Title : Combines Effects of Drought and Heat Stress on Germination and Early Seedling Growth of Selected Brassicaceae Species

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ABSTRACT

Drought and heat stress frequently occur simultaneously under climate change and pose serious constraints on seed germination and early seedling establishment in crop plants. This study investigated the individual and combined effects of drought and heat stress on germination and early seedling growth of selected Brassicaceae species (P1-P9). Seeds were exposed to drought stress induced by polyethylene glycol (PEG6000) and elevated temperature 35±2 °C, applied individually and in combination. Germination percentage, mean germination time, seedling vigor, root and shoot growth were evaluated. The results showed that both drought and heat stress significantly inhibited germination and seedling growth, with the combined stress exerting more severe negative effects than either stress alone in some species. Among the tested species, differential tolerance was observed, indicating species-specific responses to combined abiotic stress. Multivariate analyses clearly distinguished stress-tolerant and stress-sensitive groups among the tested Brassicaceae species. Pak choy (P1) exhibited the highest integrated tolerance, maintaining root and shoot growth, biomass accumulation, and the greatest Stress Tolerance Index (STI) values under

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drought, heat, and combined stress conditions. Chinese radish (P4), Chinese mustard (P5) and Kale (P6) showed moderate tolerance, particularly under drought stress, indicating adaptive plasticity during early seedling development. In contrast, cabbage (P8), and Water cress (P9) were classified as stress-sensitive, displaying pronounced reductions in root elongation, biomass, and overall vigor, especially under combined heat and drought stress. Overall, the findings highlight that combined drought and heat stress intensifies physiological constraints during early developmental stages and should be considered when screening Brassicaceae species for stress tolerance under future climate scenarios.

Keywords: heat stress, drought stress, brassica, germination, seedling

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