Can wheat roots improve soil health and reduce fertilizer requirement?

A new research project seeks to optimize soil-microbe-plant interactions

Humanity is reliant on healthy and fertile agricultural soils, for improved crop production, to provide food and nutrition to support the increasing population. One of the candidate crops to provide food and nutrition is wheat, which is high yielding with gluten protein fractions, essential amino acids, minerals, vitamins, and beneficial phytochemicals. Wheat ranks as the second most important cereal crop, following maize in terms of production and area under cultivation. Globally, wheat is cultivated on approximately 220 million hectares of agricultural land.

In South Africa approximately 533 000 ha is utilized for wheat production. To ensure that the global calorie requirement is met, wheat production is required to increase by 11% until 2026, with a mere 1.8% increase in cultivated land. Hence, optimization of wheat cultivation, in a sustainable manner, is mandatory.

Conventional agricultural practices have promoted the introduction of wheat varieties with selected capabilities, such as tolerance to abiotic and biotic stresses, improved yield and better nutrient use efficiency in an attempt to optimize wheat cultivation. However, yield increase has also been supported by the use of copious amounts of chemical fertilizers, herbicides and pesticides, which are hazardous to the environment. An environmentally friendly alternative to sustainably improve wheat yields is to promote beneficial soil microbes that are associated with the plants. Traits related to wheat roots are linked to their architecture and the release of root exudates, which in turn aid in shaping the soil and its associated microbiome. This influences both soil properties and the functionality of soil microbes that are associated with soil structure, biodiversity and nutrient availability to the plants, which greatly influence overall soil health.

> Optimizing soil-microbe-plant interactions will not only increase crop yields but also improve the sustainability of the cultivation process

Modern wheat cultivars have resulted from intensive breeding programmes which favoured mostly above-ground traits such as higher yield and nutrition, with minimal focus on the root zone and soil health. This has resulted in an urgent need for the identification of below-ground traits that can improve and support soil health and important ecosystem functions, including nutrient cycling, for optimal nutrient utilization. The soil-microbe-plant interactions play an integral role in soil health status; therefore, optimizing these interactions will not only increase crop yields but also improve the sustainability of the cultivation process.

In order to address the soil-microbe-plant interactions, a project titled "Tuning the wheat root microbiome to improve soil health and optimize rhizosphere nitrogen cycling and availability (WISH-ROOTS)" was initiated. The aim of the project is the restoration and preservation of soil health through wheat root traits. The project is funded by the European Joint Programme Soil ERA-NET (HORIZON 2020) and the New Zealand Government to support the objectives of the Global Research Alliance on Agricultural Greenhouse Gases. The Agricultural Research Council (ARC) in South Africa is part of a research consortium in collaboration with partners in the United Kingdom, Italy, South Africa, China, Germany, Belgium and Spain (Figure 1).

All WISH-ROOTS project partners will be growing 20 landrace cultivars of both bread and durum wheat on fields in their respective countries, and evaluating the effect of the different cultivars on soil microbiome dynamics and nitrogen cycling (Figure 2). Overall, the project anticipates to provide advantageous cultivars by reintroducing the positive traits of the landrace, that supports a more sustainable use of land, improving soil microbial biodiversity, nutrient cycling and soil structure.

The results obtained from the South African field trial will provide the only data from the southern hemisphere.

This will not only be invaluable to the project itself, but the results are also envisioned to broaden the scope for wheat cultivation in South Africa, in a sustainable manner. The knowledge exchange across partners, with specialists such as soil scientists, plant scientists and soil microbiologists in collaboration is key to the success of the WISH-ROOTS project. The ARC will also benefit substantially in terms of access to unique materials like the wheat germplasms from John Innes Centre (JIC) and University of Bologna (UniBo). ■

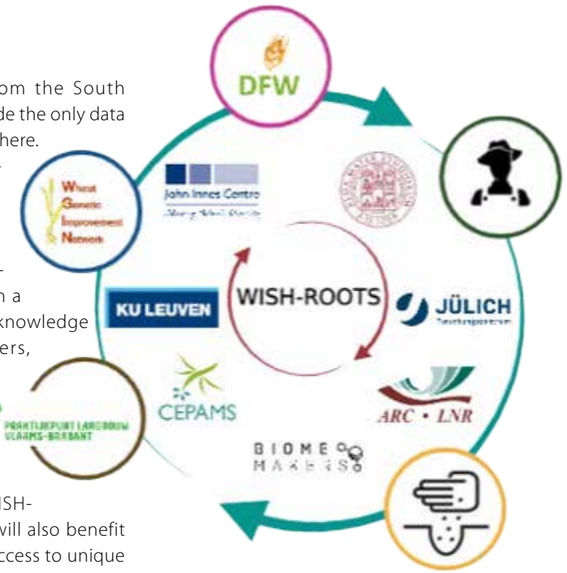

Figure 1: WISH-ROOTS project partners and selected stakeholders. (Figures have been created with BioRender.com)

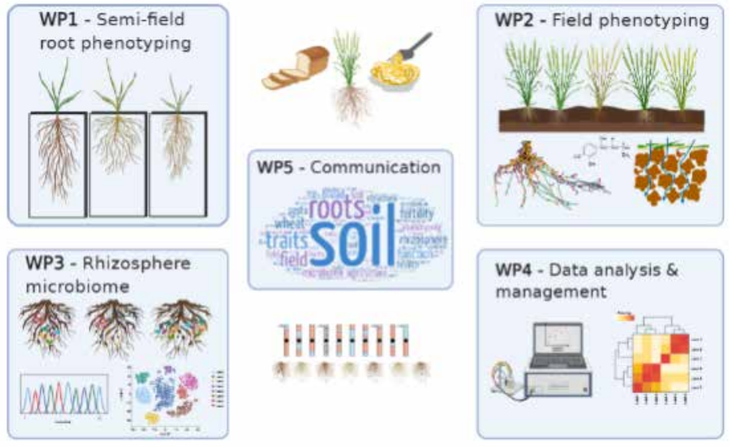

Figure 2: The WISH-ROOTS approach. Root traits with potential to improve soil health markers will be identified in semi-field conditions and tested in field trials. Physical, chemical and ecological parameters will be measured to develop predictive models for soil health and introduce beneficial root traits in wheat agrosystems.

For more information:
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