Controlled release in nanoagrochemicals

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The current global environmental crisis is remarking the inadequacy and unsustainability of current development and production models, particularly in the agrifood field. There is urge for a paradigm change to underpin novel approaches based on green and renewable materials and circular economy principles with the aim to reduce pollution and related health risks.
Awareness is growing around the need for a better management of plant pathologies that is fostering the development of new nanotechnology-based approaches granting control of active agent delivery in space and time. What does actually mean controlled release or delivery of actives? It is known that treatment efficiency depends on how the active agent is made available at the site of action. According to needs, extended or localized effects may be desirable. This determines the choice of the carrier, either it be macroparticles, nanoparticles or hybrid systems. While microparticles can be employed to grant a depot long-term effect, nanoparticles allow specific or non-specific drug delivery by accumulating in certain districts. Particle size, surface chemistry, morphology are known to influence nanoparticle behavior. Naturally, the other major player is the active molecule, whose properties determine the choice of materials and carrier features. Knowledge of the physicochemical laws governing nanoparticle-active agent-environment interactions is demanded for perfect fit with treatment target. Albeit well-known in the pharmaceutical field, translation of knowledge and such technologies to agrochemicals delivery is not straightforward. Cost and material limitations narrow the available development space, without forgetting regulatory constraints. Field and climate conditions, administration modalities, and crop growth and disease pattern have to be accounted to pick the right system. Evidence is rapidly growing on promising natural and/or renewable material-based nanoparticles and microparticles as well as nanofertilizer or nanopesticides, along with the need for a better understanding of their actual environmental impact.