

# Impact of Earthworm Activity on the Transformation and Distribution of 2,4,6-trinitrotoluene (TNT) in Soils



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# TNT Contamination

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- TNT contamination is a concern at many military facilities
  - Large scale production over last 100 years
  - 1.2 million tons of contaminated soil
  - Health and ecological effects
  - Toxicity studies indicate an impact on many soil dwelling organisms

# Earthworm Activity

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- Earthworms have an impact on various soil properties
  - Physical (aggregate size distribution)
  - Biological (microbial biomass)
  - Chemical (carbon content)
- Earthworms have shown potential as a tool in contaminant remediation

# Research Objectives

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- Determine the influence earthworms have on the:

- distribution
- transformation
- bioavailability



of TNT within soil aggregates

# Methods and Materials

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## -Soils:

### Appling Sandy Loam (GA)

- TC 1.25%      - CEC 5.6 meq/100g
- Clay 15.7%   - pH 5.4

### Theresa Silt Loam (WI)

- TC 2.88%      - CEC 19.1 meq/100g
- Clay 15.1%   - pH 6.8

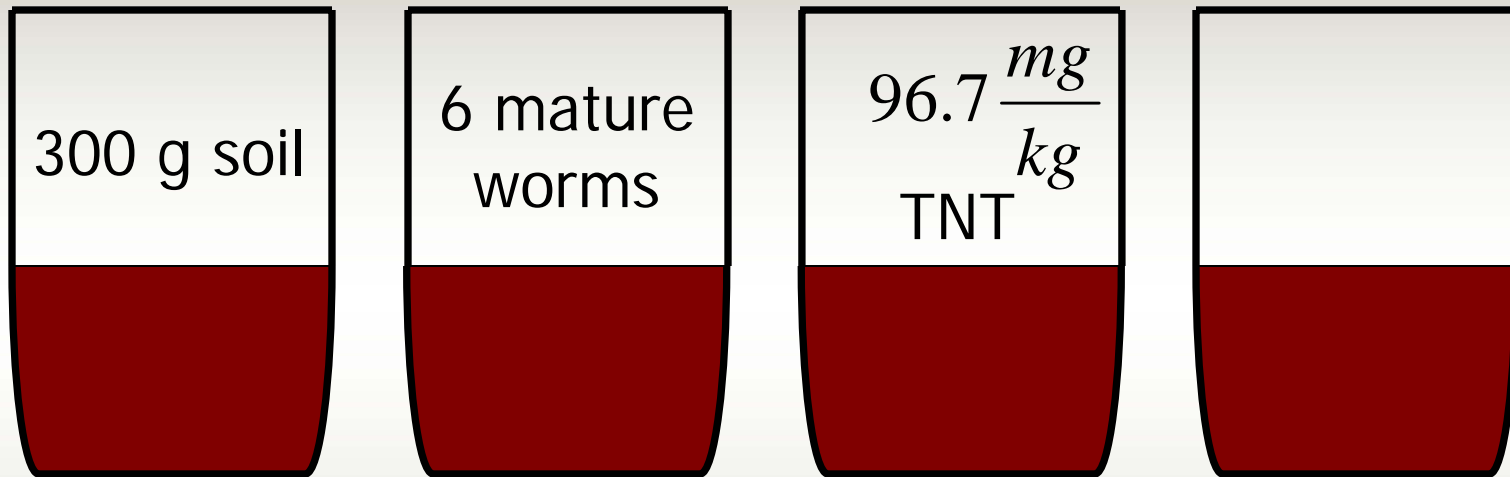
## -Worms: *Eisenia fetida*

- Mature worms (with visual clitellum)
- Worms selected for uniformity in size and mass

# Methods and Materials

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1 L mason jars



Control

Worm Only

TNT Only

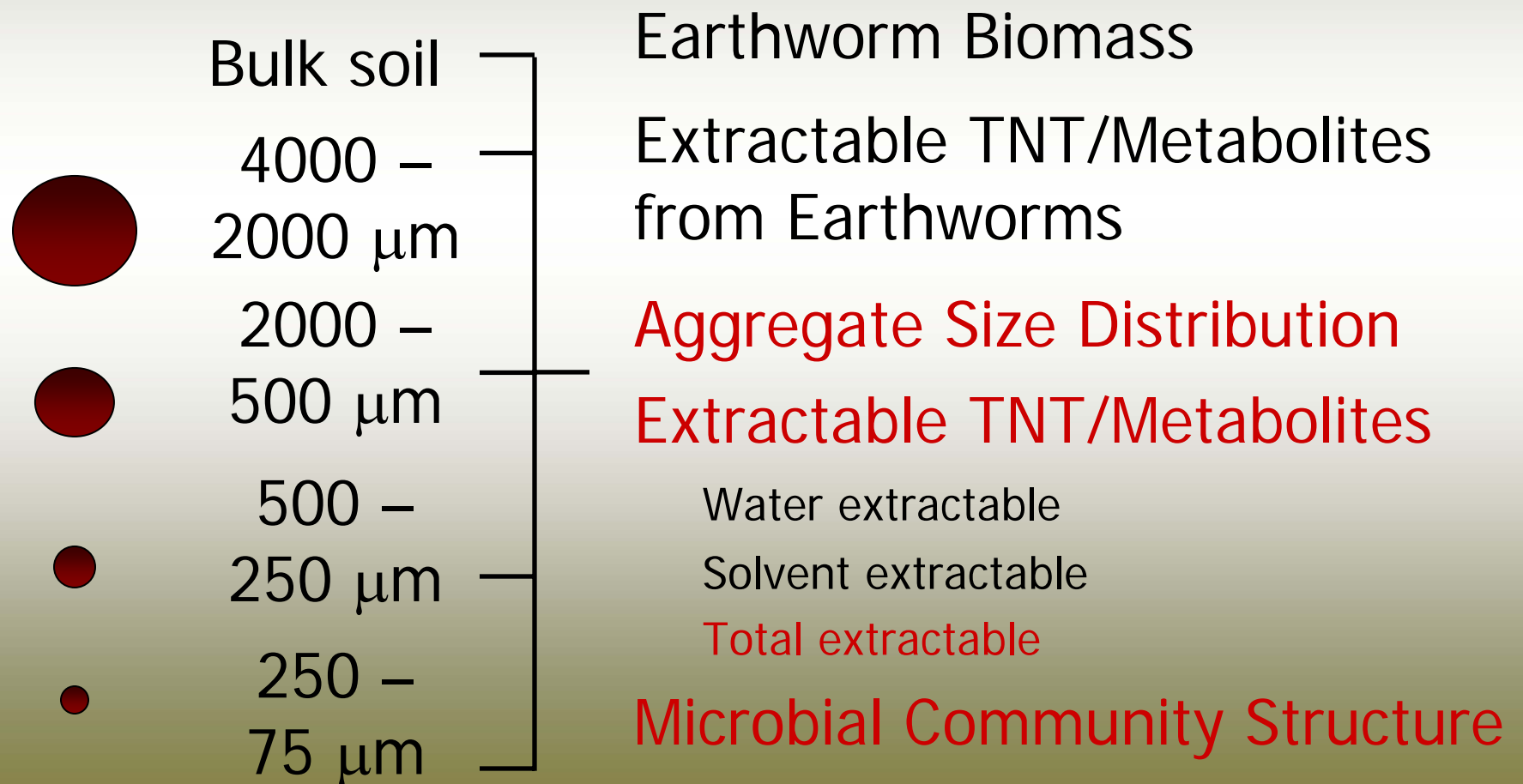
Worm/TNT

- TNT delivered in 20 mL of Acetonitrile
- Moisture content maintained at 70% FC
- 4 time periods (0, 7, 14, and 21 days), 3 replicates

# Methods and Materials

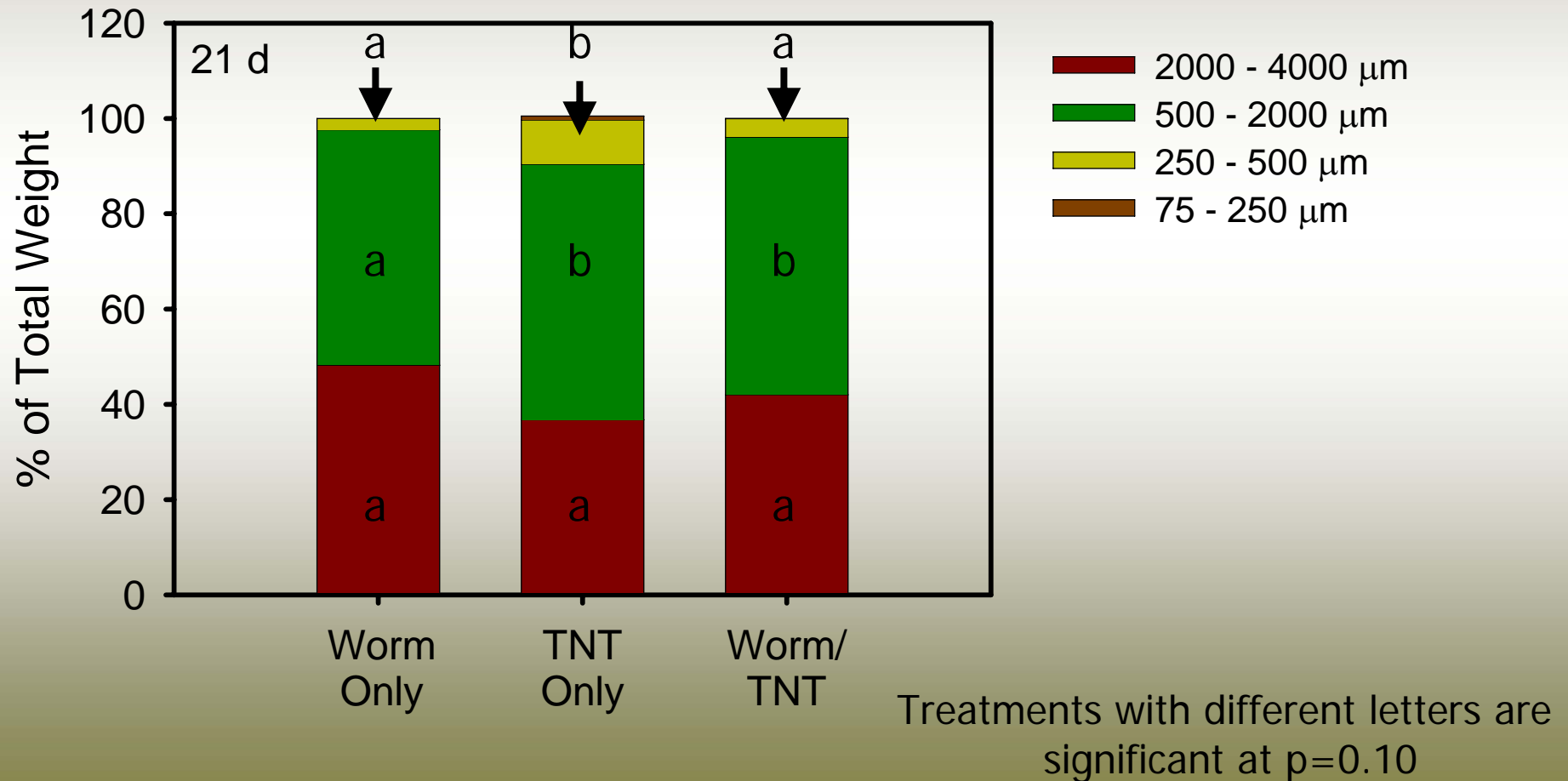
Soil dry sieved  
(Ro-Tap<sup>©</sup> shaker)

Analysis



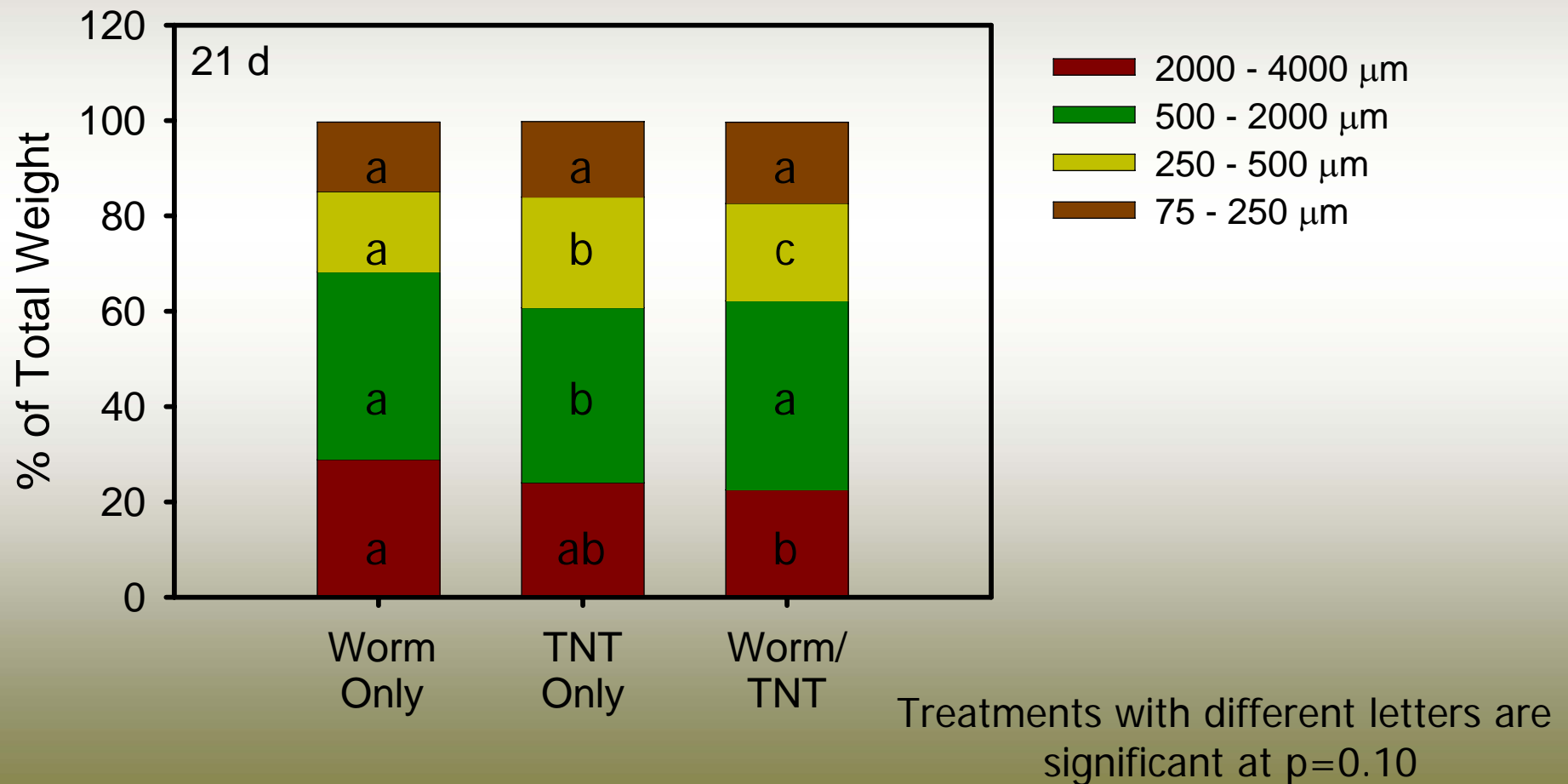
# Aggregate Size Distribution

Applying sandy loam (GA)



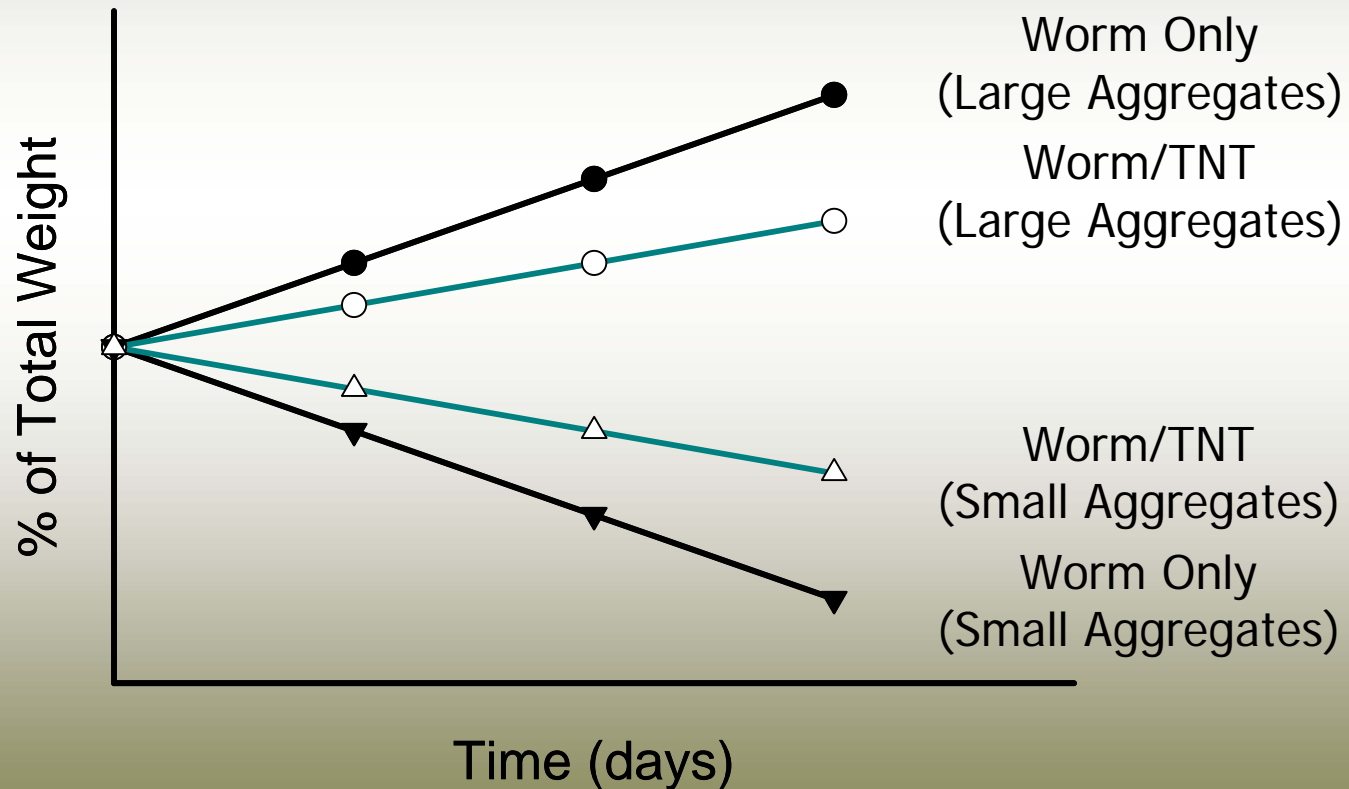
# Aggregate Size Distribution

Theresa silt loam (WI)

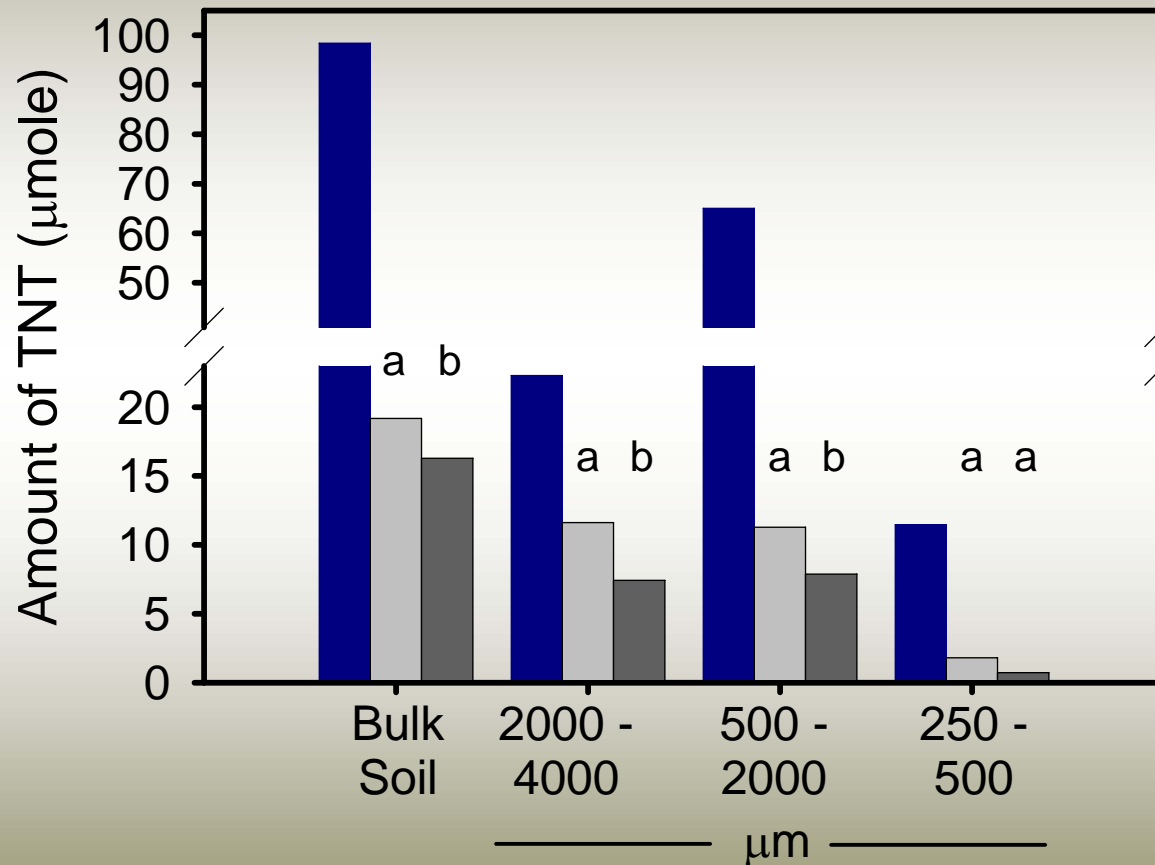


# Aggregate Size Distribution

## Qualitative Assessment



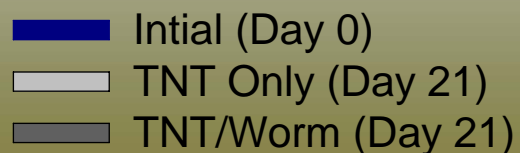
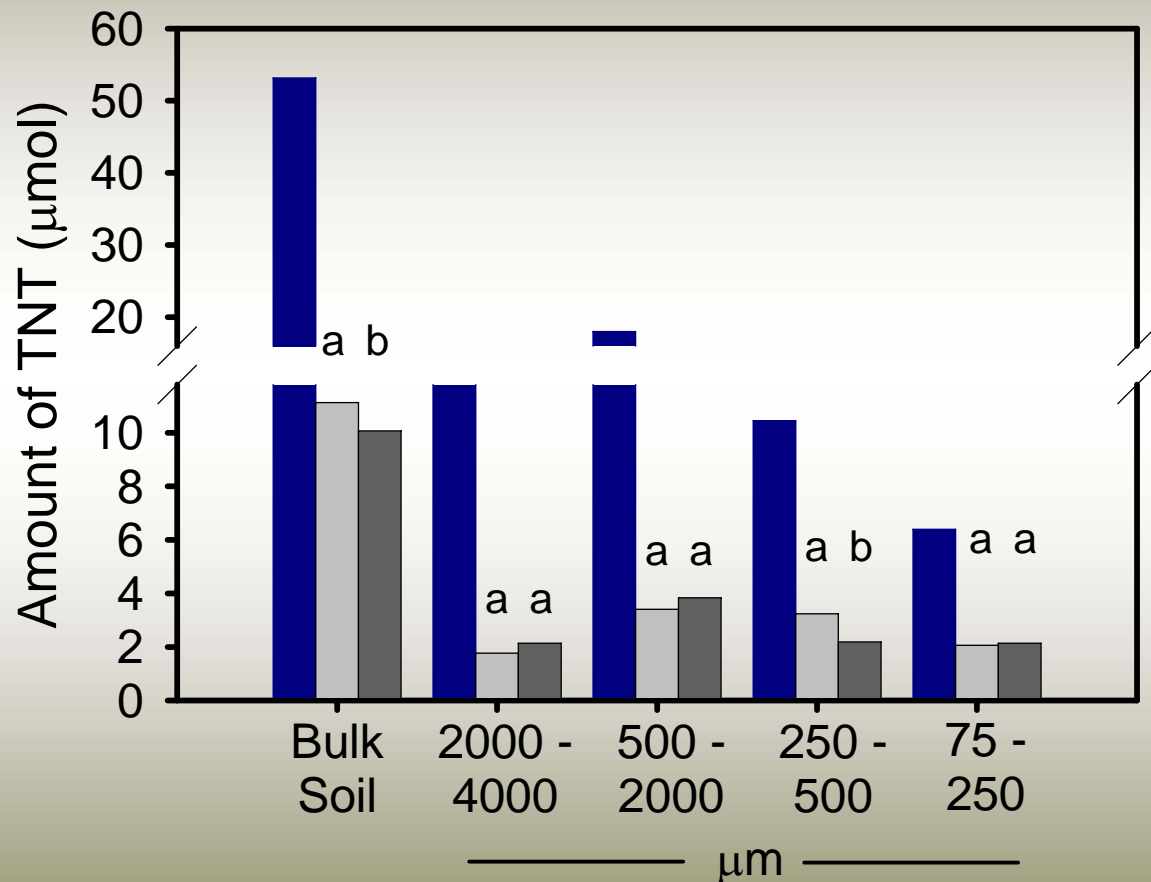
# Total Extractable TNT (GA)



- Initial (Day 0)
- TNT Only (Day 21)
- TNT/Worm (Day 21)

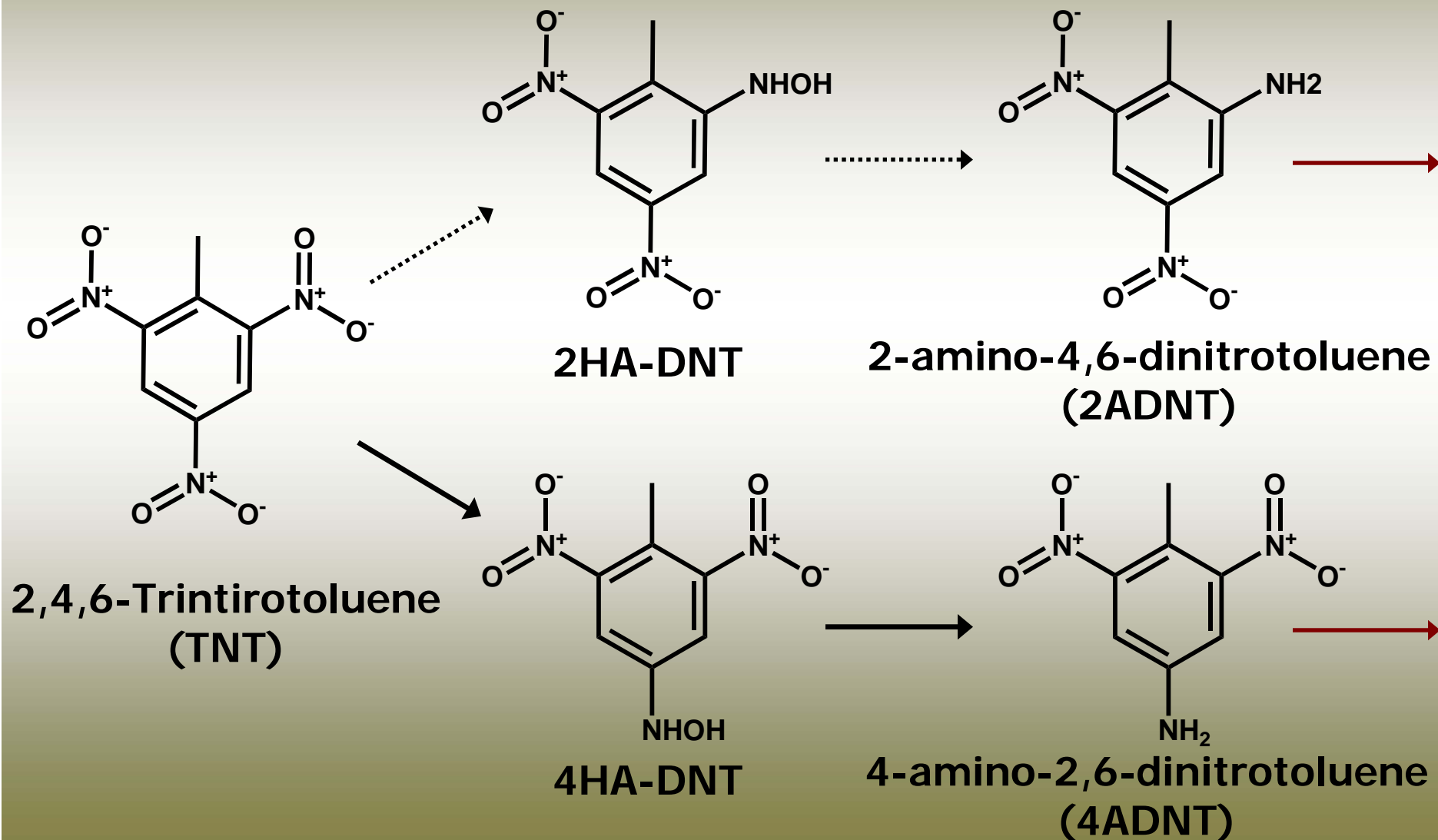
Treatments with different letters are significant at  $p=0.10$

# Total Extractable TNT (WI)

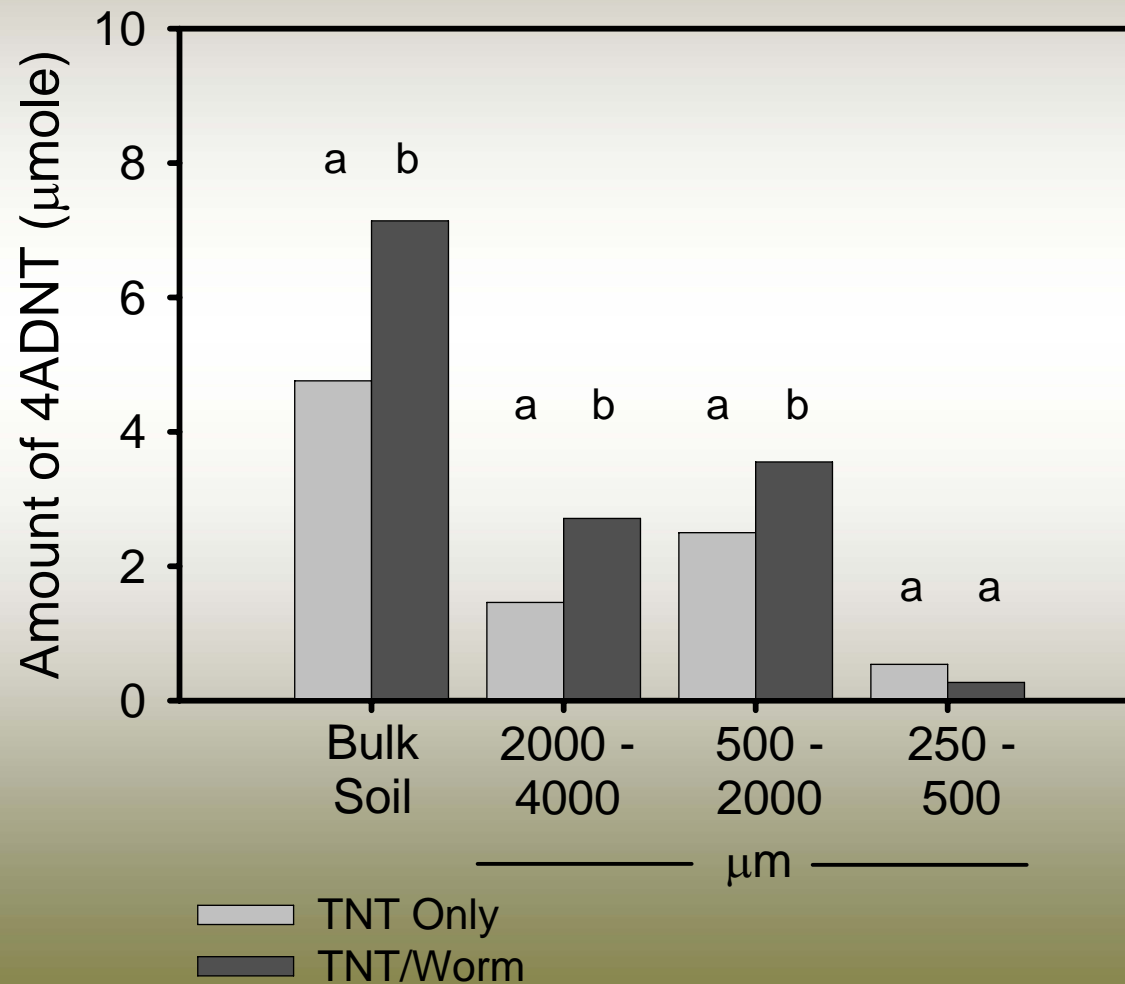


Treatments with different letters are significant at  $p=0.10$

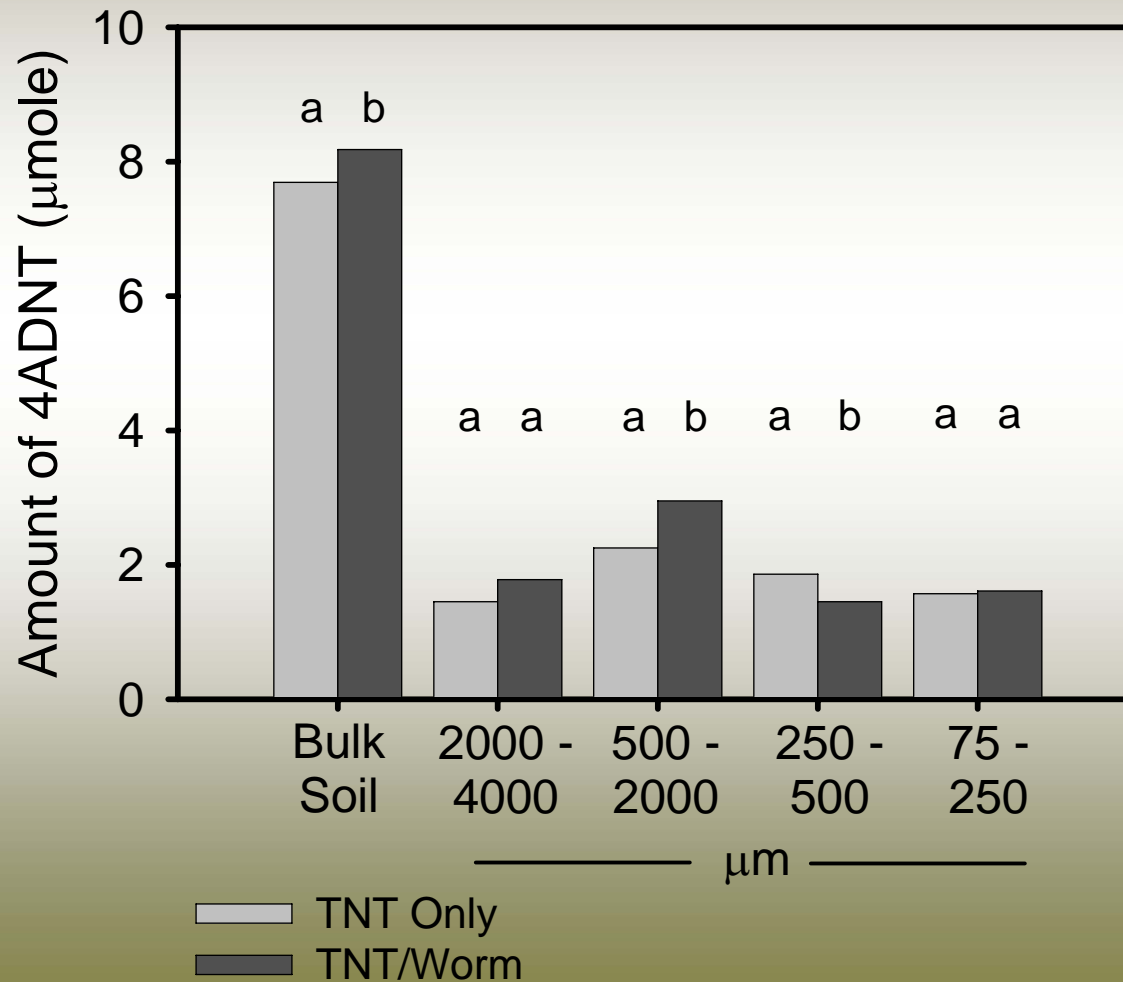
# Transformation Pathway



# Metabolites – 4ADNT (GA)

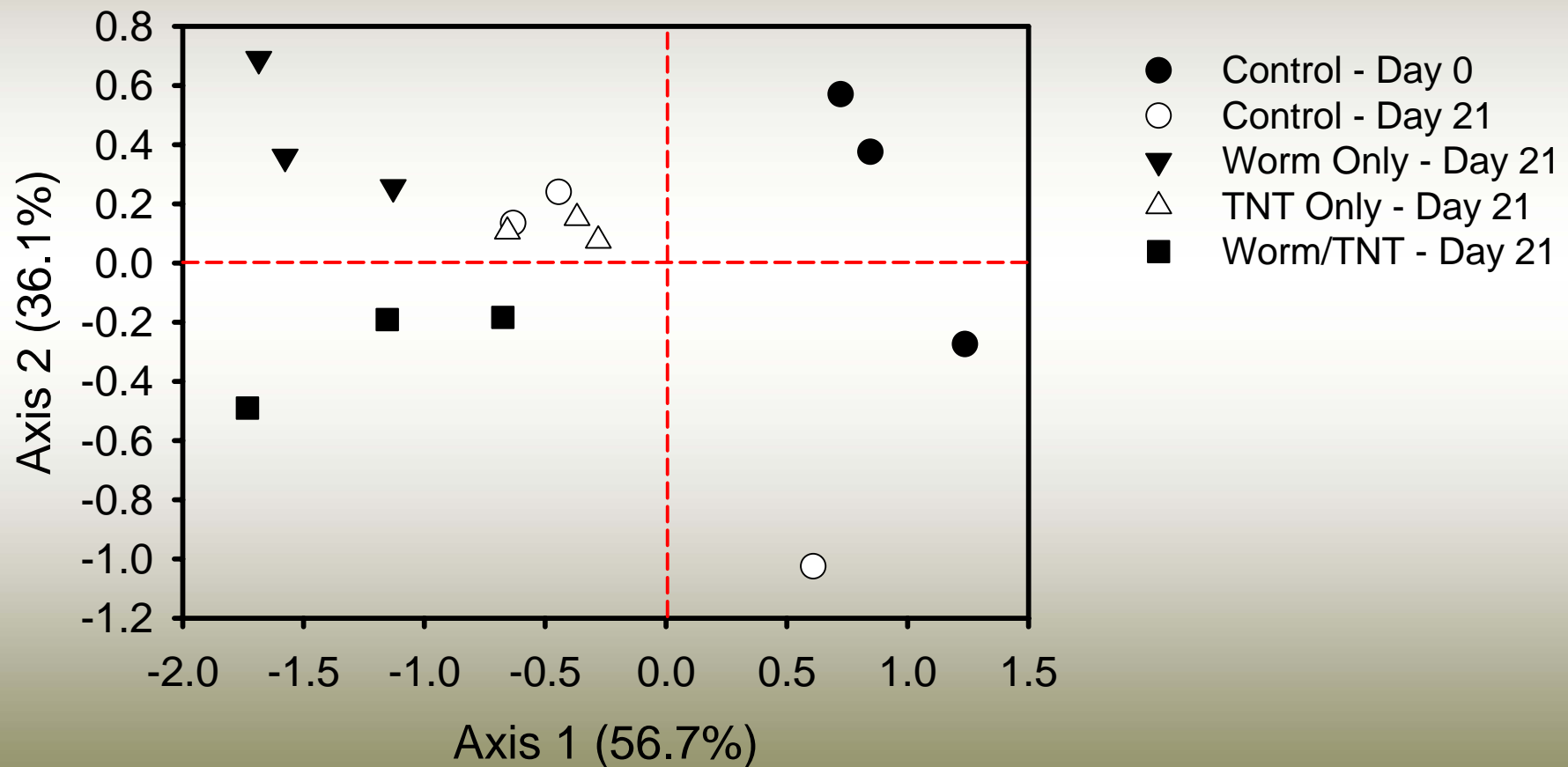


# Metabolites – 4ADNT (WI)



# Microbial Community (WI)

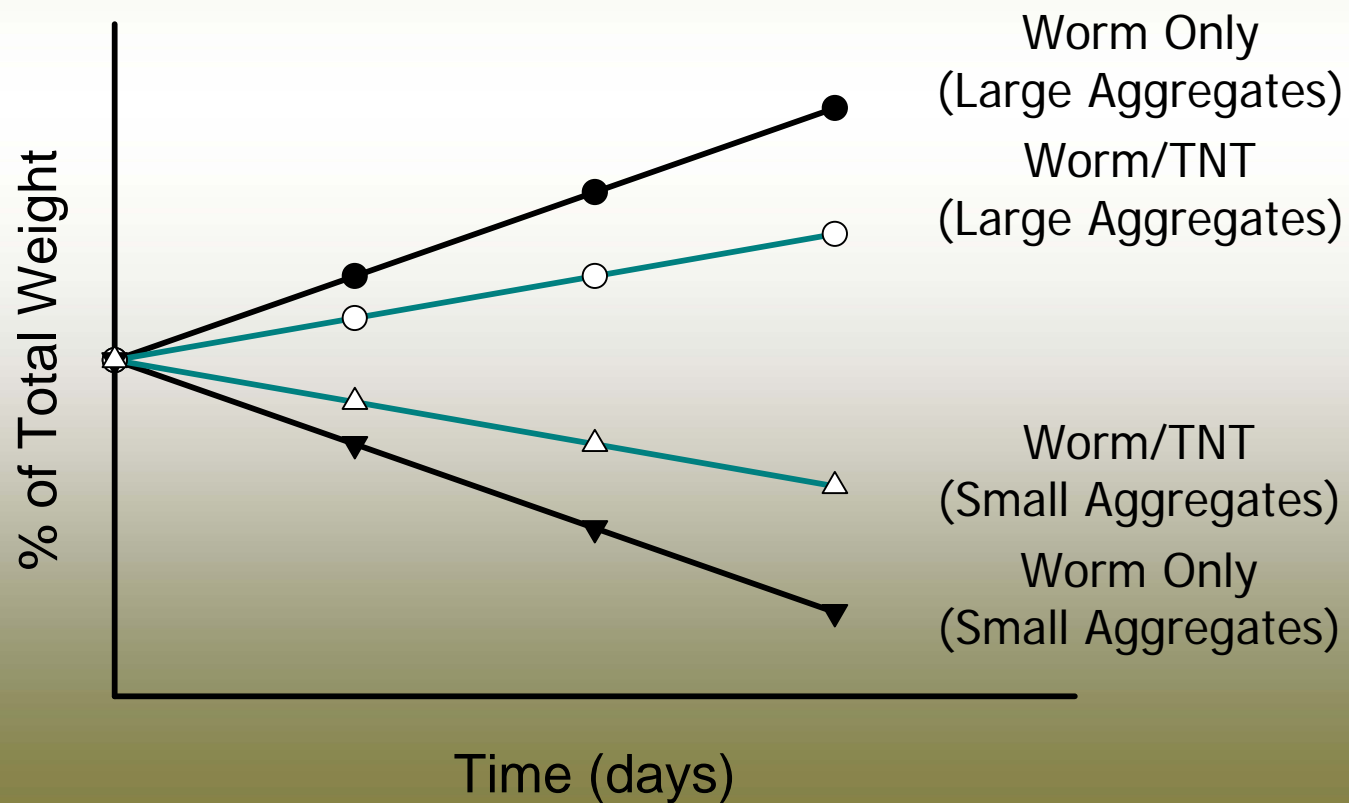
## Theresa silt loam (WI)



# Summary

Earthworm activity:

- was reduced in TNT spiked soil

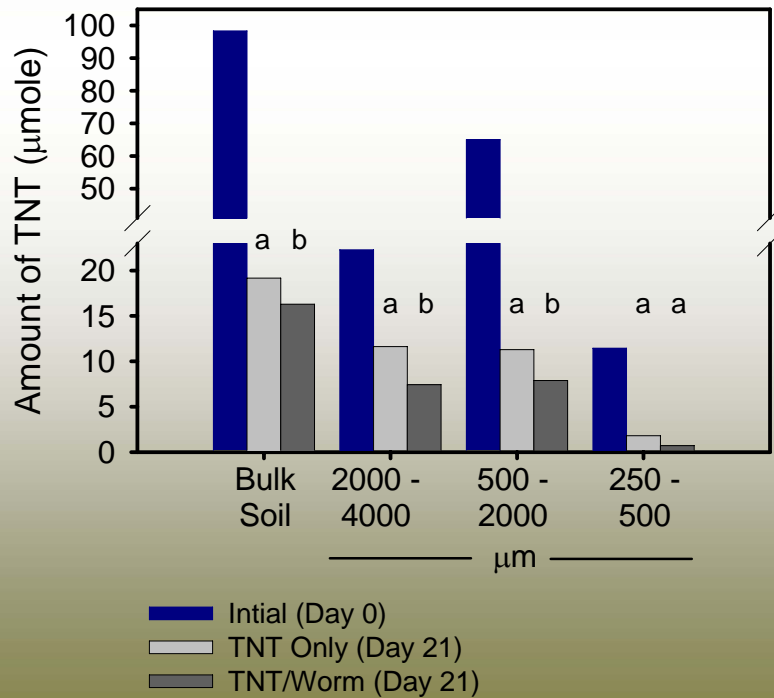


# Summary

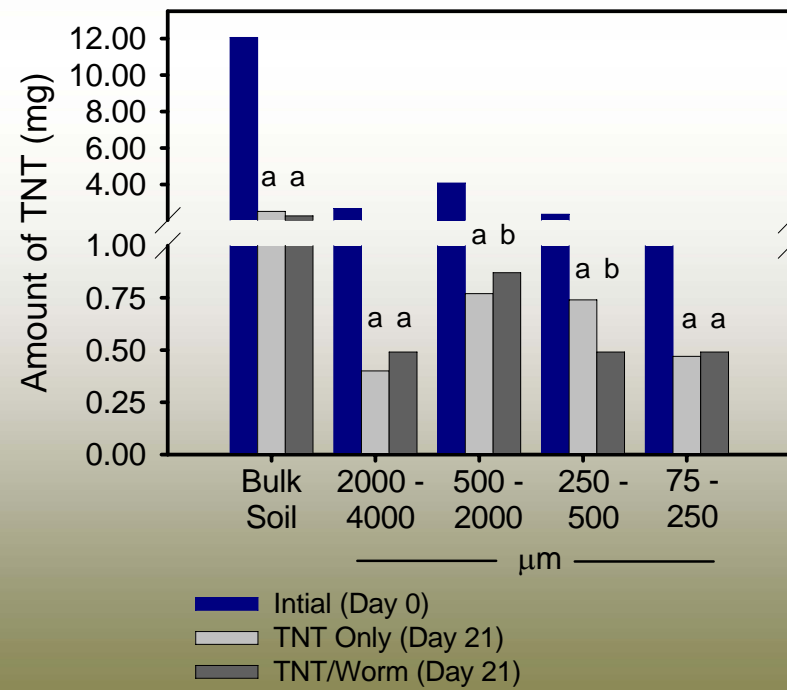
## Earthworm activity:

- facilitated a reduction in extractable TNT

Applying sandy loam (GA)



Theresa silt loam (WI)

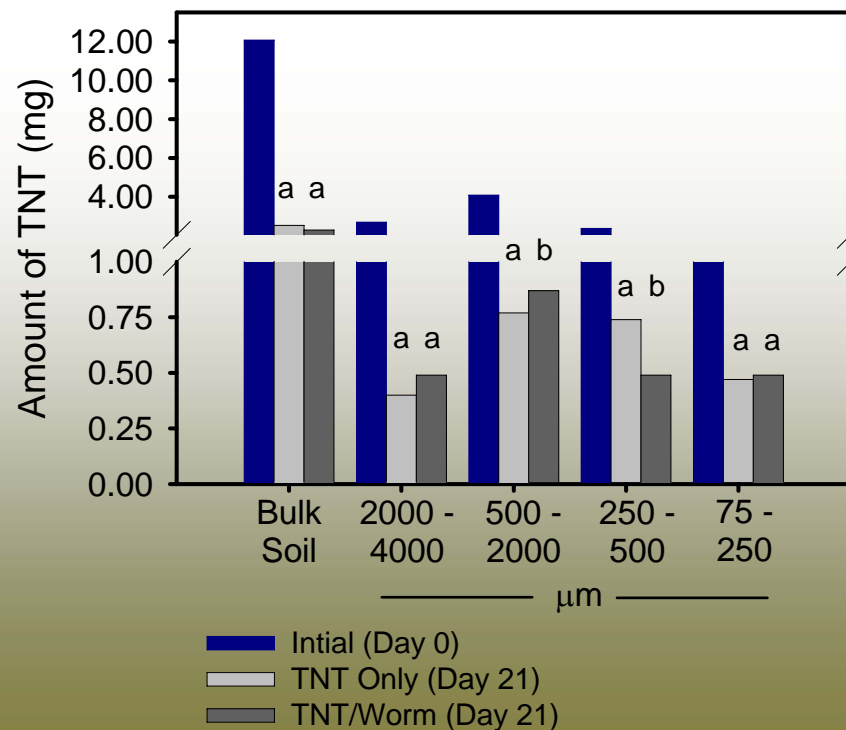


# Summary

## Earthworm activity:

- had a potential effect on the distribution of TNT in soil aggregates

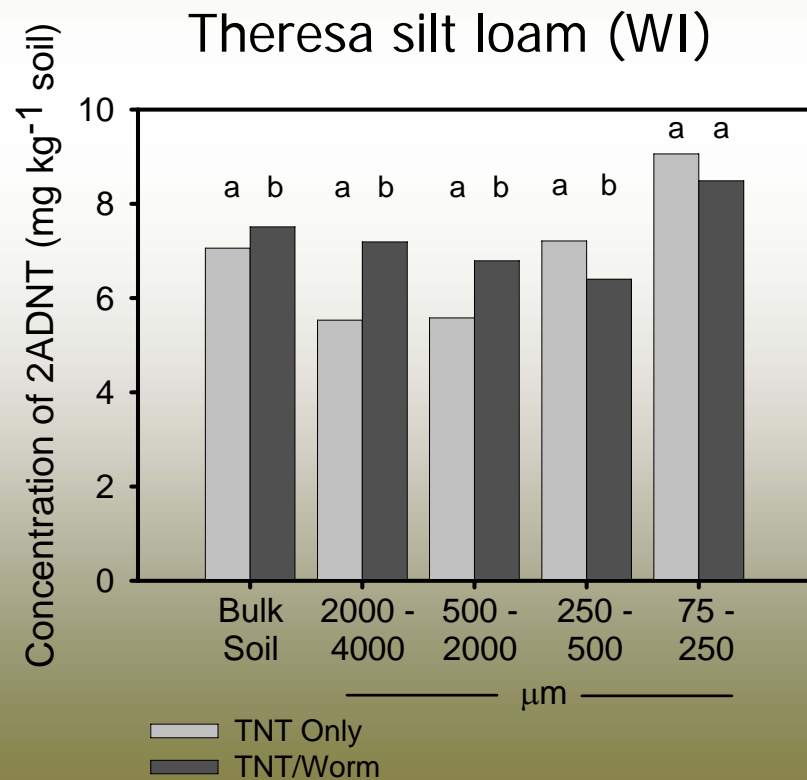
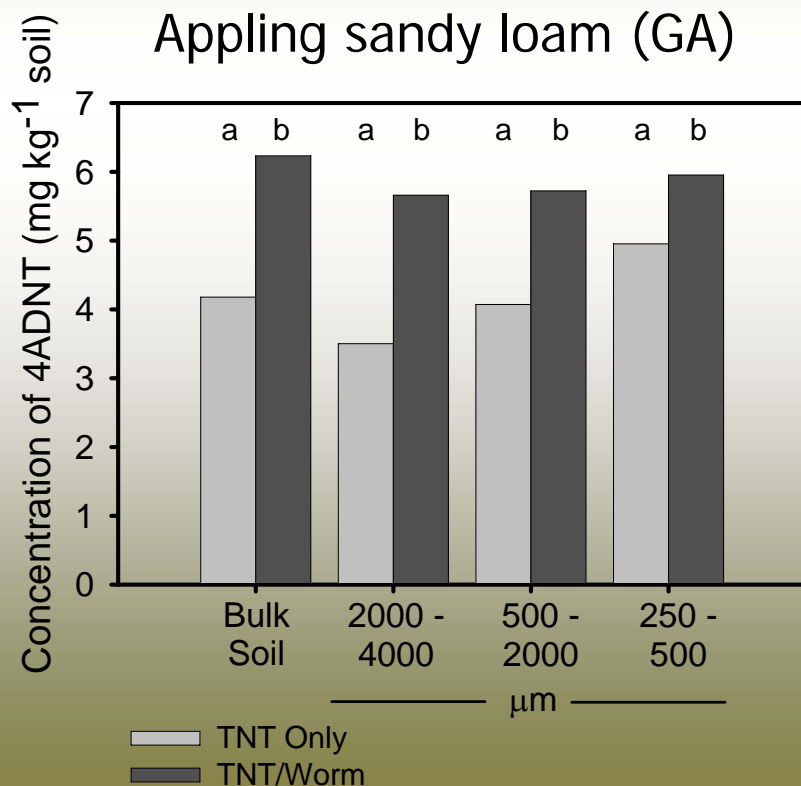
Theresa silt loam (WI)



# Summary

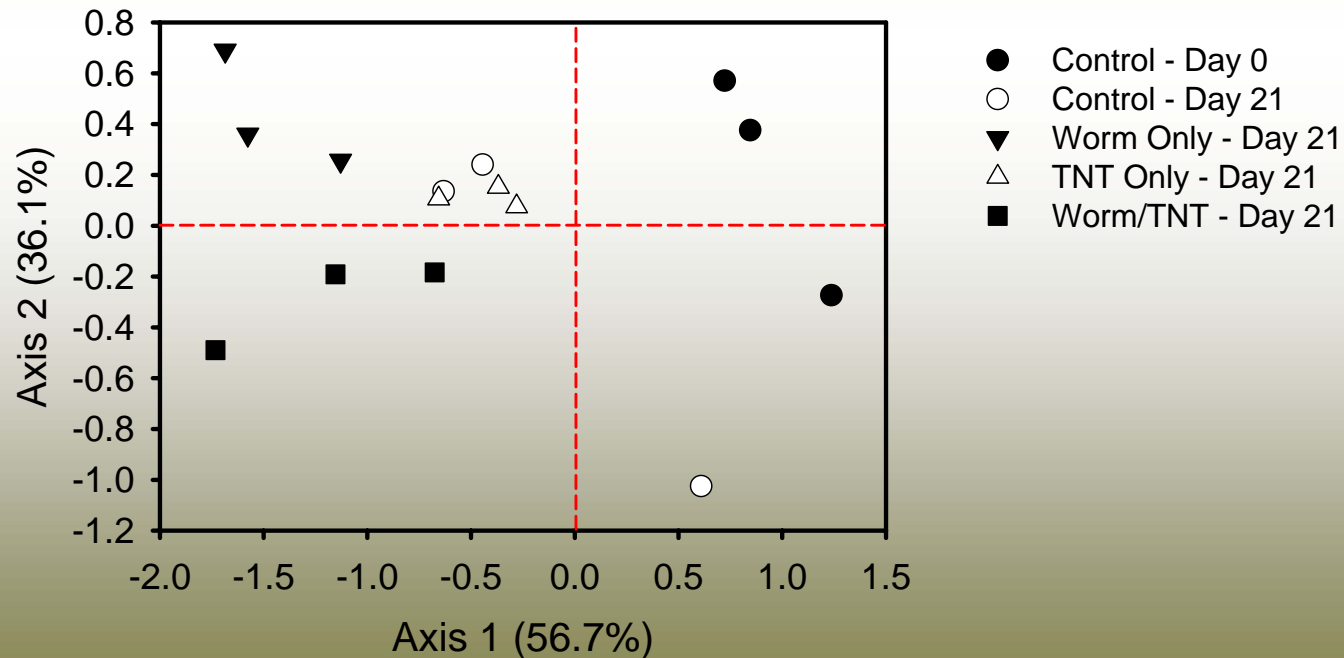
Soil with earthworms:

- contained more extractable 4ADNT



# Summary

Earthworm activity and TNT contamination:  
- had an impact on the microbial community structure

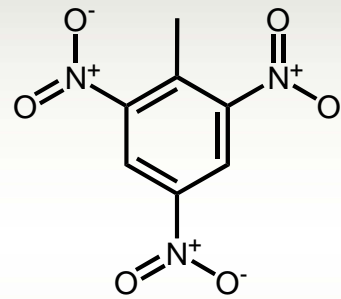


# Conclusion

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-Earthworms have potential to influence TNT:

- transport
- bioavailability
- transformation



- direct: degradation/transformation
- indirect: soil microbial community

# Thank You



The University of Georgia

College of Agricultural & Environmental Sciences

