



## Seventh Article (Shared with others outside the specialization – Published in International Journal).

### Fennel and ammi seed extracts modulate antioxidant defence system and alleviate salinity stress in cowpea (*Vigna unguiculata*)

Scientia Horticulturae. 2020, 272, 109576.

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Article status

Shared with others outside the specialization –  
Published in International Journal

Impact Factor: 2.769

#### Abstract

The use of biostimulants, including plant extracts, enables plant species to noticeably lessen abiotic stress effects, including salinity. The aim of this study was to explore the potential impacts of two biostimulants; seed extracts of *Foeniculum vulgare* (FSE) and *Ammi visnaga* (ASE), foliarly applied at 2000 ppm, on growth, yield, physiological parameters, nutrient status, and antioxidant system ingredients in *Vigna unguiculata* plants growing under irrigation with diluted seawater (3.5 and 7 dS m<sup>-1</sup>) during the 2017 and 2018 seasons. Salt stress significantly increased Na<sup>+</sup> content, electrolyte leakage (EL), and oxidative stress biomarkers [malondialdehyde – (MDA), hydrogen peroxide – (H<sub>2</sub>O<sub>2</sub>), and superoxide-(O<sub>2</sub> –)], which were associated with high concentrations and activities of osmoprotectants and antioxidant system (enzymatic and nonenzymatic) ingredients. On the other hand, growth and output traits, leafy relative content of water (RWC), membrane stability index (MSI), photosynthetic efficiency, contents of nutrients (e.g., N, P, K<sup>+</sup>, and Ca<sup>2+</sup>), ratio of K<sup>+</sup>/Na<sup>+</sup>, and plant anatomical features were decreased. The adverse impacts of saltiness were more noticeable under 7 dS m<sup>-1</sup>. Both ASE and FSE applications significantly increased contents of osmoprotectants and activities of antioxidant system ingredients, which were reflected in reduced Na<sup>+</sup> content, EL, and oxidative stress biomarkers and in increased growth and yield traits, RWC, MSI, photosynthetic efficiency, nutrient contents, K<sup>+</sup>/Na<sup>+</sup> ratio, and anatomical features (using ASE only) in both seasons. Compared to FSE, better results were obtained by ASE application, which can be recommended for use to maximize *Vigna unguiculata* productivity in environments having salinities up to 7 dS m<sup>-1</sup>.