Nanofertilizers: a new production for the industry or a new opportunity for agriculture?

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Mineral fertilization has been one of the three “golden shares” for the green revolution together with mechanization and genetics. The success since then has encompassed important targets like an increase in gross global production of grain cereals: the nutritional sufficiency for the largest countries (China, India, United States, Russia, Europe), the possibility for the farmer to access to a better life and for the consumers to have safer food. However, still one third of the global world population suffer famine or is undernourished and food security in not totally confirmed, through years due to increasingly unpredictable environmental conditions.
Within this scenario the worst perspective was the continually diminishing of the efficacy of actual mineral fertilizers, because of plant low nutrient uptake. When the advent of nanotechnology industry has learned how to produce different nanomaterials from bulk materials for different purposes, nanomaterials have become familiar in the industry for optical devices, solar energy, fuel cells and even in medicine and dye production.
However, nanomaterials are extremely reactive and this has caused concerns of toxicity for human health and for the Environment. When translated into the agricultural context this attention may concern the entire food chain, from the plant in the soil to the food on the table. Actual chemical fertilizers have a low nutrient uptake efficiency, are with high losses and in many cases determine gross environmental problems (considering the case of bloom of algae, due to increasing Nitrogen, phenomenon known as “hypertrophism”).
The actual losses of Nitrogen and Phosphorus are drastically reduced when these minerals are included within a nanomaterial. Nanofertilizers can also have beneficial effects because their slow release in the soil does not force the uptake system of the plant and because of the limited losses with the time. Actual researches in the field are providing all a list of comparison between nano- and non-nano fertilizers in terms of costs/benefits analysis.
A particular case of nanofertilizer is the black-carbon or char (biochar, when from biological origin).
Biochar has a nano-structured matrix of aggregation which makes its reactivity similar to a nanomaterial. Differently from nanofertilizers, biochar is non-toxic, non-transferable to food chain, durable in the environment (long weathering) and extremely low expensive. Biochar can be also functionalized with microorganisms to obtain an advanced “nano-biofertilizer”.