Insights from the VI Symposium on Physiology and Breeding of Cereals (SEFIMEC VI): Advancing Oat Research for a Resilient Future

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The recent VI Symposium on Physiology and Breeding of Cereals (SEFIMEC VI), supported by the Spanish Network on Resilient Cereals (CERES, RED2022-134922-T), brought to light a wealth of groundbreaking research that underscores the critical role of cereals (and, in particular, oats) in addressing agricultural challenges. Our group, from the Cereal Resilience Lab in Spain (CSIC), presented a series of works ranging from enhancing disease resistance to improving drought tolerance and climate adaptability. These studies highlight the importance of interdisciplinary approaches to oat research. The findings presented demonstrate the potential for oats to play a pivotal role in sustainable agriculture, food security, and human health.

Tackling Powdery Mildew Resistance Costs. Understanding the molecular basis of powdery mildew resistance (*Blumeria graminis* f. sp. *avenae*) has long been a challenge for oat breeders. We observed that many resistant genotypes have stomatal and photosynthetic dysfunctions that activate chlorophyll degradation pathways, leading to decreased chlorophyll a and b levels and accelerated leaf senescence. However, genotypes with particular genetic backgrounds avoided these physiological trade-offs, maintaining photosynthetic efficiency. These findings not only shed light on the intricate balance between resistance and productivity, but also provide a pathway for breeding oat varieties that combine robust disease resistance with minimal physiological penalties.

Avenanthramides: Multifunctional Defender. Avenanthramides, unique polyphenolic compounds in oats, are promising contributors to disease resistance. Known for their antioxidant and anti-inflammatory properties, avenanthramides were shown to correlate with resistance levels against powdery mildew. Elevated avenanthramide concentrations in resistant genotypes and successful pharmacological application in susceptible varieties highlight their potential as a natural defense mechanism. This research paves the way for leveraging avenanthramides in breeding programs, aiming to enhance disease resilience while simultaneously boosting the health benefits of oats for human consumption.

Addressing Drought Stress with Phytoglobins. The role of nitric oxide (NO) and phytoglobins in mediating drought stress responses was another significant highlight presented at the symposium by our group. Research comparing drought-resistant and susceptible oat cultivars revealed that higher phytoglobin expression in resistant genotypes reduced NO-induced oxidative stress, thereby mitigating cellular damage. This finding establishes phytoglobins as key regulators of stress tolerance and opens new avenues for breeding drought-resilient oats. By targeting NO-scavenging mechanisms, breeders can develop varieties better suited to increasingly arid environments.

Adapting Oats to Climate Change. As climate change reshapes agricultural landscapes, understanding the genetic basis of oat adaptation becomes crucial. Through a landscape genomic study, we are studying the utility of a Mediterranean oat landrace collection in identifying genetic markers linked to environmental adaptation. By uncovering genomic regions associated with traits like temperature, precipitation, radiation, etc., this research provides a foundation for developing oat varieties that thrive under diverse and challenging agroclimatic conditions. This work emphasizes the importance of preserving genetic diversity and leveraging it to address future climate uncertainties.

Combating Crown Rust. Crown rust (*Puccinia coronata* f. sp. *avenae*) remains a significant threat to oat yields, particularly in the Mediterranean region. In this work, we identified durable resistance sources and unveiled molecular mechanisms underpinning resistance, including basal resistance, hypersensitive responses, and post-haustorial defenses. Further, genome-wide association studies pinpointed markers linked to key resistance candidate genes, offering breeders targets to develop rust-resistant varieties. This research exemplifies the importance of integrating field evaluations, histological analyses, and genomic tools to tackle evolving pathogen challenges.

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