Effects of Zinc Oxide Nanoparticles on Drought Tolerance in Winter Wheat

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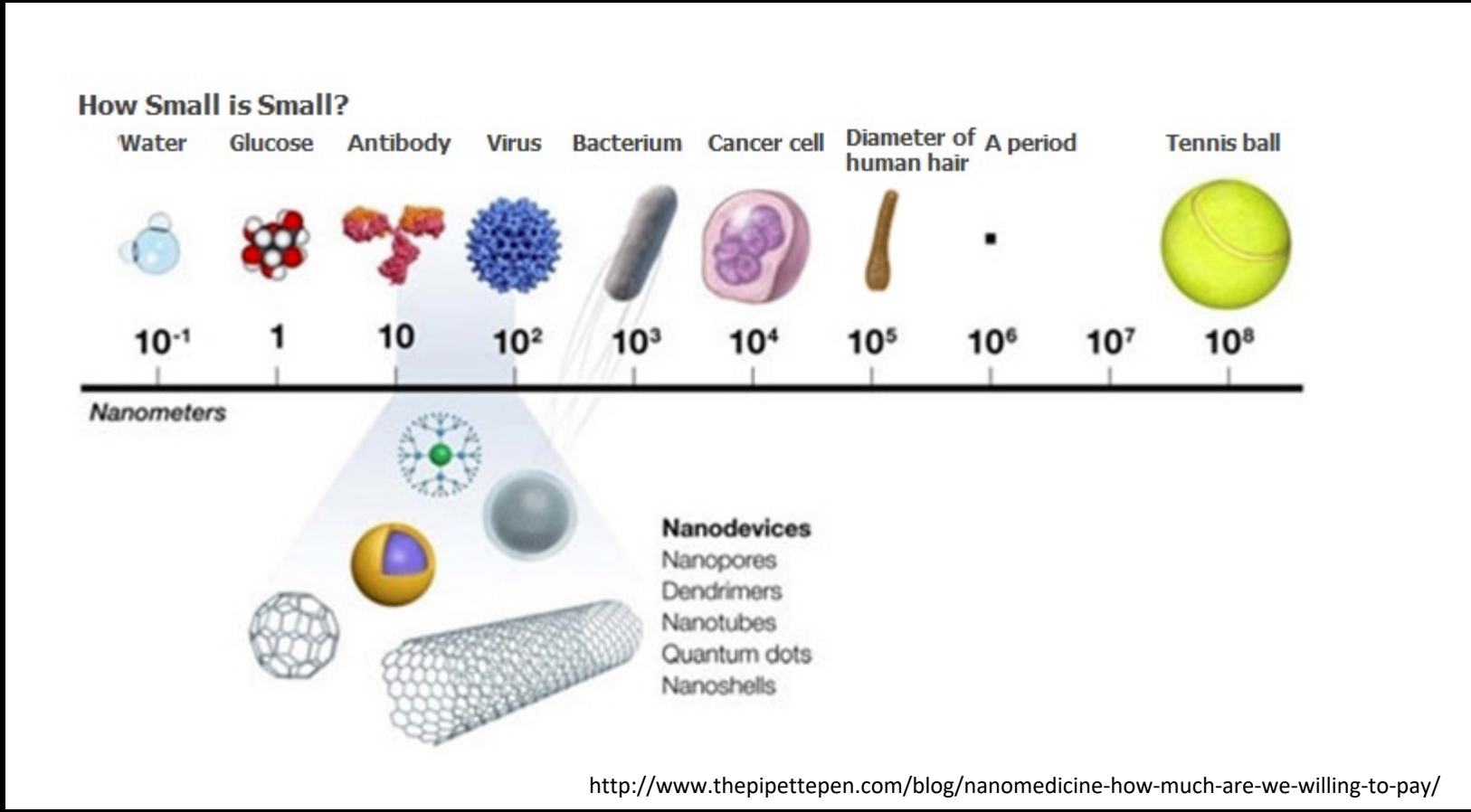
Introduction

- 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).

https://www.agric.wa.gov.au/mycrop/diagnosing-spring-drought-wheat-and-barley

What is a Nanoparticle?

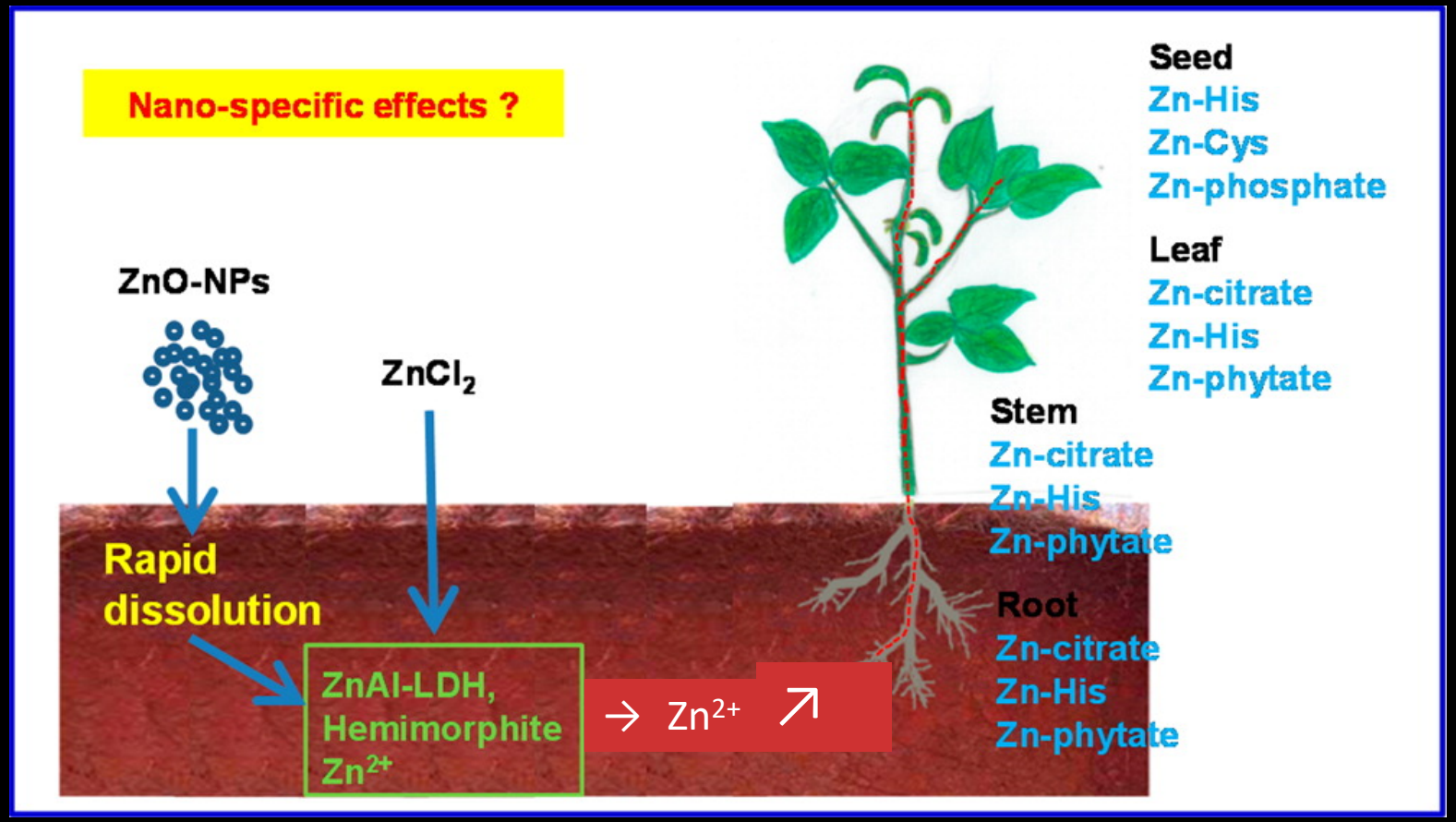
- A nanometer is 10^{-9} m (one billionth)
- A particle less than 100 nm in at least 1 dimension
- Nano-size particles are smaller than cells, thus can interact with an organism on a cellular level



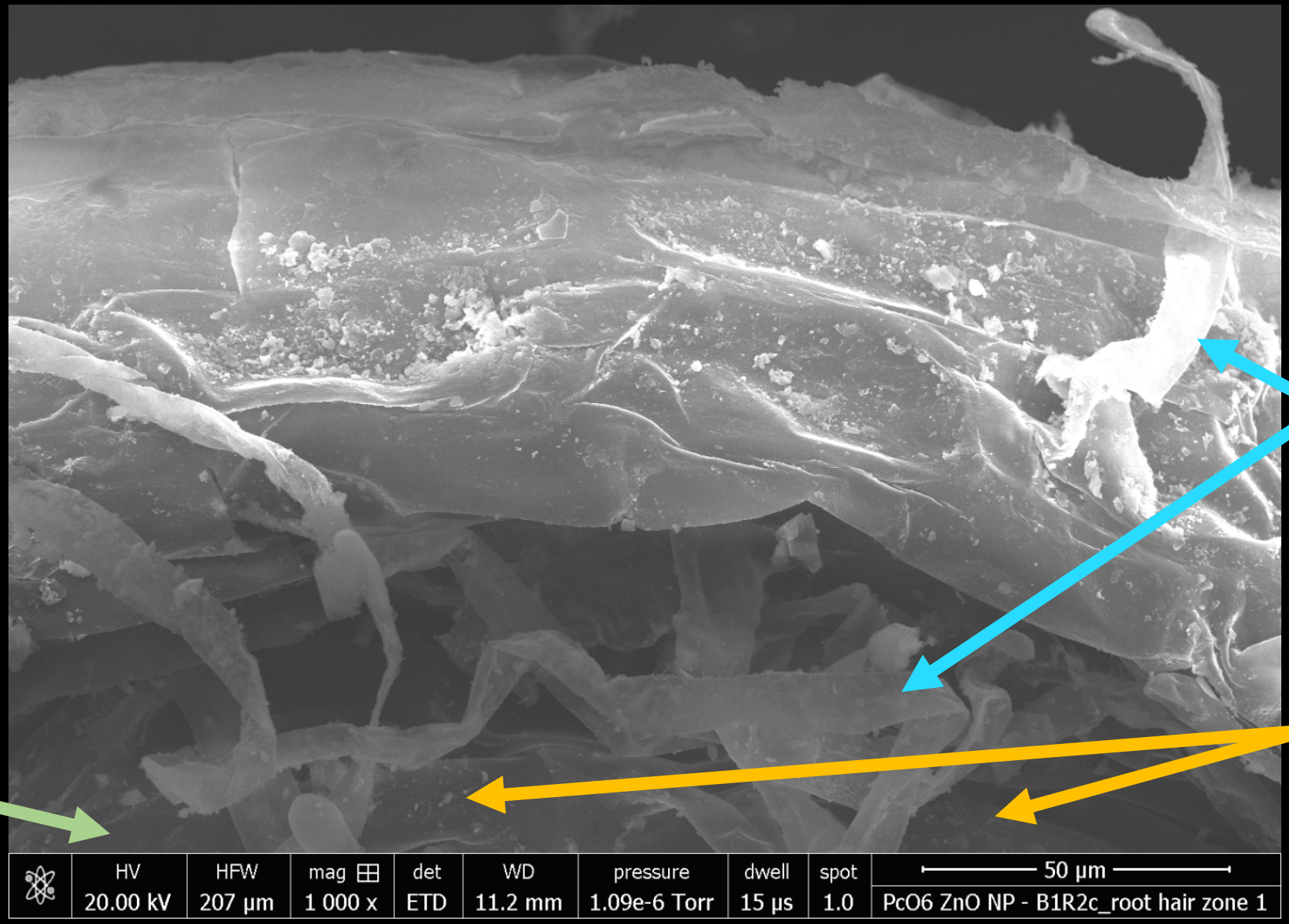
http://www.thepipettepen.com/blog/nanomedicine-how-much-are-we-willing-to-pay/

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 *Pc*O6 and ZnO NPs: 10 days



Hypothesis

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

Methods

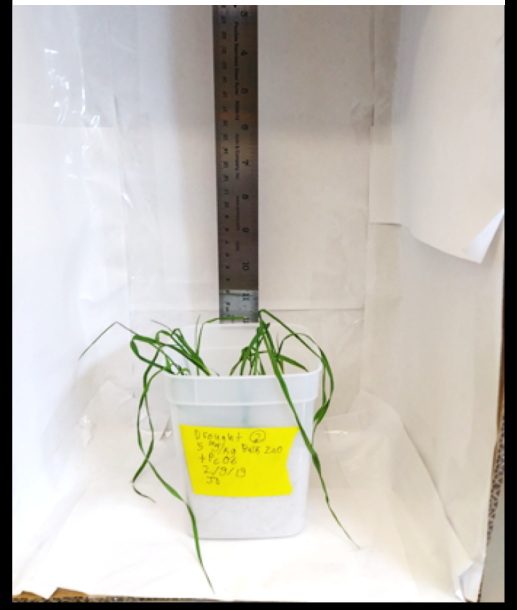
- Wheat seeds (v. Juniper) inoculated with *Pseudomonas chlororaphis* isolate O6 (*Pc*O6)
- Inoculated seeds planted in sand amended with Zn
  - 0.5 mg/kg Zn as ZnO NPs*
  - 5 mg/kg Zn as ZnO NPs*
  - 5 mg/kg Zn as bulk ZnO
  - 2.8 mg/kg Zn as bulk $ZnSO_4*7H_20$
    - ZnO nanoparticles: 10-30 nm (SkySprings 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.

Control 5 mg/kg ZnO NP

Drought 5 mg/kg ZnO NP

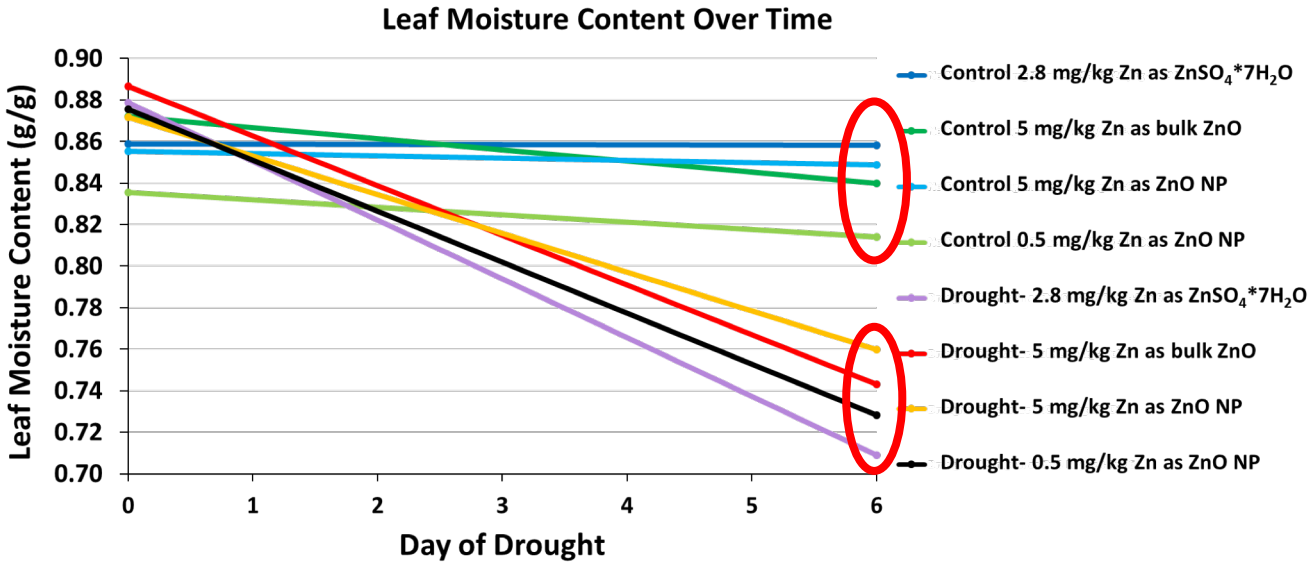
Control 5 mg/kg bulk ZnO

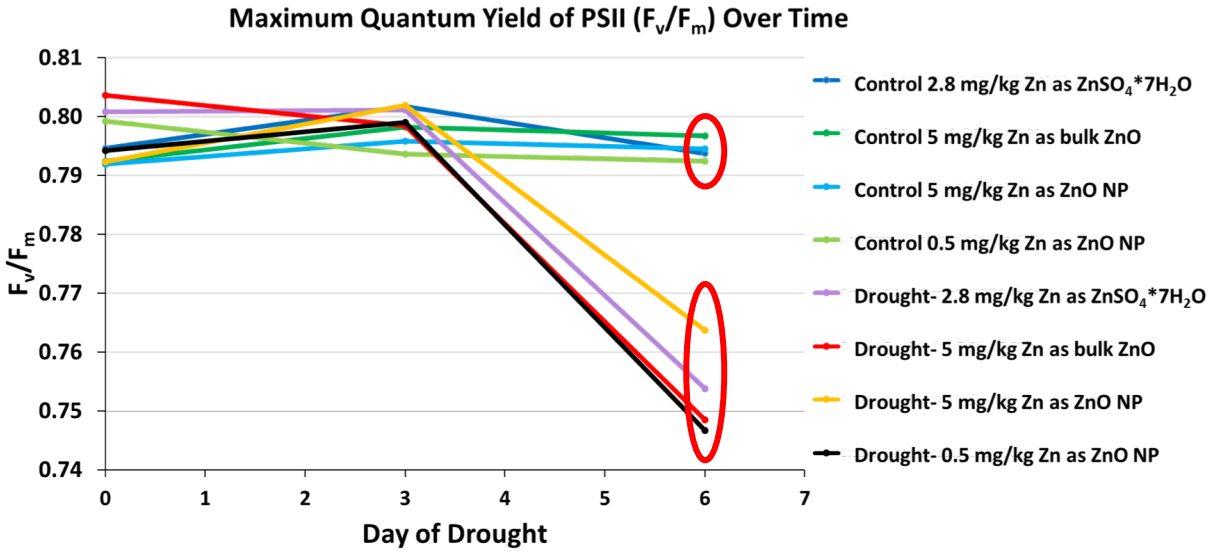
Drought 5 mg/kg bulk ZnO



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.

Refrences

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Acknowledgements

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