



INNOVATIVE FERTILIZERS FOR AGRICULTURE, WITH “BIOECOACTIVE” PARTICLES TECHNOLOGY

Characteristics of the particles

Nanotechnology permits the synthesis of new materials: thanks to their nanometric dimensions, they have particular physico-chemical characteristics as well as an area and a surface reactivity that make them able to perform innovative functions and unusual behavior, if compared with traditional materials. For these reasons they deserve the appellation of “smart materials”. Bio Eco Active Srl was founded in May 2012: it represents an innovative Start Up in this field, which is able to synthesize geomimetic hydroxyapatite, made up of nanostructured and biocompatible microcrystals. They imitate the behavior of geological apatite crystals, as regards the presence of specific metals in their structure, which are active in agrifoods sector and have common characteristics with the mineral component of soil.

“BIOECOACTIVE” nanocrystals are characterized by lamellar shape, with a medium length and width of 100-150 nm; their surface area is equal to 100-120 m²/g.

“BIOECOACTIVE” particles

Bio Eco Active Srl produces these particles thanks to an exclusive method of synthesis, using an eco-friendly technology, which respects the environment and does not use solvents or toxic substances. This technology is inspired by biological and geological synthetic processes that take place in nature.

“BIOECOACTIVE” particles’ activity

Calcium phosphate crystals that are used present a thin and amorphous surface layer, where cations and anions are not structurally neutralized and can bind biologically active molecules and ions, such as Potassium, Zinc, Manganese, Boron and Iron (in addition to the carbonate group).

Functions of “BIOECOACTIVE” particles

“BIOECOACTIVE” particles contain Calcium and other elements (such as Potassium, Zinc, Manganese, Boron and Iron, besides phosphate and carbonate), which contribute to improve the natural resistance of the plant.

Calcium is one of the elements that are essential for the plant nutrition and is absorbed by the soil. Also the other compounds are fundamental nutrients for the plant. They can be found inside the structure of “BIOECOACTIVE” particles; they are slowly released on the surface of the treated leaves, representing an innovative fertilizing method.

Moreover, the special structure of the particles determines the presence of considerable weak surface charges, to which ions of each element (contained in large amounts in fertilizers) can bind.

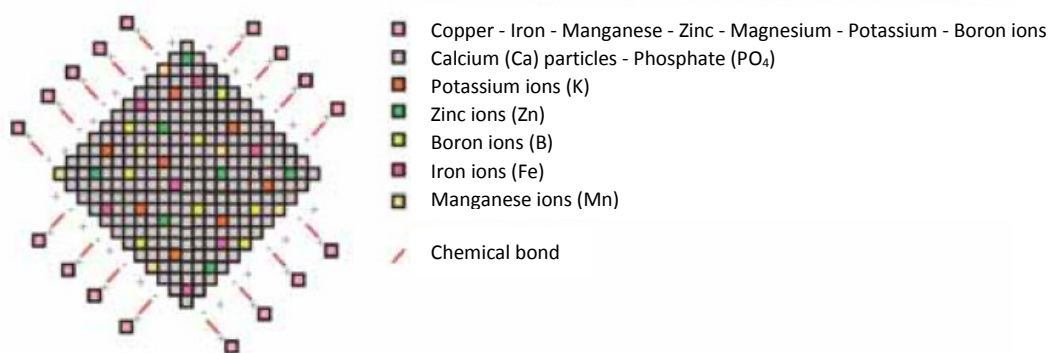
“BIOECOACTIVE” particles are at the base of the formulation of specific foliar fertilizers, such as:

- **Bio 3 Ferro**, composed of Iron;
- **Bio 9 Rame Plus**, composed of Copper, Zinc and Manganese;
- **Bio Eco Top**, composed of Copper, Zinc and Selenium.

These fertilizers are recommended when deficiencies occur. They are characterized by a double kinetics release of micronutrients: at first, “BIOECOACTIVE” particles gradually release the elements that are externally linked and then, through a slower process, the elements that are contained inside the particles themselves.

In this way, the effectiveness of “BIOECOACTIVE” particles is due to the synergy between the different releasing processes, which enhances the efficacy of the elements involved.

Scheme of the existing bonds in a **BIOECOACTIVE**® particle, functionalized externally by metal ions and internally by nutritional microelements for the plant (see key)

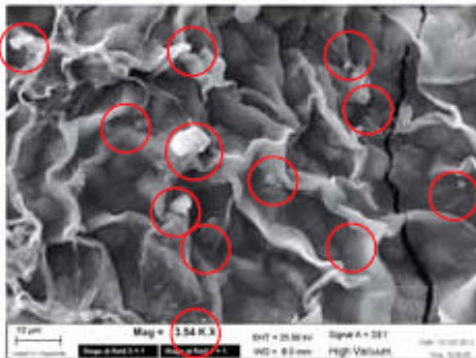




“BIOECOACTIVE” particles on the leaf

The structure and the dimensions of the particles vary between 0,5 and 2 microns, thus they are homogeneously dispersed inside the micronized drop, allowing a uniform distribution of the particles on the foliar surface.

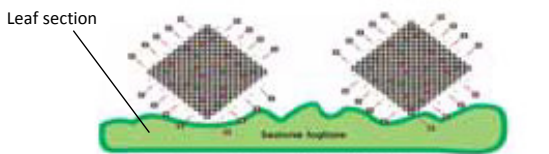
(Scheme of a water droplet containing **BIOECOACTIVE**® particles).



In general, according to the sprayer used, droplets may have a diameter ranging from 50 to 800 microns. The ideal size of the droplets is believed to be between 150 and 250 microns (to avoid drift phenomena with too small drops or dripping phenomena with too large drops). The greater the number of impacts is, the better the coverage density will be, without overlapping or runoff.

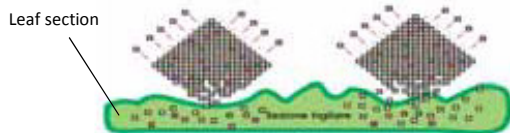
Distribution of “BIOECOACTIVE” particles on the leaf.

Inside the red circles, you can see the particles uniformly adherent to the foliar surface.

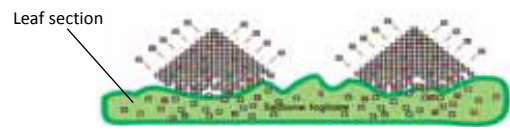


- Copper - Iron - Manganese - Zinc - Magnesium - Potassium - Boron ions
- Calcium (Ca) particles - Phosphate (PO₄)
- Potassium ions (K)
- Zinc ions (Zn)
- Boron ions (Bo)
- Iron ions (Fe)
- Manganese ions (Mn)
- ✓ Chemical bond

Initial situation, with the “BIOECOACTIVE” particles laying on the leaf



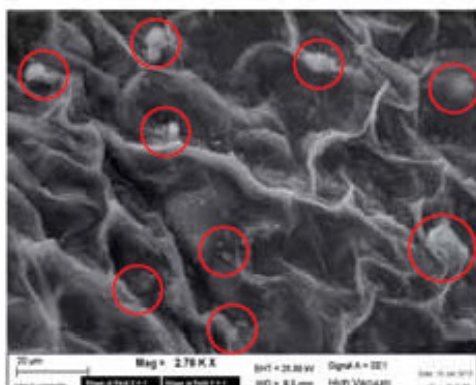
Initial dissolution of the “BIOECOACTIVE” particles on the leaf with nutrients release



Example of the kinetics of dissolution of “BIOECOACTIVE” particles on the leaf with nutrients release

Scheme of the gradual release of the active elements contained in the “BIOECOACTIVE” particles on the leaf surface.

Once laid on the leaf surface, the “BIOECOACTIVE” particles start releasing the nutrients therein contained or externally bonded.

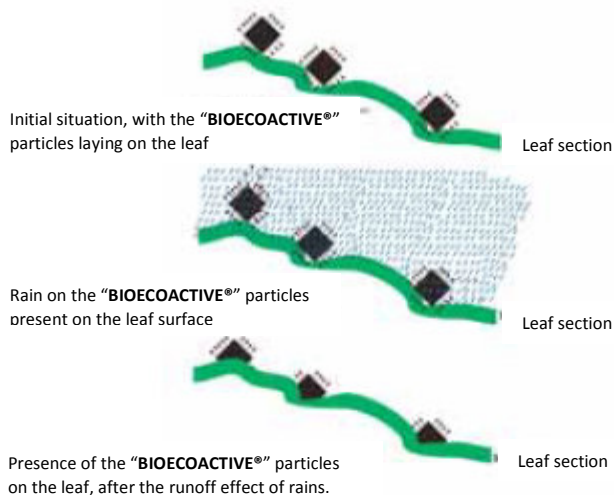


Leaf adhesion and runoff action

“BIOECOACTIVE” particles do not need gripping or adhesive products to adhere to the leaf surface.

Thanks to their high surface area, their dimensions, their morphological irregularity and their remarkable electrostatic activity, they succeed in adhering firmly to the leaf surface in a very short time, about 3-4 hours.

Leaf surface analyzed after a few days from the treatment. Inside the red circles, you can see the “BIOECOACTIVE” particles adherent to the leaf surface.



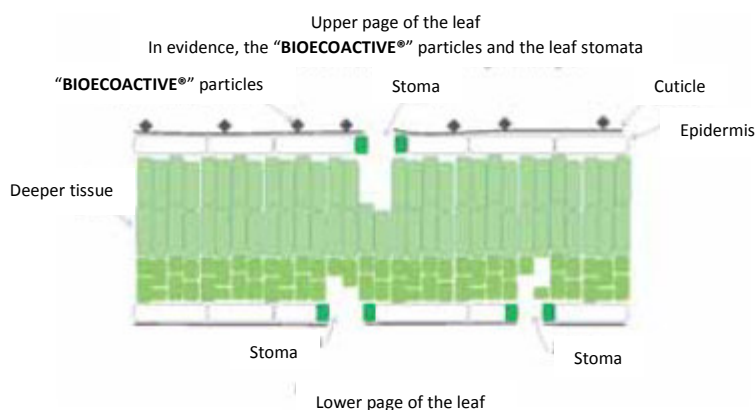
The trials carried out on the treated leaf surface through electron microscopy have shown the presence of the "BIOECOACTIVE" particles even after several days from the application, unlike the common products that, if not used together with gripping products, are easily washed away by a simple rain.

In the picture here beside, you can observe how the runoff caused by a rainfall dissolve the particle only partially, thus allowing a long permanence and efficiency of the particle itself on the leaf surface. Runoff effect on the leaf surface.



In the picture here beside, it is possible to observe that the dimensions of the "BIOECOACTIVE" particles are similar to those of the leaf stoma analyzed.

The picture shows the lower page of the leaf with the stomata marked in red circles and the product evenly distributed on the surface.



Scheme of the leaf section highlighting the dimensions of the "BIOECOACTIVE" particles and of the stomata.