Biostimulant Benefits from Biosolids

SCHOOL OF PLANT AND ENVIRONMENTAL SCIENCES, VIRGINIA TECH

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A plant biostimulant is "any substance or microorganism applied to plants with the aim to enhance nutrition efficiency, abiotic stress tolerance and/or crop quality traits, regardless of its nutrients content" (du Jardin, 2015). Biostimulants were first described by Zhang and Schmidt (2000) as *'materials that, in minute quantities, promote plant growth'*. Today, no legal or regulatory definition exists anywhere in the world of plant biostimulants. The push for biostimulants centers on the promotion of sustainable agriculture and maximizing resources and productivity (du Jardin, 2015).

Biostimulant substances include: humic and fulvic acids, protein hydrolysates and amino acids, and seaweed extracts and botanicals, chitosan and other biopolymers, and inorganic compounds (Calvo et al., 2014; du Jardin, 2015). Such substances may be produced by plant growth-promoting rhizobacteria and fungi.

Biosolids contain substances that enable them to fit into several subcategories of biostimulants. Humic substances, hormones, amino acids, and vitamins have been identified and isolated from biosolids (Lemmer and Nitschke, 1994; Sanchez-Monedero et al., 1999; Zhang et al., 2005). To date, biosolids biostimulants research has focused on hormones, such as auxins and humic substances (humic and fulvic acids) supplied by or derived from biosolids (Pascual, 2011; Zhang et al., 2005, 2007, 2009, 2012, 2013; Zhang and Ervin, 2004). Auxins are growth hormones that stimulate shoot elongation, control seedling orientation, stimulate root branching, and promote fruit development. Most of these effects can be attributed to the auxin, indole-3-acetic acid (IAA) (Teale et al., 2006). Humic substances are the heterogeneous compounds that make up soil organic matter. Historically, these compounds were categorized into humins, humic acids, and fulvic acids based on their molecular weights and solubility.

Zhang et al. (2005) and Zhang and Ervin (2004) reported that humic acids contain IAA and cytokinins (class of phytohormones). The results of Zhang et al. (2007, 2009, 2012, 2013) suggest biosolids application may improve plant drought tolerance by enhancing hormones, antioxidant enzyme activity, and N metabolism. Zhang et al. (2007, 2009, 2012, 2013) demonstrated that for turfgrass, biosolids increased soil IAA, root length density, and root surface area under both drought stress and well-watered conditions. These results were attributed to biosolids supplying hormones (IAA) directly or stimulating the activity of microbes that supply substrates and hormones. Pascual et al. (2011) showed that humic substances derived from composted biosolids significantly enhanced the growth (leaf, shoot, and root) of pepper plants during the vegetative and flowering stages (earlier flowering and ripening).

Research regarding biostimulants and biosolids impact as a biostimulant for plant growth is in its infancy. Future research is needed to investigate biostimulant mechanisms and the effects on a larger expanse of crops as the majority of biosolids biostimulant research has focused on turfgrass.

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