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Application of biostimulants promotes growth and productivity by fortifying the antioxidant machinery and suppressing oxidative stress in faba bean under various abiotic stresses

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El-Sayed M. Desoky[a], Ahmed S. Elrys[b], Elsayed Mansour[c], Rania S.M. Eid[d], Eman Selem[e], Mostafa M. Rady[f,*], Esmat F. Ali[g], Gaber.A.M. Mersal[h], Wael M. Semida[i]

[a]Botany Department, Faculty of Agriculture, Zagazig University, Zagazig 44519, Egypt
[b]Soil Science Department, Faculty of Agriculture, Zagazig University, Zagazig 44511, Egypt
[c]Agronomy Department, Faculty of Agriculture, Zagazig University, Zagazig 44519, Egypt
[d]Botany Department, Faculty of Agriculture, Benha University, Moshtohor, Qalyoubia 13736, Egypt
[e]Botany and Microbiology Department, Faculty of Science, Zagazig University, Egypt
[f]Botany Department, Faculty of Agriculture, Fayoum University, Fayoum, 63514, Egypt
[g]Department of Biology, College of Science, Taif University, P.O. Box 11099, Taif 21944, Saudi Arabia
[h]Chemistry Department, College of Science, Taif University, P.O. Box 11099, Taif 21944, Saudi Arabia
[i]Horticulture Department, Faculty of Agriculture, Fayoum University, Fayoum, 63514, Egypt

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Abstract

Natural extracts and biostimulants have recently been used to enhance growth and productivity of stressed plants. A pots trial was performed to verify the impacts of maize grain (MgE, 60 g L^{-1}) and/or propolis (PrmE, 40 g L^{-1}) extract foliar application (three times) on growth, physio-biochemical attributes, and productivity of faba bean plants exposed to drought (40% of soil capacity), salinity (150 mM NaCl), or cadmium (2.0 mM Cd^{2+}) stress versus absence of stress as a control. Alterations in the antioxidant system and its relationship with stress tolerance were also examined. The results indicated that each stress caused a significant decrease in yield traits, photosynthetic efficiency, pigment contents, gas exchange, relative water content, membrane stability index, and osmolyte contents compared to non-stressed plants. Otherwise, MgE and/or PrmE enhanced the plant's stress tolerance and increased the aforementioned attributes under normal or stress conditions. Moreover, MgE and/or PrmE increased enzymatic activities (SOD, CAT, POX, and APX) and antioxidant levels (proline, glutathione, ascorbate, and α-tocopherol) under the studied stresses compared to untreated controls. The combined MgE+PrmE was the most efficient treatment. Salinity considerably increased Na^+ content, whereas, MgE+PrmE treatment reduced Na content by 39.6, 16.7, or 37.0% under salinity, drought, or Cd^{2+} stress, respectively. Under Cd^{2+} stress, the best treatment (MgE+PrmE) reduced root and leaf Cd^{2+} contents by 74.1 and 78.6%, respectively compared to untreated plants. Our findings indicated that foliarly-applied MgE+PrmE was highly effective in enhancing the antioxidant machinery, thus reducing ROS, Na^+, and Cd^{2+} levels resulting in increased plant productivity under salinity, drought, or Cd2+ stress.