Identification of new products with biostimulant action and evaluation of their effects on plant growth and development by using genomic and metabolomic approaches

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Biostimulants are substances and/or microorganisms that, when applied to a plant at very low doses, improve natural physiological mechanisms such as nutrient uptake and use efficiency, response to abiotic stress and crop traits (1). These products represent a good tool to increase crop yield, in a moment in which to feed the growing world population with the decrease of arable land became a necessity (2). The main goal of this PhD thesis was to identify new matrices with a biostimulant action and investigate their effects on plants by using multidisciplinary approaches. Moreover, the chemical characterization of these matrices was of paramount importance to identify active compounds involved in the biostimulant activity in order to understand their mode of action. In this perspective, the PhD project was divided in two subprojects, both concerning the development of new products able to act on plant at different levels.

In the first one, the effects of **KIEM®**, a pre-sowing biostimulant, based on lignin derivatives, amino acids of plant origin and molybdenum were evaluated on soybean (*Glycine max* L.) and cucumber (*Cucumis sativus* L.) seed germination. Biometric parameter measurements, followed by transcriptomic and biochemical analyses performed on seeds germinated in optimal and heat stress conditions, suggest the role of KIEM® as a priming product, able to protect the seed from heat damage and improve plant growth. Based on these studies, KIEM® is now available on the market.

In the second project, the effects of **GHI_18_120**, a new prototype based on hydrolysable and condensed tannins, were evaluated on tomato (*Solanum lycopersicum* L.) plants. Biometric parameter measurements, transcriptomic and metabolomic analyses carried out on treated and control plants, showed that this biostimulant, tested under standard and salt stress conditions, was effective in improving the root system development and plant growth and in enhancing salt stress tolerance .

In conclusion, in this work we tried to get insights on the potential of two biostimulants, under different conditions and crops. These products are normally not species-specific and the idea is to make them able to reduce the use of more polluting and dangerous fertilizers.

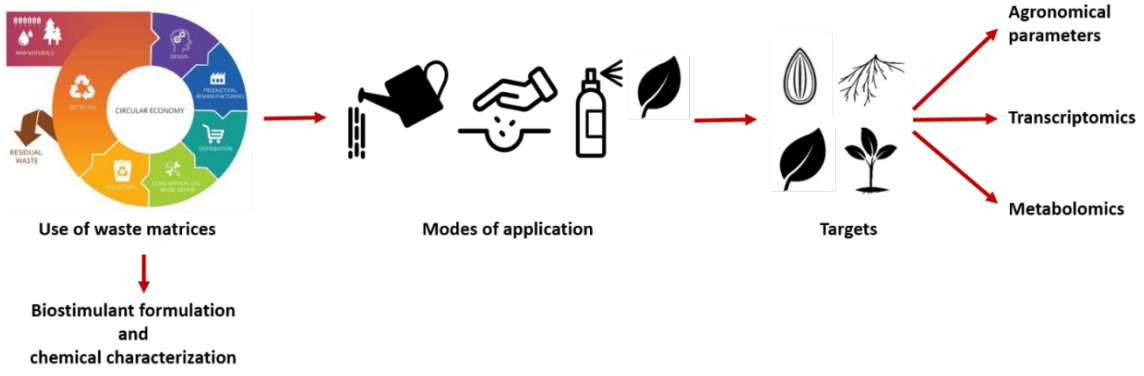

Fig.1 Graphical representation of the main steps involved in the study of biostimulant effects. Biostimulants are often obtained from industrial waste and then chemically characterized to identify active compounds. Methods of application and target depend on the nature of the biostimulant. Finally, to get insights on the mechanism of action, a multidisciplinary approach including biometric parameter measurements and transcriptomic and metabolomic analyses is usually applied.

1) du Jardin, P. (2015). *Scientia Horticulturae*, *196*, 3-14.
2) Povero, G., Mejia, J. F., Di Tommaso, D., Piaggesi, A., & Warrior, P. (2016). *Frontiers in plant science*, *7*, 435.