

Nanomaterials from waste for a sustainable nano-circular economy. Biostimulant effect of nanoscaled lignin and biogenic nanoparticles

Daniele DEL BUONO – *University of Perugia*

Human activities often reveal poor or absent environmental sustainability, which can irreversibly hamper and compromise the quality and health of primary resources. One such activity is agriculture, which has a high environmental footprint due to its reliance on a linear model centered around “take, use and dispose of” approach. A fundamental shift in perspective is essential, which can only be achieved by viewing waste as the final product of the production chain and considering it as a valuable resource for generating biobased materials that can be repurposed and integrated across various sectors. For this, waste valorisation from agro-industrial activities is receiving increasing attention. It has recently been shown that an intelligent and feasible way to valorise these wastes is to obtain biostimulants or plant growth promoters. Biostimulants play a crucial role in agriculture and are considered an indispensable agronomic tool. Such materials can stimulate crop productivity, plant nutrition, photosynthesis, pigment biosynthesis, and the content of specific substances with antioxidant action and improve primary and secondary metabolism traits. However, one distinctive feature of these materials should be emphasised: they increase the resistance of crops to both biotic and abiotic stresses.

Moreover, waste materials have also become attractive for obtaining biopolymers and nanostructured materials that can be used to stimulate benefits in crops. In parallel, biogenic synthesis emerges as an interesting way to get inorganic nanomaterials, using proper plant extract as capping or reducing agents, thus controlling shape and size. These nanomaterials are currently being studied for potential application in crops since they exhibit promising stimulatory effects in treated species.