Effects of Zinc Oxide Nanoparticles on Drought Tolerance in Winter Wheat

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Introduction

• Drought commonly decreases dryland wheat yields in Utah and globally.

• Zn is important to cell membrane structure, maintaining leaf water status, and superoxide dismutase (SOD) production (Ghanepour et al. 2015).

What is a Nanoparticle?

- A nanometer is $10^{-9}$ m (one billionth)
- A particle less than 100 nm in at least 1 dimension
- Nano-size particles are smaller than cells, thus can interact with an organism on a cellular level

http://www.thepipettepen.com/blog/nanomedicine-how-much-are-we-willing-to-pay/
Nano Effect?

- Cu and Zn nanoparticles (NPS) increase drought tolerance in certain wheat varieties (Taran et al. 2017).
- ZnO NPs could not be detected in soil after 1 hr incubation (Wang et al. 2013).
SEM Image of Wheat Root Grown with PcO6 and ZnO NPs: 10 days
Hypothesis

ZnO nanoparticle (NP) amendments will mitigate water stress in wheat (*Triticum aestivum*) inoculated with *Pseudomonas chlororaphis* isolate O6 (*PcO6*).
Methods

• Wheat seeds (v. Juniper) inoculated with *Pseudomonas chlororaphis* isolate O6 (*PcO6*)

• Inoculated seeds planted in sand amended with Zn
  • 0.5 mg/kg Zn as ZnO NPs*
  • 5 mg/kg Zn as ZnO NPs*
  • 5 mg/kg Zn as bulk ZnO
  • 2.8 mg/kg Zn as bulk ZnSO₄*7H₂O
    • ZnO nanoparticles: 10-30 nm (SkySprings Nanomaterials)

• Plants were grown under white LED lights (111-538 µmol/m²/s).

• After 14 days water stress was induced in half of the pots for each treatment.
Results

The moisture content differences between the drought and control treatments were significant ($p < 0.05; n = 6$); whereas, differences between the Zn treatments were not. PcO6 was included in every treatment.

Differences in maximum quantum yield of PSII ($F_v/F_m$) between the drought and control treatments were significant ($p < 0.05; n = 6$); whereas differences between the Zn treatments were not.
Conclusions

• No significant difference in water stress was observed between plants grown in sand amended with Zn as ZnO NPs, bulk ZnO, or bulk ZnSO$_4$; however visual observations and trends in measured data suggest that a nanoparticle effect may exist.

• Future experiments should include more replicates to determine if subtle effects are present.


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