

Investigation into the role of carboxylic acid and phenolic hydroxyl groups in the plant biostimulant activity of a humic acid purified from an oxidized sub-bituminous coal

Autorzy

Richard T. Lamar

Jason Gralian

William C. Hockaday

Maria Jerzykiewicz

Hiarhi Monda

Rok wydania

2024

Czasopismo

Frontiers in Plant Science

Numer woluminu

15

Strony

1328006/1-1328006/17

DOI

10.3389/fpls.2024.1328006

Kolekcja

Naukowa

Język

Angielski

Typ publikacji

Artykuł

Streszczenie

Introduction: Humic substances (HS) are increasingly being applied as crop plant biostimulants because they have been shown to increase plant productivity, especially under environmentally stressful conditions. There has been intense interest in elucidating the HS molecular structures responsible for eliciting the plant biostimulant response (PBR). The polar and weakly acidic carboxylic (COOH) and phenolic hydroxyl (ArOH) functional groups play major roles in the acid nature, pH dependent solubilities, conformation, and metal- and salt-binding capabilities of HS. Reports on the role played by these groups in the PBR of HS found growth parameters being both positively and negatively correlated with COOH and ArOH functionalities.

Materials and methods: To investigate the role of COOH and ArOH in HS biostimulant activity we used a humic acid (HA), purified from an oxidized sub bituminous coal to prepare HAs with COOH groups methylated (AHA), ArOH groups acetylated (OHA), and with both COOH and ArOH groups methylated (FHA). The original HA was designated (NHA). The four HAs were subjected to elemental, ^{13}C -NMR, FTIR, and EPR analyses and their antioxidant properties were assessed using the trolox equivalents antioxidant capacity assay (TEAC). ^{13}C -NMR and FTIR analysis revealed significant alkylation/acetylation. To determine the effects of alkylating/acetylating these functional groups on the HA elicited PBR, the HAs were evaluated in a plant bioassay on corn (*Zea mays L.*) seedling under nutrient and non-nutrient stressed conditions. Treatments consisted of the four HAs applied to the soil surface at a concentration of 80 mg C L^{-1} , in 50 ml DI H₂O with the control plants receiving 50ml DI H₂O.

Results: The HA-treated plants, at both fertilization rates, were almost always significantly larger than their respective control plants. However, the differences produced under nutrient stress were always much greater than those produced under nutrient sufficiency, supporting previous reports that HA can reduce the effects of stress on plant growth. In addition, for the most part, the HAs with the alkylated/acetylated groups produced plants equal to or larger than plants treated with NHA.

Conclusion: These results suggests that COOH and ArOH groups play a limited or no role in the HA elicited PBR. Alternatively, the HA pro-oxidant to antioxidant ratio may play a role in the magnitude of the biostimulant response.

Słowa kluczowe

biostimulant, humic acid, carboxylic acids, phenolic hydroxyls, quinones, semiquinone radicals

Licencja otwartego dostępu

CC-BY

Licencja na prawach której można swobodnie kopiować, rozprowadzać, zmieniać i remiksować objęty prawem autorskim utwór (Utwór-przedmiot prawa autorskiego) pod warunkiem podania imienia i nazwiska autora utworu pierwotnego oraz źródła pochodzenia utworu.

Pełny tekst licencji:

<https://creativecommons.org/licenses/by/3.0/pl/legalcode>

Adres publiczny

<http://dx.doi.org/10.3389/fpls.2024.1328006>

Strona internetowa wydawcy

http://www.frontiersin.org/plant_science/about