Master thesis: Photosynthesis and nitrogen fixation in pea mixtures

Peas (*Pisum sativum* L.) emerge as a major source of plant protein for alternative meat production. Several pea genotypes are registered as varieties but lack description of agronomic and quality traits. To improve the agronomic performance of peas, intercropping with lentils (*Lens culinaris*) or barley (*Hordeum vulgare*) is a promising approach. Often partners in mixtures are benefiting from each other, especially between nitrogen fixing legumes and non-legumes. Legumes grown in mixtures usually derive a greater proportion of nitrogen (N) from the atmosphere than when grown alone. Last year we observed also different photosynthetic performance between the two systems – in the context of a small multi-species field trial (https://www.fibl.org/en/themes/projectdatabase/projectitem/project/1743) that will be replicated this year in Eschikon.

Photosynthesis is the basis of plant growth and a promising target to improve yield. Photosynthesis reacts highly dynamic to changes of the environment and requires close monitoring. Chlorophyll fluorescence, which is produced by light absorbance of the plant can be used to quickly estimate photosynthesis. Photosynthesis is dependent on light intensity, temperature, soil moisture and humidity and therefore indicates stress tolerance to the actual growth conditions. Furthermore, photosynthetic traits, such as photosynthetic quantum efficiency and CO_2 assimilation, were successfully linked to biomass production. However, photosynthetic traits to improve yield and yield stability have been exploited only to a minor extent, especially in legumes, which can use photosynthates for biological N fixation.

In this project, photosynthesis and N fixation of pure stands of several pea varieties and of species mixtures will be compared. Photosynthetic quantum efficiency will be assessed by top of canopy leaf measurements using the MultispeQ device. Measurements will be carried out under various environmental conditions during the growing season. In addition, the soil mineral N content will be determined. The proportion of fixed N in legumes will be assessed by the ^{15}N isotope natural abundance and amounts of N fixed will be derived considering the legume N yield.

The following **research questions** are to be answered:

- Does N uptake and photosynthesis differ between peas in pure stands and mixtures? Is there a correlation between high photosynthesis and high N fixation in plant stands?
- Is the N fixation higher in peas grown together with barley than when grown alone?
- Which strategy maximizes nitrogen fixation and (protein) yield while minimizing the use of mineral fertilizer and land?

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Location of field trials: Eschikon **Ideal thesis start:** April 2023

Literature:

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Kuhlgert, S., Austic, G., Zegarac, R., Osei-Bonsu, I., Hoh, D., Chilvers, M. I., ... & Kramer, D. M. (2016). MultispeQ Beta: a tool for large-scale plant phenotyping connected to the open PhotosynQ network. *Royal Society Open Science*, *3*(10), 160592.
Serraj, Rachid, Thomas R. Sinclair, and Larry C. Purcell. "Symbiotic N2 fixation response to drought." *Journal of Experimental Botany* 50.331 (1999): 143-155.

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