PROJECT TITLE

Analyses of the influence of leaf rust (Puccinia triticina Erikss.) on carbohydrate and antioxidant metabolism and phytohormones of wheat by combining multispectral imaging with physiological phenotyping

CONSORTIUM

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SUMMARY OF THE REPORT

Wheat may be attacked by a large number of diseases and pests, but some have global distribution, such as leaf rust (*Puccinia triticina* Erikss.). Leaf rust, has a great economic impact on the cereal industry due to reduction in the yield and end-use quality of wheat genotypes. Each year, across Europe, severe epidemics of wheat leaf rust in combination with yellow rust occurred and there was a significant yield loss in susceptible wheat genotypes, when rusts were responsible for 40-50% yield loss. Epidemic conditions of leaf rust can occur early in the growth season on the leaves or later on the spikes (high humidity and temperatures 15°C to maximum 23°C) which can lead to severe outbreaks.

The best approach to control leaf rust is to use the least susceptible wheat varieties with effective resistance genes which is the most environmentally and economically efficient approach. Under pathogen infestation, plants activate numerous specific mechanisms that partially restrict pathogen extracellular and intracellular growth and penetration. In the early stage of plant-pathogen interaction, plant produces excessive concentration of reactive oxygen species (ROS), like H_2O_2, superoxide ($O_2^{\cdot-}$) and hydroxyl ($OH^{\cdot}$) radicals, that can cause irreversible changes in the cell like unspecific oxidation of proteins and/or nucleic acids and membrane lipids degradation resulting in loss of physiological functions. The purpose of this project is to find the wheat genotypes that have a certain level of resistance to leaf rust infections by linking physiological and the optical scales in a high-throughput approach using multispectral imaging at the early stage of infection. In general, we want to check with high-throughput technique with controlled environment if this will lead to effective and efficient screening of wheat-leaf rust interactions.

Multispectral imaging is a powerful non-destructive tool for detection of early disease changes in chlorophyll fluorescence which should be quite interesting in the point of photosynthesis view which plays an important role in modern winter wheat varieties. In addition, the activity of antioxidant metabolism enzymes (superoxide dismutase, catalase, peroxidase, ascorbate peroxidase, dehydroascorbate reductase, monodehydroascorbate reductase, glutathione reductase, glutathione, S-transferase and apoplastic peroxidase) with kinetic enzyme activity assays, antioxidant potential and compounds, and lipid peroxidation in a 96-well microtiter plate was measured. There are not many studies on comparing of antioxidative enzymes in susceptible and resistant wheat varieties upon the inoculation with leaf rust, so therefore multispectral imaging and the activity of antioxidant metabolism enzymes are of great value for this research.