**Nanotechnology for Abiotic and Biotic Stress Mangement in Soybean**

Multiple experiments were conducted in vitro and in vivo during 2018-2020 to explore the role of Nano-Zinc-oxide (NZO: 10-30 nm, 40-60 nm, and 80-100 nm) and Common-Zn-oxide (CZO; µm) in addressing abiotic and biotic stress management. Our results showed the effective management of soybean looper in vitro by using NZO (10-30nm). This treatment caused 100% mortality of larvae within 5 to 24 hr after application. NZO of different sizes effectively inhibited the growth of root rot fungal pathogens, *Fusarium solani* (FS) and *Fusarium oxysporum* f. sp. *lycopersici* (FL). NZO (10-30 nm, 40-60 nm, and 80-100 nm) completely suppressed the growth of FS and FL at 25 mM concentration using in vitro conditions. Based on in vitro data, 25 mM concentration and 10-30 nm size was selected for in vivo experiments to manage these fungal pathogens, Pots with sterilized vermiculite were used for fungal inoculation and nanoparticle treatments. NZO (10-30 nm) and CZO at 25 mM concentration was applied through drenching. Application of both NZO and CZO showed toxic effects on shoot morphology, but positive effects on root morphology. NZO application increased both the number and size of secondary and tertiary roots. In addition, NZO partially restored the FS and FL compromised root and shoot system in soybean by managing root growths and dry matter partitioning. NZO and CZO both shift biomass allocation towards the root system. Major conclusions of this work are:

1: NZO (10-30 nm) is the most effective nanoparticle to manage soybean looper using *in vitro* conditions.

2: NZO (10-30 nm, 40-60 nm, and 80-100 nm) particles at 25 mM concentration effectively inhibited the growth of Gray mold, *Fusarium solani*, and *Fusarium oxysporum* f. sp. *lycopersici.*

3: NZO (10-30 nm) particles at 25 mM concentration *in vivo* showed toxic effects on shoot growth and development. However, positive effects were observed on root growth in terms of higher number and larger size of secondary and tertiary roots.

4: Nanoparticles of ‘Zinc’ shifts more biomass accumulation towards root growth and development, which can be utilized to mine nutrients from the soil.

5: NZO (10-30 nm) particles at 25 mM concentration partially overcome the FS and FL compromised root system but failed to recover the above ground plant parts.

6: NZO (10-30 nm) particles at 25 mM concentration effectively managed fungal growth *in vitro,* but failed to completely suppress the fungal growth *in vivo*.

7: Future work is required to manipulate NZO concentrations to promote soybean root growth without interfering with shoot growth. This approach will help sustainable nutrient mining on the Delmarva Peninsula.

8: We also suggest to testing nano-chitosan for the management of soybean root diseases.

9: These treatments were effective on the target organisms and promoted root growth, but ariel portions did not recover/benefit. These preliminary studies are not yet ready for effective field control of the infections and can reduce yield potential.