Abstract

This thesis examines physiological, structural, and biochemical leaf traits in grasses (Poaceae family) and how they contribute to oxidative stress protection. Light is a major factor contributing both to oxidative stress in plants and the induction of protective mechanisms at the leaf level. The agriculturally important species barley (*Hordeum vulgare*) was used to investigate responses to varying irradiance and atmospheric CO_2 levels. Barley was further used as a model organism to study the influence of different spectral qualities on oxidative protective mechanisms, particularly phenolic compound induction. This thesis also examines the protective leaf functional traits of wild grass species (*Nardus stricta, Calamagrostis villosa, Molinia caerulea,* and *Deschampsia cespitosa*) in a high-irradiance arctic-alpine tundra grassland.

Phenolic compounds are important protective secondary metabolites in plants that protect against oxidative stress from high irradiance. This thesis evaluates phenolic compounds and their contributions to plant stress tolerance and introduces a novel method of quantifying the histochemical detection of phenolics in leaf cross-sections. Key results indicate that light quantity and quality play major influential roles in the accumulation of phenolic compounds. High irradiance conditions promote high phenolic accumulation — although elevated CO_2 can induce a similar effect. When it comes to inducing phenolic compounds, blue light (400-500 nm) is an essential spectral component (in the absence of UV) for phenolic accumulation, especially protective di-hydroxylated flavonoids. Although often considered aggregately, individual phenolic compounds have varying responses to drivers of oxidative stress and offer varying levels of protection. Thus, addressing phenolic profiles rather than total phenolics can provide useful clues about grass stress tolerance and response mechanisms.

Additionally, plant functional traits, including biochemical profiles, physiology, and morphology, all contribute to the ability of a grass species to endure its environmental conditions. Differences between phenolic profiles and stomatal traits influencing water use efficiency are observed between barley genotypes; and differences in growth strategy, resource utilization, and stress indicators are observed between wild grass species. The adaptive significance of leaf functional traits in Poaceae, such as growth morphology, phenology of pigment accumulation, phenolic profile, and element utilization are discussed in the context of wild grasslands. In the absence of human intervention/grazing, tall grasses (especially with early phenological leaf-out and brad phenolic profiles) have an adaptive advantage that may allow them to spread aggressively (e.g., *C. villosa*). Conservative morphology (e.g., *N. stricta*) reduces the stress experienced by an individual, however, it can be a population-level disadvantage in an increasingly competitive environment. Localized changes can result in microhabitats that favor certain grasses (e.g., *D. cespitosa*) leading to expansion and decline in different areas.