Understanding and improving the hailstorm resistance of crop plants

Supervisory team:
Main supervisor: Dr Ulrike Bauer (University of Exeter)
Second supervisor: Dr Michael Deeks (University of Exeter)
Prof Marc Holderied (University of Bristol), Dr Sareh Rowlands (University of Exeter), Dr Dominic Farris (University of Exeter)

Collaborators: Dr Lidia Badarnah (University of the West of England; UWE)

Host institution: University of Exeter (Streatham)

Project description:
In times of changing climate, hailstorms are increasing in frequency and intensity. Climate models predict up to 50% more hail-induced damage by 2050. Hailstorms can cause considerable yield losses; however, not all plants are equally affected. Identifying and understanding the adaptations that enable some plants to survive hail impacts relatively unscathed will be key to breeding crops that are fit for the future. Past research has focused on field-scale assessments of damage only. This PhD project will investigate the interaction of hail impacts with plants at the individual organism level. The student will (1) characterise the mechanical properties of leaves and stems, as well as their kinematic and physiological responses to simulated hail impacts, (2) establish a framework for objectively assessing and quantifying impact-induced damage, and (3) investigate the influence of weather preceding a hailstorm on the likelihood and severity of damage, with the aim to identify leaf traits and growth conditions that confer increased damage resistance during extreme weather events.

The project builds on previous projects in the main supervisor's lab and benefits from a custom-built and extensively tested hail simulation setup, as well as the availability of four brand new, fully controllable weather simulation units at Exeter University. The student will be based in a lab with two decades of experience of studying the biomechanical adaptations of plants to deal with physical challenges in their natural environment. An interdisciplinary supervisor team of ecologists, biomechanists, molecular biologists and computer scientists offers the opportunity to receive training in a diversity of methods from 3D motion capture and AI-guided video analysis to state-of-the-art bioimaging techniques, physiological measurements, and quantification of molecular responses to hail impacts. The project would equally suit a student from a biology, physics or engineering background, and it is flexible to accommodate individual interests and strengths within the overall scope.

Understanding the physiological costs of hail impacts and the biomechanical underpinnings of hail resistance in plants will not only help to inform crop breeders of traits to select for in order to produce more resilient crop plants, but also provide inspiration for architects and engineers aiming to construct buildings that are better equipped to withstand hailstorms and other extreme weather events. Understanding how the prevailing weather and microclimate influence the susceptibility of plant to hail damage will further help farmers to optimise growth conditions and identify time windows of increased damage risk in crop life cycles.

Our aim as the SWBio DTP is to support students from a range of backgrounds and circumstances. Where needed, we will work with you to take into consideration reasonable project adaptations (for example to support caring responsibilities, disabilities, other significant personal circumstances) as well as flexible working and part-time study requests, to enable greater access to a PhD. All our supervisors support us with this aim, so please feel comfortable in discussing further with the listed PhD project supervisor to see what is feasible.