
SON

AgroSON®

Precision Agriculure

SON

Design and production of Inorganic Advanced Materials & Development of nano-objects with several applications

REPRODUCTIBLE

Highly CARACTERIZED

VERSATILE

MAGNETIC

BIOCOMPATIBLE

"Solving the today's issues by using smart materials"

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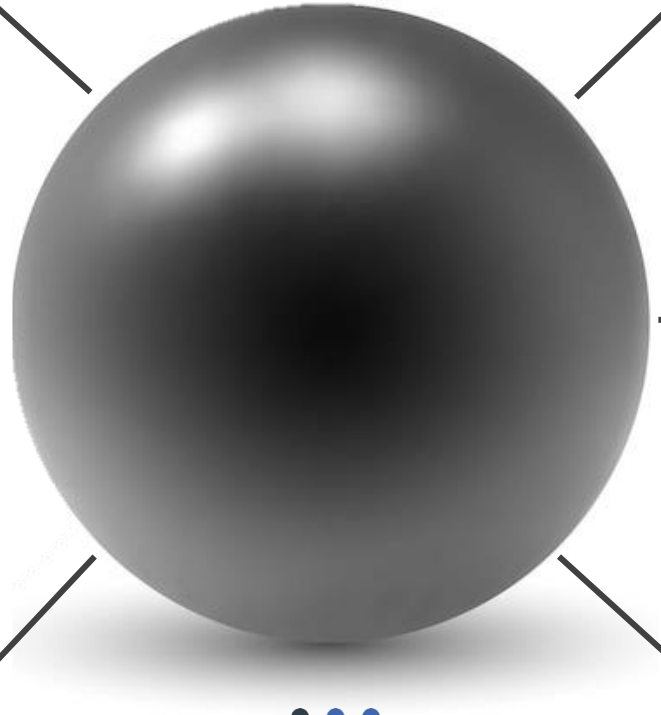
SON's application

GREEN CHEMISTRY
Substitution of critical metals

CIRCULAR ECONOMY
Reusable and recyclable nanomaterials.



PHARMA & BIOTECH
Precision medicine, drug delivery, magnetic sorting

BIODIVERSITY & CLIMATE
Reduction of water stress and increase in foliage

CLEAN ENERGIES & DECARBONIZATION
Optimization of hydrogen storage, transportation, and production without electrolysis

POLLUTION CONTROL
Chelating nano-agents for recovering heavy or precious metals

AGROTECH & AGROECOLOGY
Precision agriculture, bio-control, and bio-fertilization

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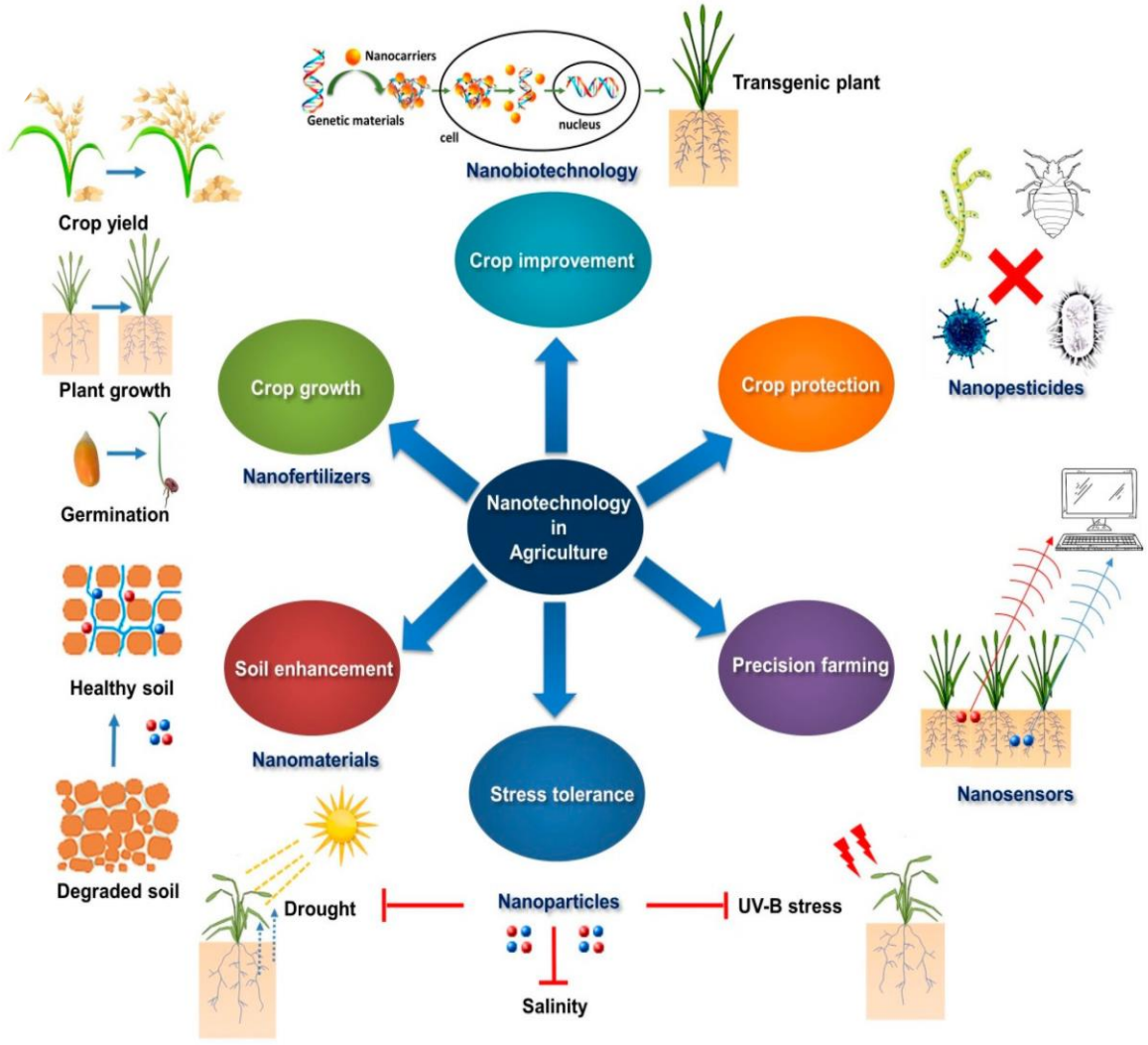
Precision Agriculture

Today's problems in Agriculture:

- **Too much pesticides**
- **Need to Increase Fertilization with greener solutions**
- **Climate Change : Iron oxides - Water and ROS reduction**

The **precision Agriculture** make reference at a **reduced utilization of Pesticides** (Bio-control and fertilizing for Bio-stimulation).



Molecules **2019**, *24*, 2558; doi:10.3390/molecules24142558

SON NP’s & Precision Agriculture

Iron oxide (Fe_3O_4) or Manganese ($MnFe_2O_4$) are minerals present in mostly all the soils around the world and the use of mineral Nanoparticles in the Agrotech is in fast expansion.

Today the use of Iron oxide or Magnanese can be selected in 3 environments :

- As a **BIOCONTROL** : Similarity of Drug Delivery System in Nanomedicine, NP’s will play the role for the reduction of pesticide usage with a more targeted delivery!
- As a **BIOSTIMULANT** : Increase the Natural fertilization and plant become Greener
- As a **CLIMATE CHANGE RESPONSE** : Iron oxide NP’s allow the plant to protect itself against a average draught period.

Iron and Manganese are already natural elements in the soil…

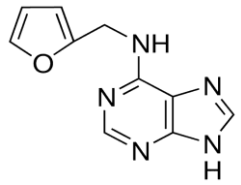
Fe3O4 or MnFe2O4 are biocompatible, no toxic at small dose.

Iron is found in the soil and particularly in sediments in the form of complex mineral oxides at concentrations ranging between 4 to 100 mg/g.

The formation of mineral oxides essentially depends on the pH, clay and organic matter content (IRSN, 2002).

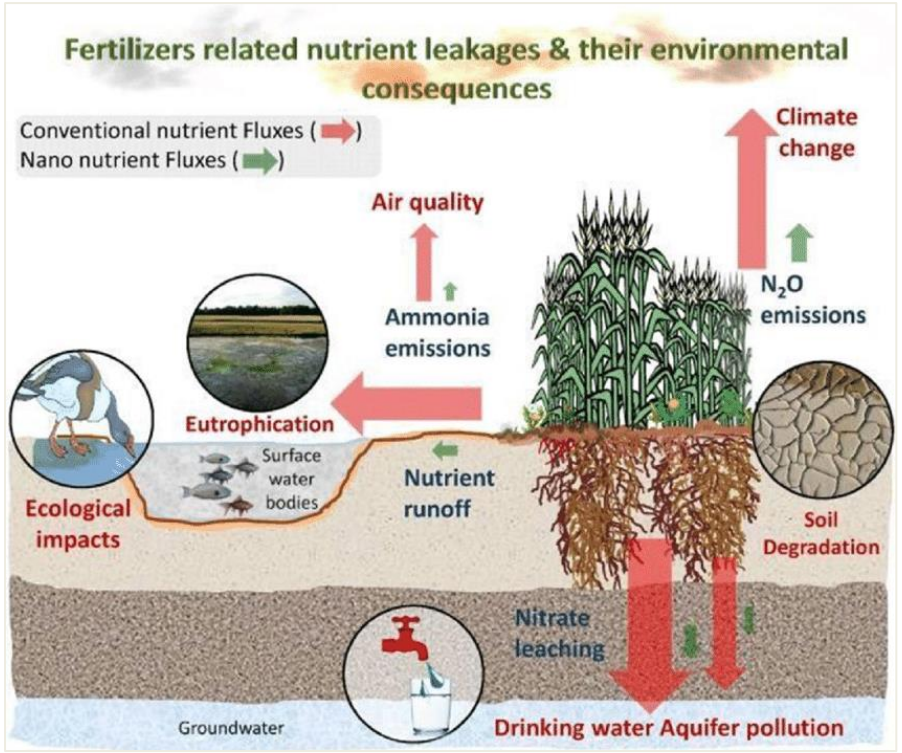



and can be used as bio-stimulant…



Kinetin

the current effect with the delivery of N-rich fertilizers such as Kinetin from layered porous solids



Recurring detrimental impact of agrochemicals on the ecosystem, And a glimpse of organic farming as a possible rescue
Pavidra Devi Gnanaprakasam & Arambakkam Janardhanam Vanisree
Received: 16 August 2021 / Accepted: 22 August 2022

Positive Effects of the Iron oxide as a bio-simulant :

- +33 % of germination.
- Increase of the Chlorophyll.
- Increase of Vitamin C.
- Increase of Bio-mass and root size

Effects on the soil :

- Catalytic activity when Magnetite is coated with citrate
- Good for Conservation and Reforestation.

Negative Effects :

- Penetration of discharge when NP are in the soil and ecological systems (very true of none Iron NP's Ag, Cu, Tios) . A need for more studies.
- Toxitciy depend on metals, size of NP , Degradation level of NP's and the type of plant (Ions generated).

Recent developments in the application of nanomaterials in agrosystems / Dec 2, 2020 Haleema Saleem & Al. ***Nanomaterials***

NP’s Interactions with the plant

Systematic approach for selectivity of NP’s : Size Matter!

- The size determines the capacity of the NP to penetrate by the stomata .
- 4-100nm : The best penetration Fe3o4 is 20nm / TEM studies
- < to 5 nm, NP’s can traverse efficiently the cell wall of intact cell
- Interaction of NP’s with the cell wall creates large size pores

Electric Charge :

The role of electrical charges on the surface of NP’s Physiochemical interactions can change the surface of receptors, transporters and membrane proteins:

- Negative cell charge = **positive charge Np’s** / penetration cationic rather than anionic / roots.
- **Negative charge NP’s** have better internalization and translocation.

Crossing roads for the NP’s in the Plant:

- Apoplast: exchange extra cellular spaces
- Symplast: echange in the cells
- Cyplamatic bridge: NP’s 20-50 nm.

- **NP’s Impacts in Soils :** Mineral Elements can expect Physiochemical changes in the soils. There is a need of a better understanding especially for the NP’s well-known for their Toxity (Tios, Silver, Carbon based NP’s...)

Mode of application and uptake for NP's.

The uptake of NP's inside plants largely depends on the size, chemical composition, and functional groups present on their surface and the type of coating

2 methods of application is currently used :

- Spray on Foliar
- Spray on seeds / seed priming technique with the help of nanotechnology is **a promising strategy**.
- Encapsulation

The ability of NP's to penetrate the hard coating of seeds and allow water importation is the deciding factor for increased growth and vigor.

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