PHENOROB

Rhizotector: *Automatic detection of rhizoctonia crown and root rot affected sugar beet fields from orthorectified UAV images*

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Challenges

Disease

- Caused by the soilborne fungus *Rhizoctonia solani* AG2-2IIIB
- Characterized by permanent wilting and collapse of leaves (Fig. 1)
- Root symptoms dark lesions up to rotted tissue
- Severe yield and quality losses
- Most common approach: development of resistant varieties

Modeling

- Requires large amount of data
- High heterogeneity essential

Breading

- Time and capital -demanding
- Large heterogeneity in scoring

Future Approach

- UAV imagery
- Machine Learning

Fig. 1: Plant affected by Rhizoctonia.

Methods

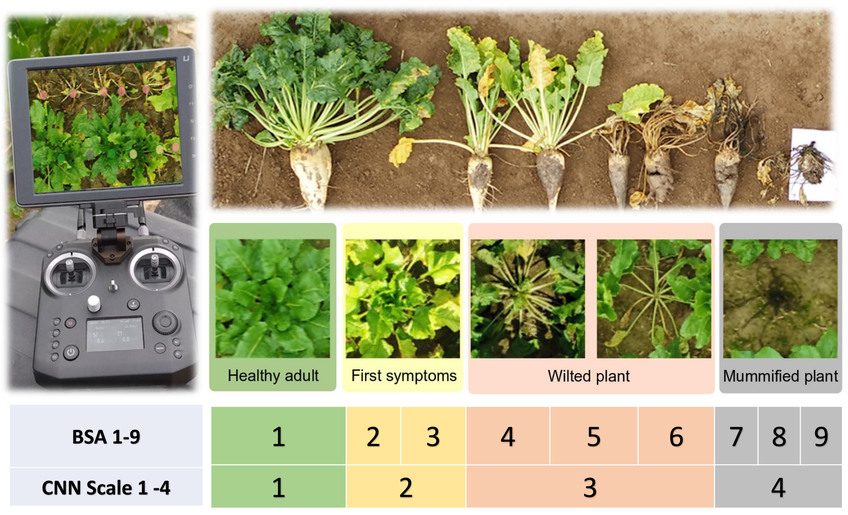

Fig. 2: Comparison of scales used for modeling: Used by the German Federal Plant Variety Office (Büttner et al. 2004, 1 to 9) and Convolutional neural network (CNN) scale (1 to 4)

- Variety trail in the field with artificial inoculation
- RGB and multispectral UAV-imagery
- Plot level scoring based on the scale used by the German Federal Plant Variety Office (BSA) (Fig. 2)
- Plants level geo-referenced scoring (Fig. 2)
- Implementation of the workflow for plant cataloging
- Convolutional neural network (CNN) training to classify individual plants in a scale from 1 to 4
- Automatic machine learning for plots scoring in scale from 1 to 9

Günder et al.: "Agricultural Plant Cataloging and Establishment of a Data Framework from Crop Images."

Ispizua Yamati et al "Sensing the occurrence and dynamics of Cercospora leaf spot disease using UAV-supported image data and deep learning,"

Results

- Classification of individual plants into 4 classes by CNN: High accuracy (>0.93)
- Classification of extreme classes in the plots: High accuracy (Fig. 3)
- Classification of intermediate classes on the BSA scale: Moderate accuracy (Fig. 3)
- Generally: Classification error is between adjacent classes (Fig. 4)

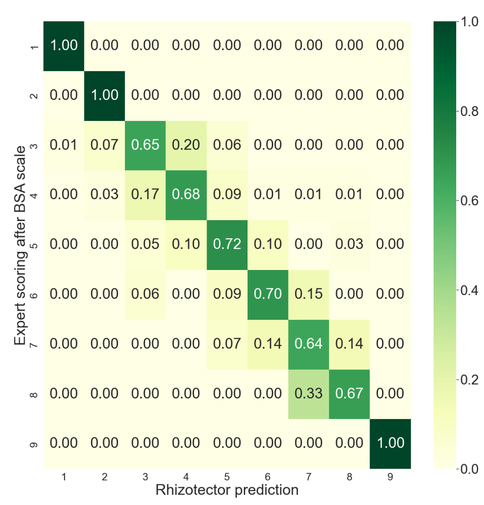

Fig. 3: Confusion matrix of the test data set for the plot classification model according to the BSA scale.

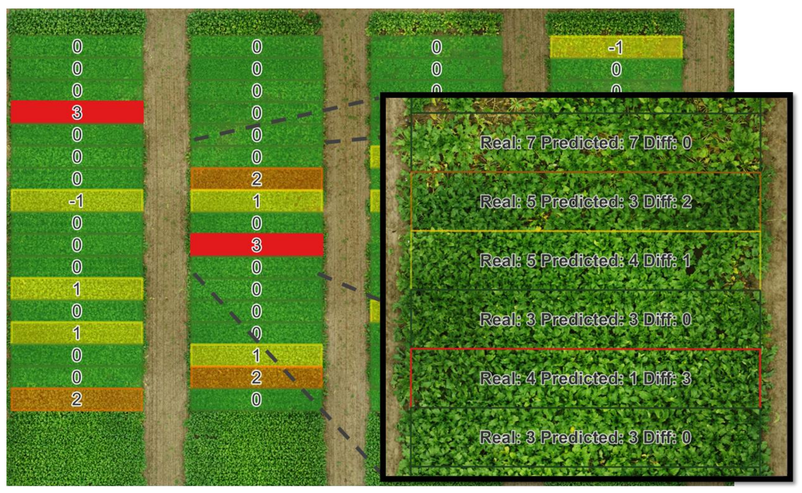

Fig. 4: RGB-image of 08/24/2021 classified and compared with expert data. In red difference of more than 3 classes, orange two classes of difference, yellow one class and green correct prediction.

Conclusions

- **This workflow speeds up the classification process and makes it possible to eliminate bias by generating a standardized classification independent of the expert.**
- **The combination of ML and optical sensors demonstrates the ability to help experts achieve better phenotyping of sugar beet crops.**
- **This work is based only on the use of RGB images, limited to symptoms and visual features, therefore the use of multispectral data could help to overcome the problem of inter-class errors in the future.**

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*BÜTTNER, G. & PFÄHLER, B. & Märländer, Bernward. (2004). Greenhouse and field techniques for testing sugar beet for resistance to Rhizoctonia root and crown rot. Plant Breeding. 123. 158 - 166. 10.1046/j.1439-0523.2003.00967.x.