Master Intership Topic

Modelling and methodological development to analyse the effects of brown rust on wheat physiology and yield under water deficit conditions

Rusts are major wheat diseases which are mainly controlled by the use of resistant varieties and fungicides. However, breakdown of the deployed resistances can cause significant yield losses. Infections by wheat rust pathogens (brown rust, yellow rust, black rust) lead to the formation of pustules, which cause cuticle breach leading to increased transpiration. The effect of diseases on transpiration is poorly documented in the literature (Grimmer et al., 2012). Under water deficit conditions, infected wheat plants are likely to be considerably more vulnerable. Such conditions are increasingly encountered in Europe, and are expected to increase, as a result of climate change.
Two damage mechanisms (i.e. effects on plant physiological processes) are conventionally associated with rust: a reduction in photosynthetic surface area (on leaf surfaces occupied by pustules), and a transfer of carbohydrates for the production of fungal biomass (spores). These mechanisms are included in a process-based, agrophysiological model, WHEATPEST (Willocquet et al., 2008; 2018), which simulates the effects of diseases, pests and weeds on the physiology and yield of a wheat crop. A third mechanism of damage, increased transpiration, is important to consider, especially when the wheat crop is exposed to drought stress.

Objectives and environment of the internship

The objectives of the internship are:
(1) to include the effects of water deficit on the physiological processes of a wheat crop in the WHEATPEST model;
(2) to include the damage mechanism constituted by the effect of rust on cuticular transpiration (MC mechanism) as a function of the level of water deficit;
(3) the development of an experimental protocol to parameterise the model for the MC mechanism in the case of wheat brown rust, caused by *Puccinia triticina*;
(4) the implementation of an experiment on potted plants defined in the previous step.

Internship activities will include:
- acquiring knowledge and use of the WHEATPEST model and a literature review (concepts, approaches);
- modelling the effects of water deficit in the WHEATPEST model;
- modelling the effects of brown rust in water deficit conditions;
- definition, implementation and realisation of experiments on whole plants in pots;
- simulation of yield losses caused by brown rust as a function of the level of water deficit.

The internship will be supervised by L Willocquet, in a team with scientists working in the fields of plant epidemiology and plant physiology with experience in modelling and experimental approaches that will be implemented during the internship.

Desired skills

- Basic knowledge of plant pathology/plant health;
- Basic knowledge of plant physiology;
- Interest in modelling approaches;
- Interest in experimentation on plant material;
- Ability to work in a team;
- English (scientific; articles) read and spoken - intermediate level.

Conditions of the internship

6 months internship at the INRAE Centre of Toulouse-Auzeville, France, in the Research Unit AGIR, VASCO team;
Internship grant of about 600 euros per month.

Prospects after the internship

A 1-year contract (funding acquired) on a theme related to the internship topic: modelling of epidemics and crop losses caused by rusts and septoria in wheat; effects of varietal resistance.

A phD thesis funding is currently being actively sought on the theme: "Analysis of the effects of rusts on the physiology and yield of wheat under water deficit conditions". The proposed internship is a preliminary step to the planned thesis work.

The Master student will be able to apply for either of these positions.

Contact

Laetitia Willocquet INRAE – UMR AGIR
Email: Laetitia.Willocquet@inrae.fr

References

Grimmer, M. K., John Foulkes, M., Paveley, N. D. 2012. Foliar pathogenesis and plant water relations: a review. J. Exper. Bot. 63: 4321-4331.

Willocquet L, Aubertot JN, Lebard S, Robert C, Lannou C, Savary S, 2008. Simulating multiple pest damage in varying winter wheat production situations. Field Crop Res. 107: 12-28.

Willocquet, L., Félix, I., de Vallavieille-Pope, C., Savary, S. 2018. Reverse modelling to estimate yield losses caused by crop diseases. Plant Pathol. 67: 1669–1679.