



Micromorphological and Essential Oil Responses of Japanese Mint (*Mentha arvensis* L.) under Drought and Salinity Stress

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Abstract

Climate change-induced drought and salinity stress pose major challenges to the growth, physiology, and secondary metabolite production of medicinal and aromatic plants, including Japanese mint (*Mentha arvensis* L.). This study evaluated the effects of drought and salinity stress on growth, physiological traits, micromorphological characteristics, and essential oil content of Japanese mint under controlled conditions. The experiment was conducted in a factorial Completely Randomized Design with three drought levels (100%, 75%, and 50% field capacity) and three salinity levels (0, 50, and 75 millimoles sodium chloride). Growth traits showed limited variation under stress conditions; however, physiological responses differed significantly among treatments. Moderate drought combined with salinity improved chlorophyll content, whereas relative water content declined under severe combined stress. Micromorphological analysis revealed amphistomatic leaves with diacytic stomata and higher stomatal density on the abaxial surface than the adaxial surface. Both glandular and non-glandular trichomes were observed, with capitate glandular trichomes being the predominant type. Glandular trichome density increased markedly under severe drought conditions, suggesting stress-associated changes in metabolite production. Essential oil accumulation was strongly influenced by stress treatments, with the highest oil yield (5.16% on dry weight basis) recorded under moderate drought without salinity, while severe drought and higher salinity reduced oil accumulation and biomass production. Essential oil composition remained menthol-dominant across treatments, although menthone and pulegone contents varied under stress conditions. The findings indicate that moderate stress conditions can enhance essential oil yield and maintain desirable oil quality in Japanese mint, also, moderate stress affects in the pathway level rather than chemotypes of oil. These results provide useful insights for sustainable cultivation and quality improvement of Japanese mint under changing environmental conditions.

Keywords: Amphistomatic, Capitate trichomes, Diacytic, Glandular trichomes, Menthol

