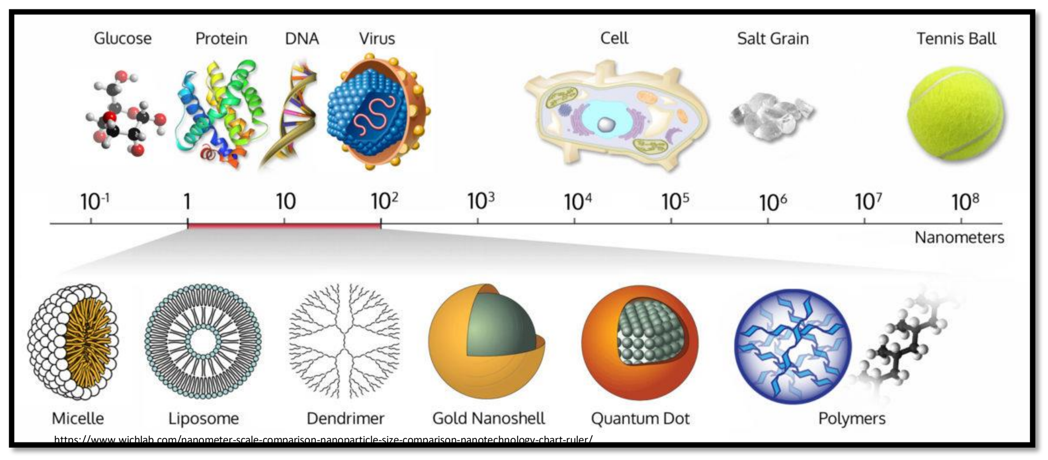
# Role of Nanotechnology in Pest Management and Food Safety


Naveen Kumar Dixit
Assistant Prof. of Horticulture & Extension Specialist
University of Maryland Eastern Shore
Email: fnaveenkumar@umes.edu

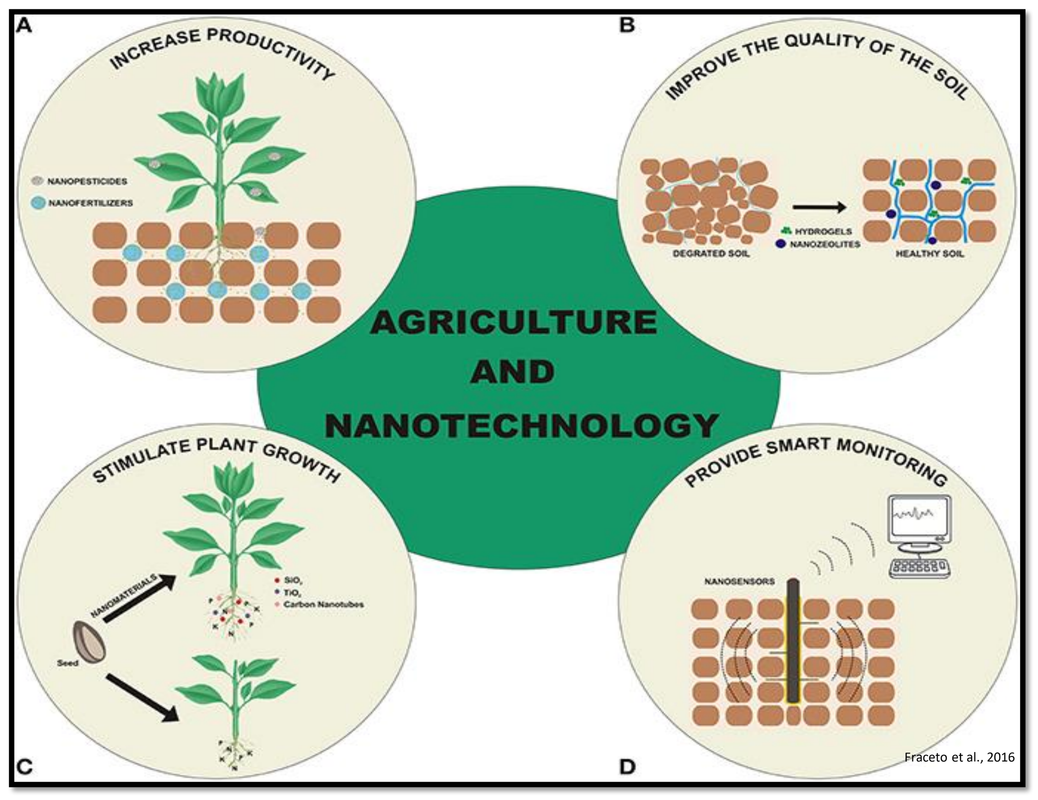

## Nanotechnology

**A nanometer (nm) is one-billionth of a meter**




**Nanotechnology deals with structures sized between 1 to 100 nanometer in at least one dimension.**

**Nanotechnology in Agriculture**

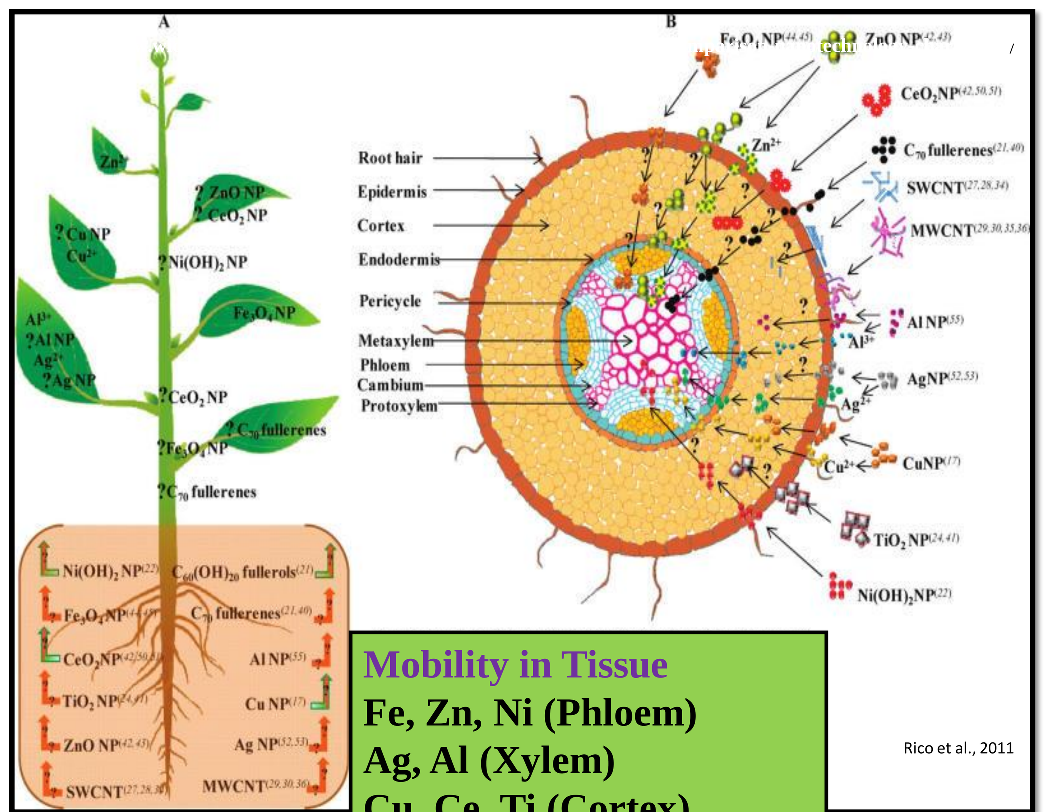



**Increase productivity using nano-pesticides and nano-fertilizers.**

**Improving the quality of soil using nano-zeolites and hydrogel.**

**Stimulate plant growth using nanomaterial.**

**Smart monitoring using nano-sensors.**




**Mobility in Tissue**
**Fe, Zn, Ni (Phloem)**
**Ag, Al (Xylem)**
**Cu, Ce, Ti (Cortex)**
**CNT (Cell Wall)**

## Hypothesis and Methodology

### Hypothesis

**High doses of insecticides, fungicides, and bactericides are used for the management of plant pathogens in different crops. Moreover, these agricultural chemicals are synthetic in nature and highly toxic for the ecosystem. Most of the plant pathogens already developed resistance against popular pesticides. We are proposing the use of nanoparticles (NP) of zinc-oxide (NZO) to manage multiple plant pathogens using *in vitro* and *in vivo* regimes. Mode of action of nanoparticles is physical, therefore, pathogens cannot develop resistance against NP. NP interferes with the charge distribution across plasma membranes, promotes chelation of essential nutrients, and generates reactive oxygen species. We expect NZO can effectively manage selected plant pathogens at lower concentrations.**

### Methodology

**Bacterial Strains**
Fire Blight ( *Erwinia amylovora*)
Peach Bacterial Spot (*Xanthomonas campestris pv. pruni*)
Generic *Escherichia coli*

**Fungal Strains**
*Fusarium solani* (FS: Root rot)
*Fusarium oxysporum* f. sp. *lycopersici* (Sacc.) (FL: Root rot)

**Plant**
Soybean (*Glycine max* (L.)

**Nanoparticles**
Common Zinc oxide (CZO)
Nano Zinc oxide (NZO): 10-30 nm/80-100 nm

**Culture and Culture Plates**
$10^6$ to $10^9$ CFU for each bacteria
$10^6$ conidia/ml
Nutrient agar plates supplemented with common zinc oxide (CZO) and NZO (10-30 nm/80-100 nm)
9 mm inoculum plug was placed in center of plates

**Concentration**
0.25, 0.5, 1, 2, 3, 4, 5 mM concentrations for bacterial strains
5, 10, 15, 20, and 25 mM for fungal stains
25 mM for soybean

**Observation for Colony Forming Units (CFU)**
24 to 72 hr

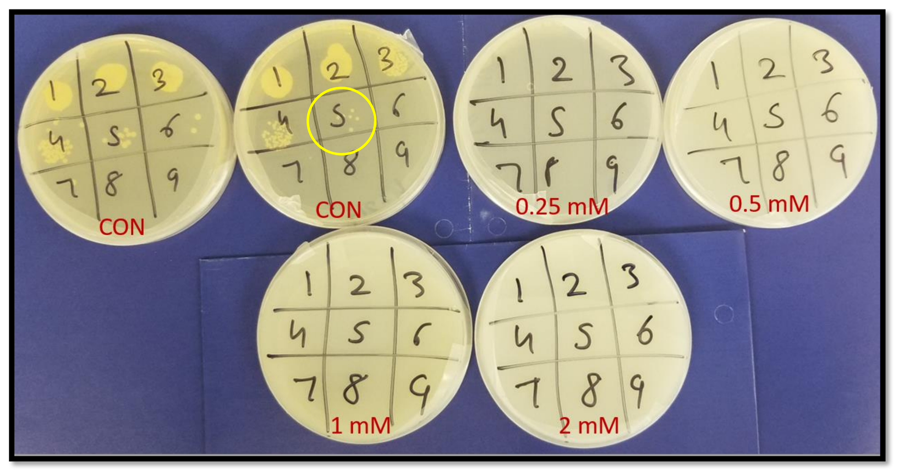
**Pots and Potting Media**
4-inch pots filled with vermiculite
Single application of NZO (25 mM;10-30 nm) /CZO (25 mM) at sowing

**Inoculation**
Roots of soybean inoculated at 7 days after germination with $10^6$ conidia/ml of (*Fusarium solani* : FS) and *Fusarium oxysporum* f. sp. *lycopersici* (Sacc.: FL)

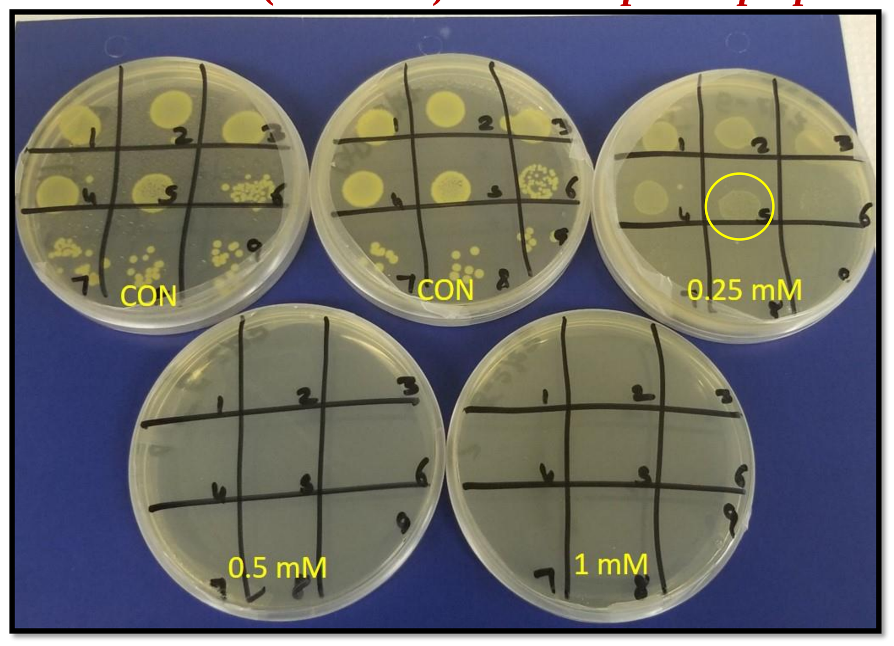
**Observations**
Root growth and fungal infection
Primary root length
Number of secondary roots
Number of tertiary roots

## *In vitro* Treatments

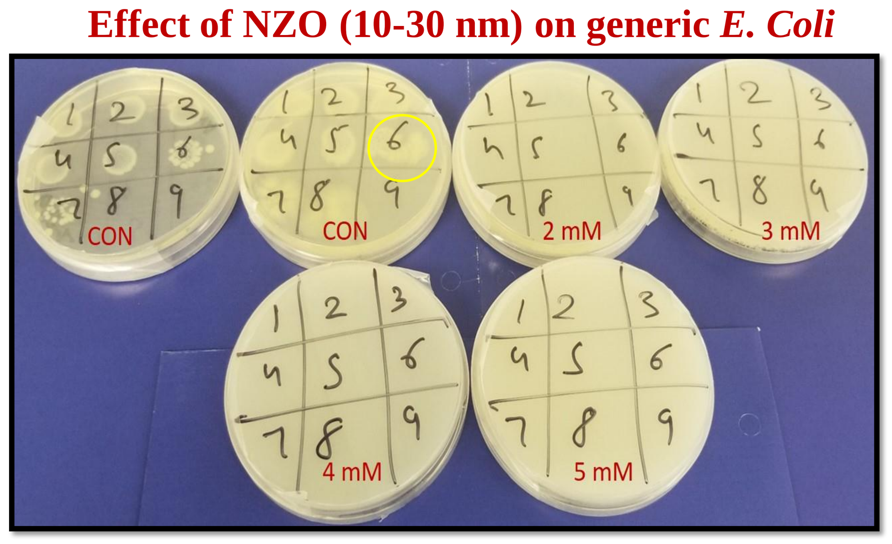
**Effect of NZO (10-30 nm) on *Erwinia amylovera***



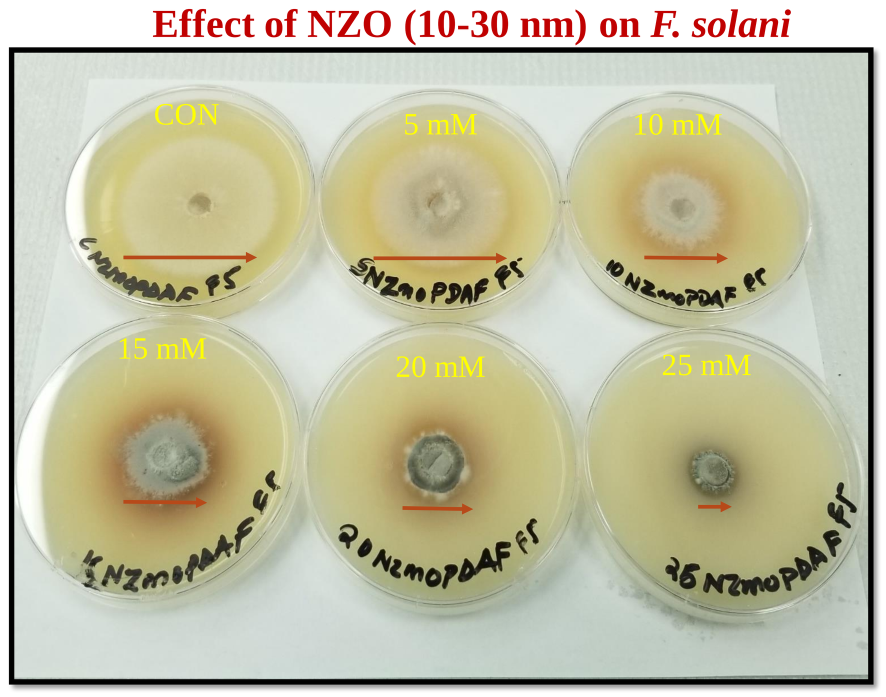

**Effect of NZO (10-30 nm) on *X. campestris pv. pruni***



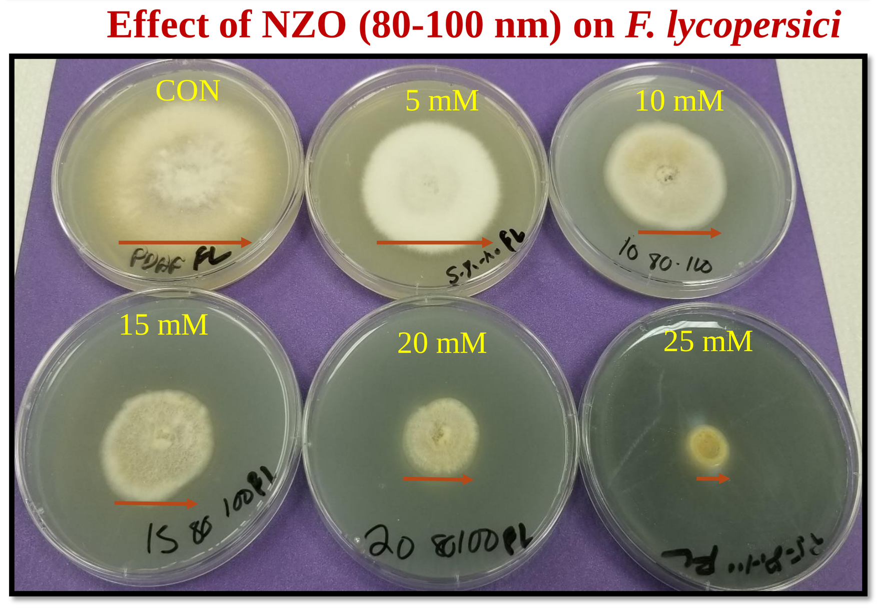

**Effect of NZO (10-30 nm) on generic *E. Coli***




**Effect of NZO (10-30 nm) on *F. solani***



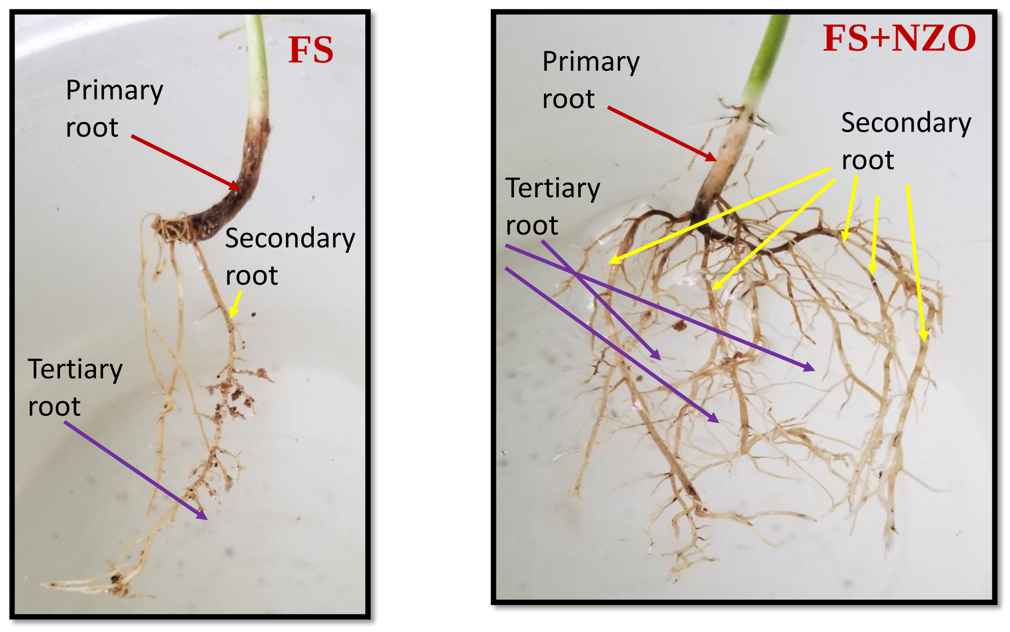

**Effect of NZO (80-100 nm) on *F. lycopersici***



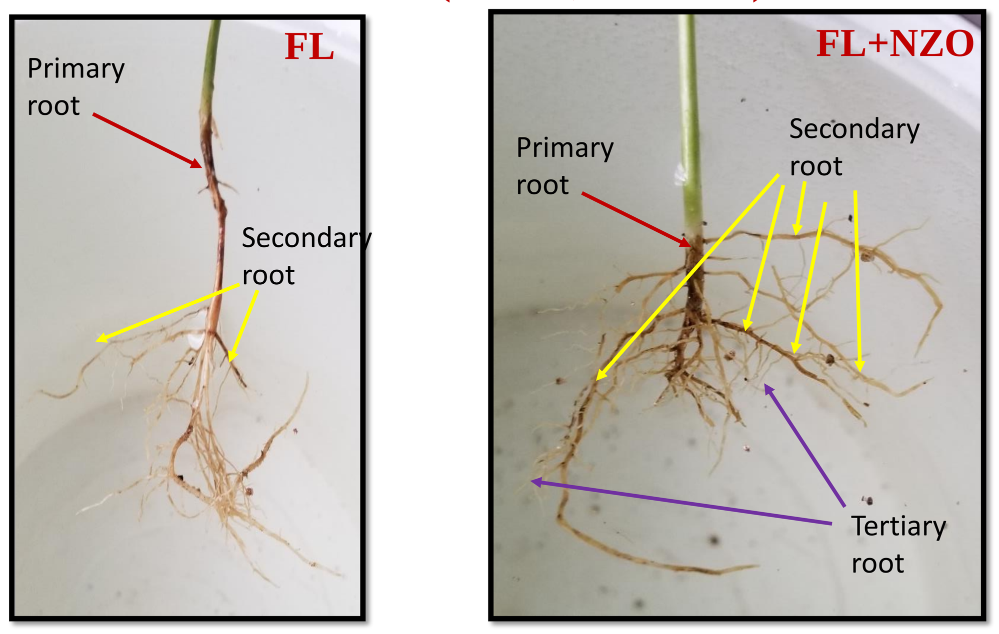

## *In vivo* Treatments

**Effect of NZO (25 mM; 10-30 nm)/CZO on Root Growth**


**Effect of FS and FS+NZO (25 mM; 10-30 nm) on Root Growth**




**Effect of FL and FL+NZO (25 mM; 10-30 nm) on Root Growth**




## Conclusions

**Nanoparticles of Zn effectively inhibited the growth of Fire Blight, Peach leaf spot, and *E.coli* within a range of 0.25 to 2 mM concentration. Common zinc oxide also inhibited the growth of Fire Blight, Leaf spot, and *E.coli*, but at 4 mM and higher concentrations (data not shown). Formulations of NZO can be used to manage Fire Blight, Peach leaf spot, and *E.coli* infection in plants.**

**NZO application decreased the length of primary root, but increased the number of secondary and tertiary roots in soybean. Secondary and tertiary roots play major roles in water and nutrient absorption.**

**FS and FL infection caused tissue decay in primary root and reduction in the number of secondary and tertiary roots in soybean**

**NZO application in FS and FL infected roots inhibited the tissue decay in primary root and increased the number of secondary and tertiary roots in soybean.**

**NZO is effective in the management of multiple plant pathogens. However, eco-toxicological studies are required to confirm the safe use of NP at commercial levels.**


Reference: Fraceto LF, Grillo R, de Medeiros GA, Scognamiglio V, Rea G and Bartolucci C (2016). Nanotechnology in Agriculture: Which Innovation Potential Does It Have? Front. Environ. Sci. 4:20
: Rico, MC, Majumdar, S, Duarte-Gardea, M, Peralta-Videa, J and Gardea-Torresdey, JL. 2011. Interaction of Nanoparticles with Edible Plants and Their Possible Implications in the Food Chain. J. Food. Agric. Chem. 59 (8): 3485-3498.