Master projects on red clover

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Red clover is an important species in agriculture in northern areas of the world. It produces forage of high quantity and quality, it is capable of fixing atmospheric nitrogen and thereby eliminating or reducing the need for artificial fertilizer, and its deep root system improves soil structure. However, although red clover is a perennial species, it tends to disappear from sown perennial grasslands after just a few years. Improving plant persistence is an important goal in breeding of new red clover cultivars.

A. Interactions between infection with *Sclerotinia trifoliorum* and abiotic stresses in red clover

Limited resistance to infection by the clover rot fungus, *Sclerotinia trifoliorum*, is thought to be one of the reasons for low persistence of red clover. In general, there is too little knowledge about the interaction of different stresses, this is one of the reasons why it is difficult to predict effects of climate change on plants. In this master project you will find out something about the interaction of different winter stresses on winter survival of red clover. The project is linked to the EU project EUCLEG (https://www.nmbu.no/en/projects/node/30452).

You will do experiments to characterize the resistance to *S. trifoliorum* in some Nordic or wider European red clover material. You will also study the effects that abiotic stress has on resistance. Does mild cold stress and cold acclimation induce resistance? If yes, is this induction dependent on light? Does freeze stress prior to infection enhance or reduce resistance? Or are infected plants more or less freezing tolerant than non-infected plants?

B. Variation in freezing tolerance in European germplasm of red clover

Limited tolerance to freezing is thought to be one of the reasons for low persistence of red clover. This master project is linked to the EU project EUCLEG (https://www.nmbu.no/en/projects/node/30452). You will do some of the following:

- Do experiments to characterize the freezing tolerance (LT50) of a wide variety of European red clover material. How much variation is there between populations, and are there any geographical or environmental patterns?
- Characterize variation in putatively associated traits (growth response to low temperature, photosynthetic response to low temperature, plant size).
- Test if results from a standardized, “high throughput” freezing tolerance screening method of young plants correlates with results from screening of older plants, or screening of plants grown under different conditions. I.e. how robust is the “high throughput” screening method?

C. Cold acclimation and de-acclimation in red clover

Temperate plants develop freezing tolerance during the cold acclimation process in autumn, a process closely linked with cessation of leaf growth. These processes are regulated by temperature and photoperiod. Other factors, such as irradiance, nutrient status and defoliation, also play a role. In early spring, a reverse process occurs – deacclimation. Deacclimation is also regulated by temperature and affected by photoperiod, but is a much less studied process than cold acclimation. Variation in temperature and photoperiod responses are of importance for adaptation of plants to different latitudes and altitudes, and to the future climate (increased temperature but no change in photoperiod).

In this master project you will characterize the cold acclimation and deacclimation response of Nordic red clover material to some of these factors, using experiments under controlled conditions.

D. Characterization and validation of candidate genes for earliness and persistence in red clover

In previous studies we have identified candidate loci and genes for earliness of stem elongation (the initial stage of flowering) and for persistence (possibly related to winter survival ability) in red clover. These are agronomically important characters. In this master project you will investigate some of these candidate genes: verify the association between allelic variation and phenotype, and characterize how gene expression varies between genotypes and is affected by environmental conditions (temperature and photoperiod). You will mainly work in the lab, but also do some work in the greenhouse.