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A meta-analysis of plant-growth response to humic substance applications

Antonio Patti (1), Michael Rose (1,2), Karen Little (1,2,3), Roy Jackson (1), and Tim Cavagnaro (2)

(1) School of Chemistry and Centre for Green Chemistry, Monash University, Clayton, Victoria, 3800, Australia, (2) School of Biological Sciences, Monash University, Clayton, Victoria, 3800, Australia, (3) School of Applied Science and Engineering, Monash University, Churchill, Victoria, 3842, Australia

Humic substances (HS) are a category of naturally occurring organic compounds that arise from the decomposition and transformation of plant, animal and microbial residues (Maccarthy 2001). The loss of humic material, together with overall reductions in soil organic matter, is of concern because they play important roles in maintaining key soil functions and plant productivity (Lal 2004). Consequently, there is interest in the application of HS-based amendments, often derived from agricultural wastes (e.g composts) to remediate and/or maintain soil health (Quilty and Cattle 2011). In light of the potential benefits of HS, together with their inconsistent performance under field conditions, we sought to quantitatively review the effects of HS on plant growth, by undertaking a meta-analysis of the literature. A total of 390 papers were originally selected from the current literature. A number of criteria were applied to reduce this number to 81, from which the meta-analysis was undertaken. The 81 papers comprised 57 studies presenting data on shoot (or total) dry weight and 39 studies reporting root dry weight. As part of the meta-analysis we attempted: (i) to quantify the magnitude and likelihood of plant growth promotion, in terms of shoot and root biomass, resulting from HS application, (ii) to determine the influence of environmental conditions, plant type, humic substance properties, and the manner of application on plant growth response to HS, (iii) to identify gaps in our understanding of the interaction of HS with plants, and (iv) to provide some general recommendations for the practical use of HS in agronomic systems and suggestions for future work. Some of the key findings from this meta-analysis included: • Many papers lack details on HS chemical characteristics • The application of HS needs to be tailored to the environmental conditions in which they will be used. • The effect of HS on shoot biomass was not only dependent on the source and rate of application, but also the plant type • Environmentally stressful conditions, rather than the plant type, played a more prominent role in shaping the root growth response to HS. This finding is especially relevant to the agronomic use of HS, because soil degradation, climate change and diminishing water and nutrient resources are becoming increasingly important constraints to agriculture production, and recommendations for using HS are often directed at alleviating these stresses.

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