Circular economy and sustainable agriculture: Hydroxyapatite from biowastes as smart nanofertilizer - CLEOPATRA

Guido FELLET – *University of Udine*

Nanotechnology has the potential to become the driver of a new technological revolution in agriculture. Nano-enabled agriculture could play essential roles in increasing crop yield and nutrient use efficiency (NUE), lowering environmental impacts, and improving agroecosystem resilience. So far, most studies have analyzed the properties of the nanofertilizers and assessed plant responses mainly at the greenhouse scale without any measure of NUE, which is a fundamental aspect concerning plant nutrition/fertilization. The main goal of the CLEOPATRA project is to develop a systematic investigation on nano-hydroxyapatite (nHAP) from biowastes (circular economy) and its derived nanohybrids to produce efficient and environmentally friendly nanofertilizers. Recent studies reported positive results of nHAP (as a source of P) - alone and combined with other elements (e.g., N, micronutrients) or molecules for plant nutrition, plant protection, and yield quality compared with conventional fertilizers. However, some results are contradictory and positive results have not been supported by mechanistic evidence. CLEOPATRA addresses this issue as it includes activities in different phases studying both the preparation and functionalization of nHAP and its effects on the plants. More specifically, extraction of nHAP from bones of various animals will be studied, together with their functionalization with P solubilizing bacteria (PSB) and urea; different strategies of nHAP application to plants; evaluation of their allocation within plants; fine assessment of nutrient releases. nHAP effectiveness in terms of NUE Plant growth will be assessed with experiments carried out at growth chamber and greenhouse scales on maize (Zea mays) as a model plant. Furthermore, studies on the use of nHAP as a fertilizer have been carried out using synthetic apatite; this will be the first study carried out using a nanohybrid of biological origin from circular economy chains as innovative fertilizer. CLEOPATRA outputs respond to EU expectations of reducing 2030 fertilizer use by at least 20%, nutrient losses by at least 50% while ensuring soil fertility and providing high-quality food.