectral imaging** (288 channels, spectral range 950-2500 nm) with the Agrover was conducted in all locations at the time points A-D (A=shooting, B=heading, C=grain filling, D=maturity) in an interval of approximately two weeks. Of all samples, ten percent were scanned for nutrients and phenylpropanoids in the wet lab. Considering traits, vegetation cover, chlorophyll content, plant height and yield were of particular interest.

DRONE TRIALS 2019 – 2020

In the upcoming season, drone flights will complement the data acquisition. Through an array of six **multispectral cameras** (spectral range 400-950 nm) and an additional **thermal sensor** (7-13 µm), the higher temporal resolution compensates a lower spectral resolution. Selected vegetation indices (REP, NDVI, WI) will help determine plant features and agronomic traits. Test flights performed successfully already.

MODELING WORKFLOW

Learning patterns for characterizing data means using modeling approaches, in this case Artificial Neural Networks (ANN). First, input image regions were discriminated on similar spectral properties between plant and weed, and plant and non-plant regions. Similar spectra based on a prototype spectrum were rearranged in a cluster to represent an image mask for further optimization and morphological treatment. Grain ears were segmented out. Relevant information was then extracted from the leaf area. Future works should boost classification results with the introduction of proper normalization methods by removing uninformative variability in the measured plant spectra caused by plant geometry, alignment of plant, and illumination.



RESULTS

	R^2 HALLE KUEHNFELD, A-D		
Nutrient	**2016**	**2017**	**2016+2017**
K	0.74	0.90	0.86
N	0.86	0.33	0.85
S	0.71	0.82	0.77
P	0.67	0.68	0.69
Mg	0.61	0.65	0.67
B	0.50	0.74	0.67
Ca	0.57	0.65	0.58

Performance values of best models for prediction of macro- and micronutrients (location Halle). Imaging was performed at the time A, B, C and D.

	R^2 MERBITZ, A-D		
Nutrient	**2016**	**2017**	**2016+2017**
K	0.83	0.94	0.90
N	0.29	N/A	N/A
S	0.14	0.74	0.59
P	0.19	0.90	0.82
Mg	0.78	0.67	0.72
B	0.86	0.55	0.72
Ca	0.82	0.66	0.74

Performance of best models for prediction of macro- and micronutrients (location Merbitz). Imaging was performed at the time A, B, C and D.

	R^2 HALLE+MERBITZ, A-D		
Nutrient	**2016**	**2017**	**2016+2017**
K	0.71	0.90	0.83
N	0.63	N/A	N/A
S	0.60	0.78	0.69
P	0.63	0.74	0.68
Mg	0.66	0.65	0.65
B	0.56	0.68	0.55
Ca	0.62	0.61	0.56

Performance of best models for prediction of macro- and micronutrients. Data for the location Merbitz and Halle was pooled for all points of time.

	R^2 HALLE 2018, A-C		
Trait	**2018 A**	**2018 B**	**2018 C**
Shooting	0.76	0.68	0.64
Heading	0.76	0.75	0.71
Maturity	0.60	0.63	0.64

Performance of best models for prediction of plant traits for the location Halle in 2018.

Hyperspectral imaging system "Agrover". The black sunlight-proof box contains both the hyperspectral- and the RGB-camera. QR code and GPS keep track of plant positions.

Additional multispectral drone trials (400-950 nm and thermal 7-13 µm) will take place in 2019.

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