Master Project Proposal

Tracking Septoria Tritici Blotch epidemics in-field using high throughput phenotyping

Supervision: Prof. Dr. Bruce McDonald, Dr. Jonas Anderegg

Project Context

Septoria Tritici Blotch (STB) caused by the fungal pathogen *Zymoseptoria tritici* is a serious threat to wheat production in Europe. STB affects yield primarily by reducing the photosynthetically active green leaf area (GLA) during grain filling, which directly penalizes grain filling by lowering carbon assimilation [1]. Moreover, affected leaves may be more prone to physiological senescence, which further reduces total assimilation during grain filling [2]–[4].

GLA dynamics are often monitored as a proxy for disease severity using labor-intensive destructive approaches. Unfortunately, different wheat genotypes exhibit significant variation in stay-green properties *per se* [5]. The elusive interaction between disease and physiological senescence further complicates the use of GLA dynamics as a proxy for disease severity [2], [6].

Due to the temporal overlap, distinguishing STB from physiological senescence and quantifying their relative effects on overall GLA dynamics represents an important prerequisite for efficient selection in resistance breeding. This distinction is extremely challenging to achieve using traditional visual inspections of canopies.

Recently, we showed that time-resolved canopy hyperspectral reflectance measurements can be used as an indicator of STB severity even in the presence of variation in stay-green properties [7], [8]. This suggested that such information may be useful for distinguishing physiological senescence from GLA loss attributable to diseases. However, the method was tested in a single year and location and requires validation in a broader context. Furthermore, hyperspectral reflectance measurements are point measurements, and as such cannot account for structural changes occurring in canopies during the measurement period. Therefore, such data should be combined with image data that can reveal such changes.

Project aims

This project will explore the potential of tracking the development of STB epidemics and distinguish STB from physiological senescence using repeated sensor measurements (spectral reflectance and RGB imagery). Different features will be extracted from spectral and image data and correlated with reference measurements of disease severity obtained through established methodology [9], [10]. Treatment and cultivar effects will be investigated through ANOVA.

Student's tasks

- Collaboration on acquisition of spectral, image and ground truth data sets during grain filling (field experiment in Eschikon)
- Analysis and visualization of hyperspectral data
- Analysis of variance

Requirements

- Willingness to perform field work (priority during a period of approximately 6-8 weeks)
- Programming skills (R or Python) or strong interest to obtain these

Practical information

- Starting date: ideally no later than 1 June 2022. A later starting date may be possible.
- Duration: 3-6 months
- Location: Lindau, Eschikon (June & July); ETH Zentrum or at distance for the remainder of the project duration

References

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[10] P. Karisto *et al.*, "Ranking Quantitative Resistance to Septoria tritici Blotch in Elite Wheat Cultivars Using Automated Image Analysis," *Phytopathology*, vol. 108, no. 5, pp. 568–581, 2018, doi: 10.1094/PHYTO-04-17-0163-R.