Wheat commercial varieties: what happens at the rhizosphere level?

T. Bardelli[1], E. Novarina[1], F. Fornasier[2,3], E. Romano[4], P.G. Bianchi[1], A.P.M. Giulini[1]
[1]Research Centre for Plant Protection and Certification, 20133 Milan, Italy
[2]Research Centre for Viticulture and Enology, 34170 Gorizia, Italy
[3]SOLIomics srl, 33100 Udine, Italy
[4]Research Centre for Engineering and Agro-Food Processing, 24047 Treviglio (BG), Italy

Introduction & Objectives

The rhizosphere is a dynamic environment where several actors as root system and microbial community are involved.
In that environment, enzymes are taking part in all biochemical processes, such as nutrient dynamics and in increasing the reaction rate of organic matter decomposition. Due to their stability and sensitivity, soil enzymes are used as indicators of soil functionality and health.
Moreover, it is well known that agrochemical inputs represented by plant growth regulator (PGR) and fungicides affect the soil microbiological parameters and, thus the soil quality.
In this context, the goal of this study is to evaluate changes in soil organic matter content and soil microbiological features as microbial biomass and enzyme activities as a function of the treatment and along commercial bread wheat varieties in different sampling periods.

Field experiment & Soil analyses

The field experimental was set up in North Italy at CREA-DC farm station (Tavazzano con Villavesco) during the VCU (Value for Cultivation and Use) field trial carried out within the InnoVar project.
The experimental set up is characterised by:

3 sampling periods:
November 2022 (at the sowing) as control, to have a «starting point» for all the soil parameters
May 2023 (at the heading grow stage) after the fungicides/PGR application
July 2023 (at the harvesting) to detect the trace of enzymes activities

7 bread wheat varieties:
Susceptible to diseases = Bandera, Aquilante, Tintoretto
Disease-resistant = Skyfall and SY Moisson
Used for organic cultivation = Antille and Bologna

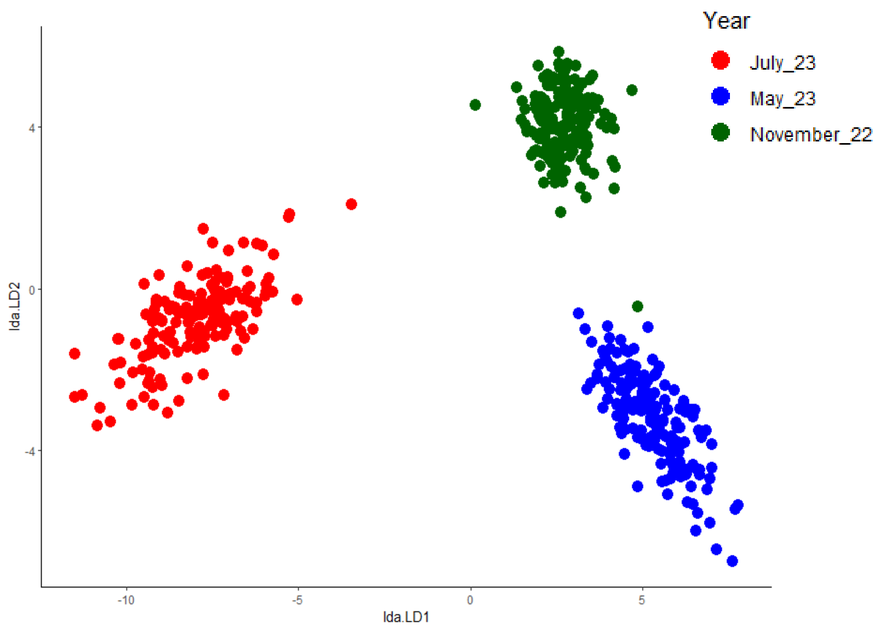
2 treatments:
T: Treated (2 fungicides + PGR)
NT: No Treated (no fungicides and PGR)
All varieties were treated using the same products/doses of fertilizer and herbicides

Soil carrots were taken nearby the plant roots at 10 cm depth

3 periods x 7 varieties x 2 treatments x 3 field replicates x 4 soil random samples:
504 soil samples

Organic matter content | **Microbial biomass** | **Hydrolytic enzymatic activities**

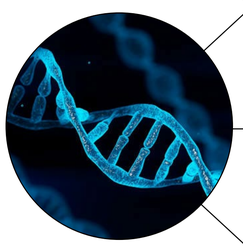
Results



The MANOVA analysis revealed that each period has a remarkable effect on the soil microbial biomass and enzymes activities where three independent clusters are generated (Eta2: 0.94; p-value: < 0.001 ***).
Overall, the specific environmental conditions in each period affect the soil micobiological parameters.

TREATMENT EFFECT

Microbial biomass (as DNA content)



Nov 22 • T = NT
May 23 • **T < NT**
July 23 • T = NT

Soil microbial biomass changed significantly (p-value: 0.05*) only in May 23 recording higher values in no treated plots (NT) compared to treated (T). This was observed in May and not in other periods may be due to the time of fungicides/PGR application.

VARIETY EFFECT in NT				
Bandera *vs.* Sy Moisson				
Cycle	Enzymes	Nov 22	May 23	July 23
C	betaG			
C	xilo			
C	uroni			
N	chit			
N	leu			
P	acP			
P	alkP			
P	bisP			
P	piroP			
P	inositP			
S	aryS			

The Simper analysis showed significant differences (p-value: 0.05*) between Bandera and SY Moisson for the enzymes labeled in green in May and July 23. This variability could be related to the varieties itself and on the period (heading = the microbial processes are pronounced due to the translocation of resources from the root to the ear; harvesting = trace of enzymes dynamics based on the root system.

Remarks

- ✓ Soil microbial biomass was negatively affected by fungicides/PGR application as observed in May 23.
- ✓ The enzymes dynamics in the rhizospere are affected by several factors such as the diversity of plant varieties and their interaction with soil microbes; thus an investigation of soil metabolities and root exudates could shed light on the biological processes.
- ✓ The in-field experiment appoach exhibits several factors as soil type, climate conditions that affect the responses of the microbiological system which cannot be under control as occurs in lab-experiment approach.

References

Fornasier, F., Margon, A., 2007. Bovine serum albumin and Triton X-100 greatily increase phosphomonoesterases and arysulphatase extraction yield from the soil. Soil Biol. Biochem. 39, 2682-2684
Fornasier, F., Ascher, J., Ceccherini, M.T., Tomat, E., Pietramellara, G., 2014. A simplified rapid, low-cost and versatile DNA-based assessment of soil microbial biomass. Ecol. Indic. 45, 75-82
Checcucci, A., Marchetti, M. 2020. The rhizosphere talk show: The rhizobia on stage. Front in Agron. 2, 591494
Bais, H.P., Weir, T.L., Perry, L.G., Gilroy, S., Vivanco, J.M. 2006. The role of root exudates in rhizosphere interactions with plants and other organisms. Annu Rev Plant Biol. 57,233–266
Herms, C.H., Hennessy, R.C., Bak, F., Dresbøll, D.B., Nicolaisen, M.H. 2022. Back to our roots: exploring the role of root morphology as a mediator of beneficial plant-microbe interactions. Environ Microbiol. 8, 3264-3272