eISSN: 2229-3213 pISSN: 2229-3205
The Journal of Applied Science and Social Science
Volume 16,Issue 05 May, 2026

BIOCHEMICAL ASSESSMENT OF OXIDATIVE STRESS MARKERS IN PLANT CELLS UNDER DROUGHT CONDITIONS

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https://doi.org/10.5281/zenodo.20445829

Abstract

Drought stress is one of the major environmental factors limiting plant growth and productivity. It induces oxidative damage through excessive accumulation of reactive oxygen species in plant tissues. This study analyzes biochemical markers of oxidative stress in plant cells under drought conditions and evaluates the adaptive role of antioxidant enzymes. The findings indicate that drought increases lipid peroxidation and alters the activity of superoxide dismutase, catalase, and peroxidase. Assessment of these markers is important for identifying stress tolerance and improving crop adaptation strategies.

Keywords: oxidative stress, drought, plant cells, antioxidant enzymes, biochemical markers

Introduction

Water deficiency causes profound physiological and biochemical changes in plants. Under drought conditions, stomatal closure limits carbon dioxide uptake, photosynthetic activity decreases, and reactive oxygen species accumulate in chloroplasts, mitochondria, and peroxisomes. Excessive oxidative stress damages cellular membranes, proteins, lipids, and nucleic acids. Antioxidant defense systems are activated to neutralize free radicals and maintain cellular homeostasis. Therefore, biochemical evaluation of oxidative stress markers provides valuable information about plant tolerance mechanisms.

Materials and Methods

The article was prepared as an analytical review of experimental studies on plant oxidative stress. Data related to lipid peroxidation, malondialdehyde content, antioxidant enzyme activity, chlorophyll concentration, and cellular stress responses were analyzed. Comparative evaluation was performed between plants grown under optimal water supply and drought conditions.

Results

The analysis showed that drought stress increased malondialdehyde content and reduced chlorophyll concentration in plant leaves. Antioxidant enzymes showed variable responses depending on plant species and severity of water deficiency. Superoxide dismutase activity increased at early stages of stress, while catalase and peroxidase activity were associated with hydrogen peroxide detoxification. Plants with stronger antioxidant responses demonstrated better growth stability under drought conditions.

Discussion

The results confirm that oxidative stress is a central mechanism of drought-induced cellular damage. Increased lipid peroxidation indicates membrane instability, while elevated antioxidant enzyme activity reflects protective adaptation. Differences between tolerant and sensitive plants may be explained by the efficiency of enzymatic and non-enzymatic antioxidant systems. Understanding these mechanisms may support breeding of drought-resistant crops.

Conclusion

Biochemical markers of oxidative stress are useful indicators of plant responses to drought. Malondialdehyde level, antioxidant enzyme activity, and chlorophyll content can be used to assess stress intensity and tolerance capacity. Strengthening antioxidant defense is an important strategy for improving plant resistance to unfavorable environmental conditions.

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