The silent battle: How crops survive in changing climate chaos

Since childhood, I have been fascinated by a simple yet profound question: Why do some plants thrive in harsh environments while others struggle to survive? Unlike animals, plants are rooted in place, unable to escape drought, heatwaves, or attacks from pests. This makes them one of the most vulnerable organisms in a rapidly changing climate. With rising global temperatures and unpredictable rainfall patterns, crops face increasing threats from seasonal droughts and extreme heat. These stressors are among the biggest challenges to global food production, causing devastating yield losses. Traditionally, scientists have studied drought and heat stress individually, examining how plants respond to each stress in isolation. However, real-world conditions are far more complex. Crops in the field rarely face just one type of stress at a time. More often, they experience multiple overlapping stresses, such as drought and heat occurring together, which can cause even greater damage than either stress alone. Despite the importance of these combined stress conditions, research on how plants handle multiple threats remains limited. We still do not fully understand how different stresses interact or how plants prioritize their survival strategies when faced with competing challenges.

This raises several fascinating questions. If a plant experiences drought, does it become more resilient to future stresses, or does it become more vulnerable to diseases? Do plants use the same survival mechanisms for different types of stress, or do they activate unique genetic pathways for each challenge? Can we "train" crops to better withstand multiple environmental threats, helping them survive in an increasingly unpredictable climate? These are some of the big questions in plant science today, and surprisingly, our understanding of these interactions is still in its early stages. Finding answers to these questions is essential for developing climate-resilient crops that can sustain food production despite mounting environmental pressures.

To tackle these questions, my research focuses on an underexplored cereal crop: oats (*Avena sativa*). Oats are nutritionally rich and economically valuable, yet little is known about how they cope with environmental stress. In the first part of my lecture, I will present a series of experiments examining oat plants at both the seedling and reproductive stages under drought, heat, and their combined effects. Using high-throughput phenotyping and omics technologies, we are dissecting the physiological, biochemical, and molecular responses that allow some plants to survive while others fail. Understanding these responses will help identify key traits that contribute to stress tolerance, which could be used to develop more resilient crop varieties. Beyond stress tolerance, another major challenge in agriculture is seed aging and vigour, a problem that directly affects crop establishment and yield. In the second part of my lecture, I will share a few findings from a recent study on oat seed aging, shedding light on possible factors that influence seed longevity and performance.

In the end, I will outline my future research directions, which will likely lead to a better understanding of the complex interplay of the signalling mechanism and hormonal dynamics during abiotic–abiotic and abiotic–biotic stress conditions. This will likely pave the way for developing more resilient crops with field-level stress tolerance.