ALLEVIATING THE ADVERSE EFFECTS OF WATER STRESS IN SWEET MARJORAM (*ORIGANUM MAJORANA* L.) AND SWEET BASIL (*OCIMUM BASILICUM* L.) PLANTS BY EXOGENOUS APPLICATION WITH PLANT GROWTH PROMOTING RHIZOBACTERIA (PGPR) OR PROLINE

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ABSTRACT

The aim of this study was to investigate possibility of overcoming the adverse effects of water deficit stress (٦٠%ETc) by improving growth, anatomical features, water relations, physiological attributes and anti-oxidants defense system of sweet marjoram (*Origanum majorana* L.) and sweet basil (*Ocimum basili*cum L.) plants grown under water stress conditions using exogenous application with plant growth promoting rhizobacteria (PGPR) [١٠^{٥}cfu seed$^{-١}$] as seed soaking application or proline (١mM) as foliar application.

Our results could be summarized as follows:

Expose both sweet marjoram and sweet basil to water deficit stress (٦٠%ETc) led to a significant decrease in all studied growth characters (i.e. plant height, number of branches plant$^{-١}$, number of leaves plant$^{-١}$, leaf area, and root fresh and dry mass plant$^{-١}$). In contrast, PGPR or proline alleviates the harmful effects of water deficit stress and significantly increased the above mentioned characters in both sweet marjoram and basil plants.

Water stress significantly increased essential oil percent and water use efficiency (WUE) in both sweet marjoram and sweet basil plants in comparison to non-water stressed plants, while it significantly decreased oil yield plant$^{-١}$ and shoot fresh and dry weight plant$^{-١}$. Shoot fresh and dry weight plant$^{-١}$, essential oil percent and essential oil yield plant$^{-١}$ were significantly increased by PGPR or proline treatments.

In both sweet marjoram and sweet basil plants, water-stressed plants without PGPR or proline (٦٠%ETc) showed a significant reduction in dimensions of stem due to the reduction in thickness of cortex, thickness of vascular cylinder, pith diameter

and diameter of xylem vessels. Similarly leaves of sweet marjoram and sweet basil plants exposed to water stress exhibited a significant reduction in blade, palisade and spongy tissues thickness as compared to non-water-stressed plants without PGPR or proline (control). While, PGPR or proline application greatly improved all anatomical features of stem and leaf in both water and non–water stressed plants as compared to the control.

Sweet marjoram and sweet basil plants exposed to water deficit stress exhibited substantial increases of photosynthetic pigments concentration, proline concentration, total soluble sugars concentration, electrolyte leakage, activities of peroxidase (POD), polyphenol oxidase (PPO) and catalase (CAT), while the relative water content (RWC) significantly decreased. The results showed that treatment with PGPR or proline enhanced the antioxidant defense activities in water stressed sweet marjoram and sweet basil plants, thus alleviating water deficit stress induced oxidative damage and enhancing drought tolerance and induced positive changes in structure of leaf and stem tissues. The protective action of PGPR was more efficient than proline.

Key words: Sweet marjoram; Sweet basil; Water stress; PGPR; Proline; Growth; Anatomy; Antioxidant system; Physiological attributes.