M2 INTERNSHIP SUBJECT 6 months

Genotype and environmental (G x E)-driven effects on growth and quality of wheat-coloured genotypes.

**CONTEXT:**

In recent years, the growing demand for wholegrain wheat products with health-promoting bioactive compounds has led to increased research on the composition, distribution, and functionality of phytochemicals within wheat grain tissues (Zhi et al., 2023). Traditional wheat flours, typically derived from red or white grain varieties, result in products with a characteristic amber hue. However, biofortified wheat species, enriched with phytochemicals such as anthocyanins, flavonoids, carotenoids, and phenolic compounds, not only produce more visually striking grains but also offer enhanced antioxidant activity and potential health benefits across a wide range of metabolic disorders (Gupta et al., 2021). Pigmented wheat varieties, for instance, are particularly notable for their higher levels of carotenoids in the endosperm, as seen in yellow wheat, or elevated anthocyanin content in the outer grain layers. Purple wheat concentrates anthocyanins in the pericarp, blue wheat in the aleurone layer, and black wheat in both structures. The concentration and distribution of these phytochemicals, however, are not uniform but are influenced by factors such as wheat genotype, environmental conditions, and farming practices (Tian et al., 2022). Moreover, there is growing evidence that pigmented wheat varieties may exhibit greater tolerance to abiotic stresses, though their potential - particularly to drought and high salinity conditions - remains underexplored (Kaur et al., 2023). Considering the growing challenges posed by climate change and diminishing resources, especially in Mediterranean regions and similar climates, it is essential to deepen our understanding of the mechanisms underlying stress resilience in wheat. Additionally, evaluating how key quality attributes fluctuate from year to year within the same location is critical for understanding the impact of environmental variability and long-term consistency on grain quality. Such insights could drive the development of advanced breeding programs aimed at creating more sustainable, nutritious, and resilient wheat varieties, rich in bioactive compounds, while contributing to healthier diets and more adaptive agricultural systems.

**OBJECTIVES**:

(1) Unravel how drought stress and high salinity interact with different genotypes and affect plant growth and kernel quality in pigmented wheat genotypes grown under controlled conditions; (2) Access the nutritional and phytochemical profile of wheat grains of different colour and genetic background over a 4-year period of open-field trials conducted in Czech Republic between 2021 and 2024.

**METHODS**:

*Climate change resilience assessment -* Two pot trials will be taking place in parallel, to test wheat tolerance to drought and to high salinity stresses. To evaluate tolerance to drought, five wheat varieties (including one yellow, purple, blue and dark-coloured genotypes plus one control) will be subjected to three experimental conditions: 75% (control), 50% (moderate water deficit) and 25% (severe water deficit) field capacity. Regarding the salinity stress, this will be achieved by adding NaCl solution prepared with distilled water to the substrate mixture two weeks after sowing. Four levels of electrical conductivity will be applied to the studied genotypes: 0 (control; without NaCl), 4, 8 and 12 dSm-1. Pots will be irrigated every week (on average) with the prepared solutions. In both trials, 10 pots per treatment will be used.

*Phenological, agronomic & physiological components* - Dates of heading, anthesis, physiological maturation and grain filling period will be registered according to Zadok’s scale. Yield components (spikes/m2, spikelets/spikes, grains/m2, thousand kernel weight), production estimation, dry matter partitioning (root, shoot, spikelets), harvest index, plant height and biomass at physiological maturity will be also evaluated.

*Nutritional characterization & metabolomic profiling* - The nutritional composition of wholegrain flours will be based on protein, lipids, ash, carbohydrates (calculated by difference), and total minerals contents, according with AOAC official procedures. Free metabolites, including phenolics, anthocyanins and carotenoids, on the other hand, will be extracted and profiled by LC-DAD-MS/MS. MS/MS data will be processed by Compound Discoverer software package (v. 3.3.1.111), using online databases, in-house-built libraries, and fragmentation prediction tools. Within the first months of pot trials, a comparative assessment of wheat varieties grown in Czech Republic through a four-year open-field trial will be taking place, thus ensuring the student's familiarity with previous methods while allowing objective (2) to be successfully accomplished.

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**KEYWORDS:** Biofortified wheat, Phytochemicals, Pigmented wheat varieties, Stress resilience, Sustainable agriculture

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