



agriculture
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PROVINCE OF KWAZULU-NATAL

Soil Organic Matter and its Management

Alan Manson

SASIAA Symposium
SASRI, 24 October 2018

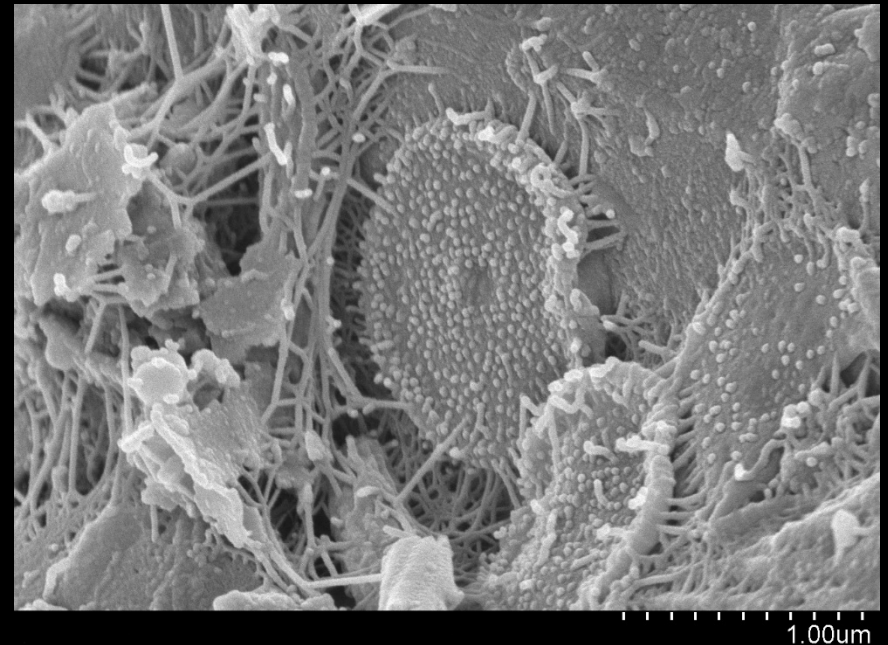
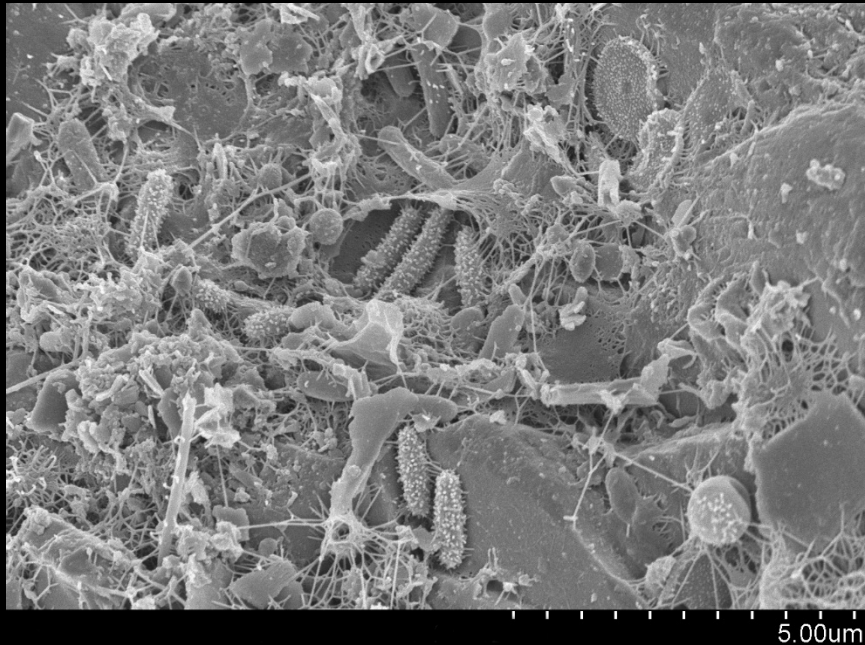
Soil Organic Matter

- Many forms of SOM
 - Living
 - Recently dead (easily decomposed)
 - Very dead (difficult to decompose)
 - Black C (charcoal)



Soil Organic Matter

- Where is the SOM & what does it look like?

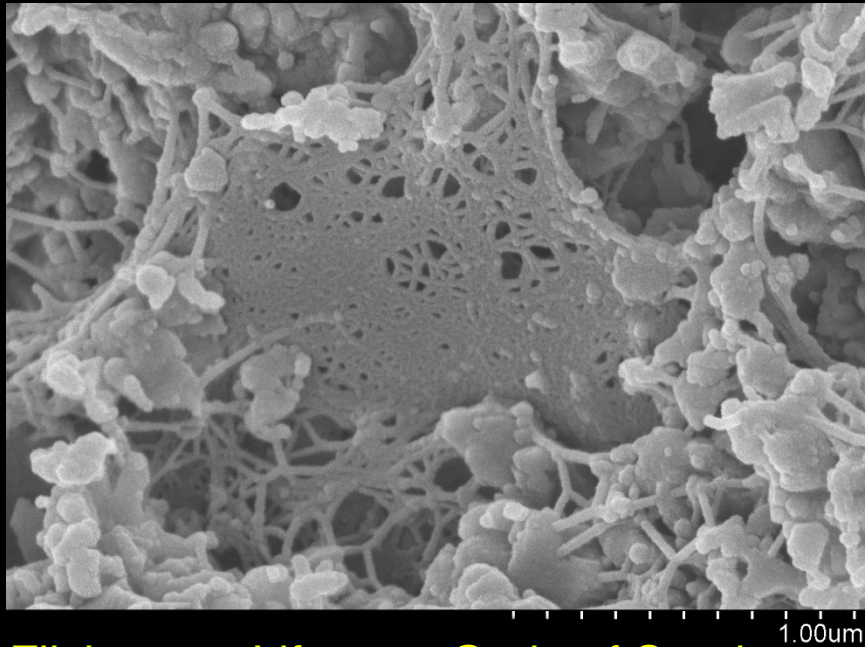


Flickr.com: Life on a Grain of Sand



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Extracellular polymeric substances (EPS)

Flickr.com: Life on a Grain of Sand

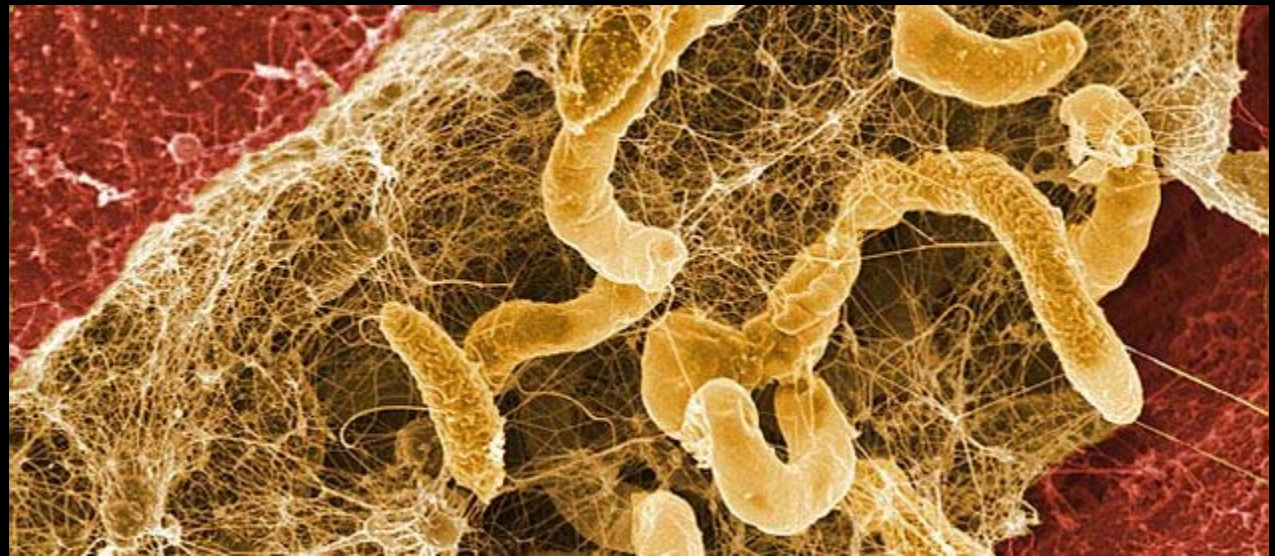


Image by Pacific Northwest National Laboratory

Extracellular polymeric substances (EPS)

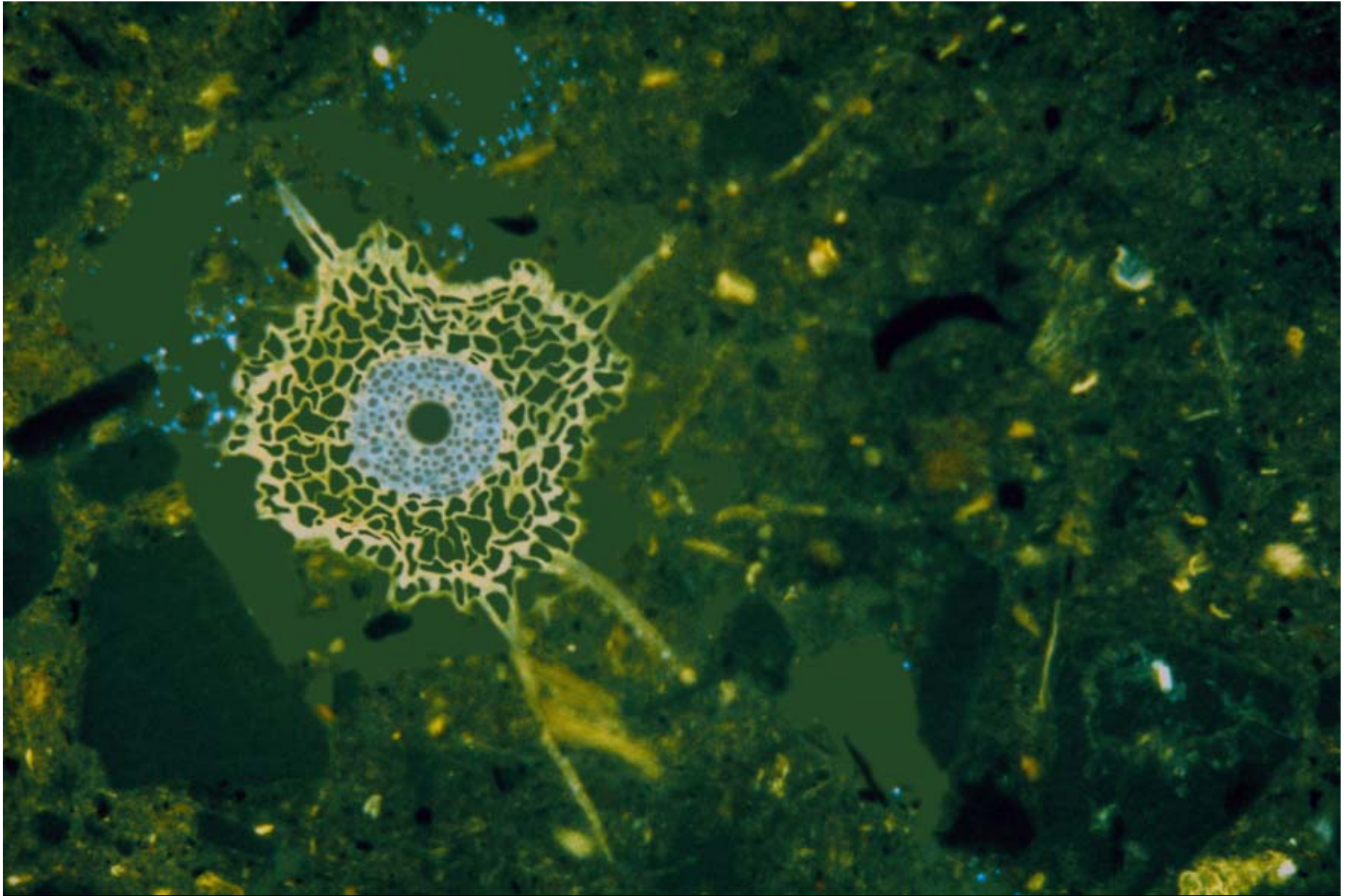
Highly hydrated polymers – mainly polysaccharides, proteins, and DNA

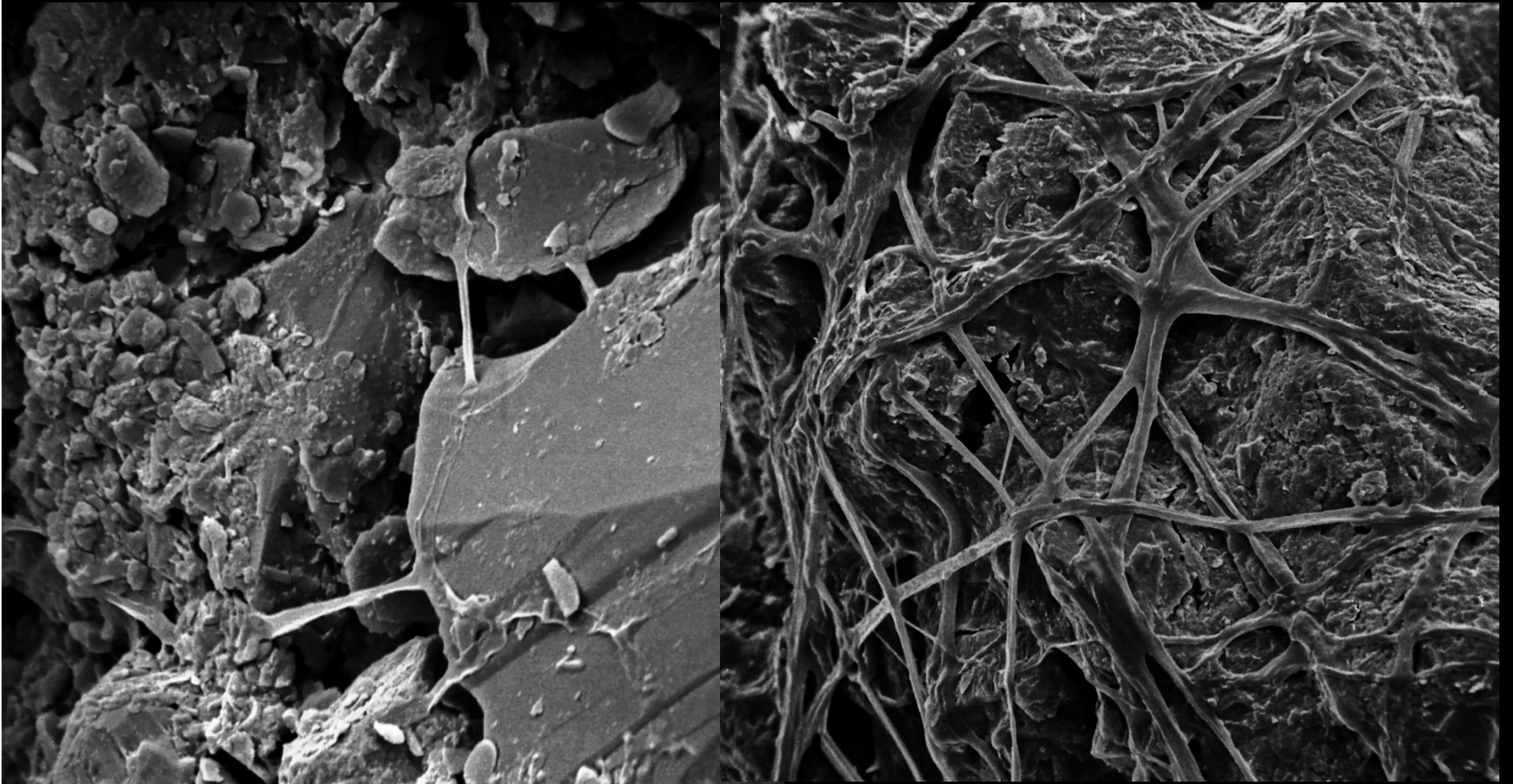
Provide an ideal environment for:

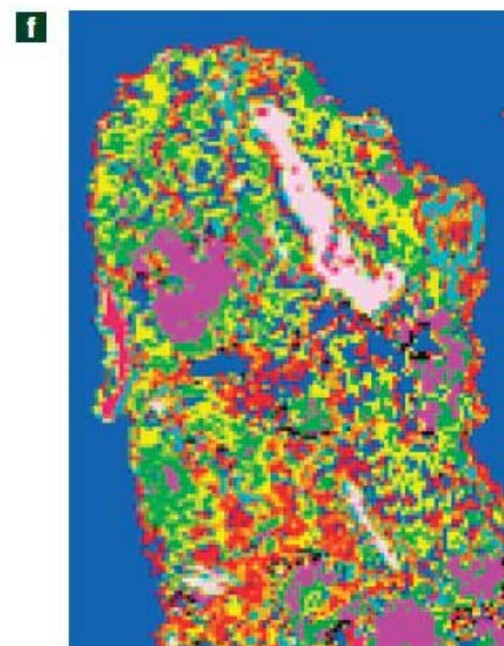
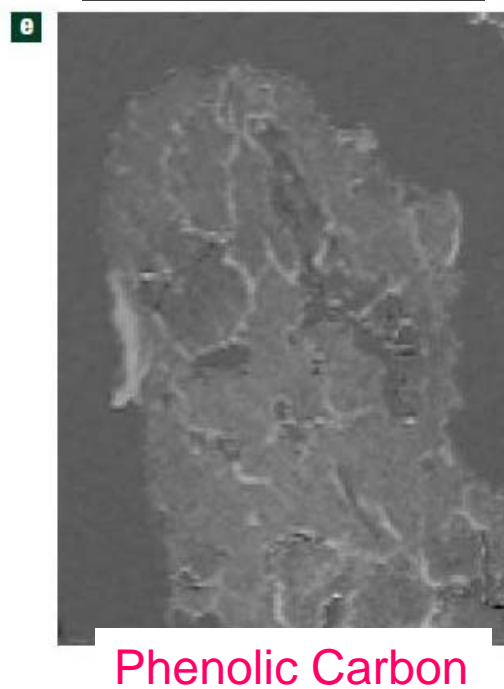
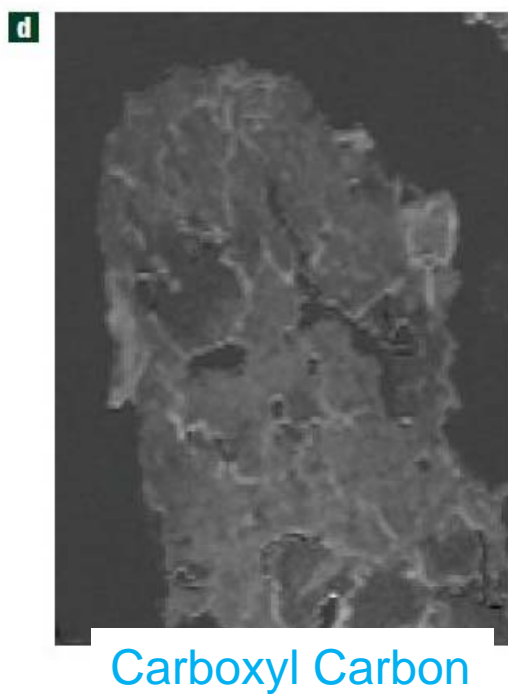
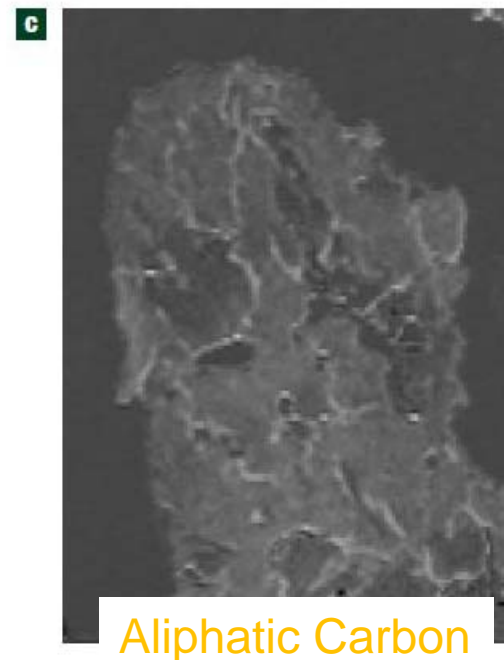
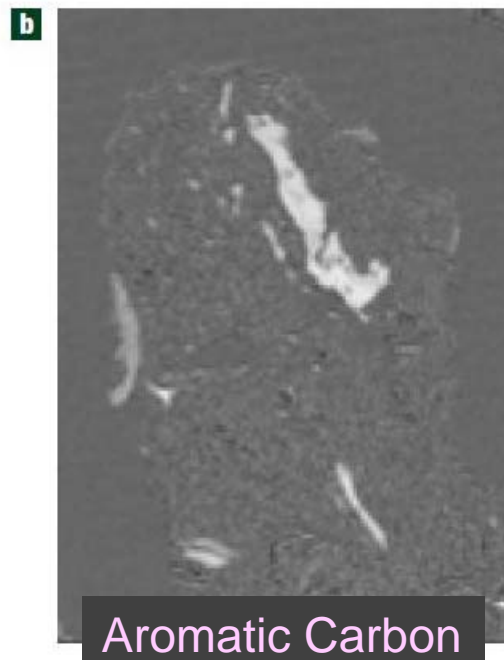
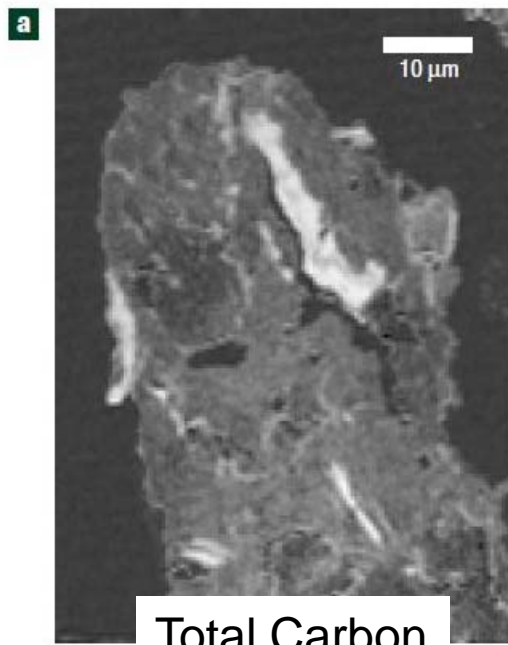
- chemical reactions
- nutrient entrapment
- protection against environmental stresses such as salinity and drought

Extracellular polymeric substances (EPS)

- Can enhance the aggregation of soil particles
- Industrial applications:
 - Maintain moisture
 - Biocompatible
 - Gelling and thickening capability





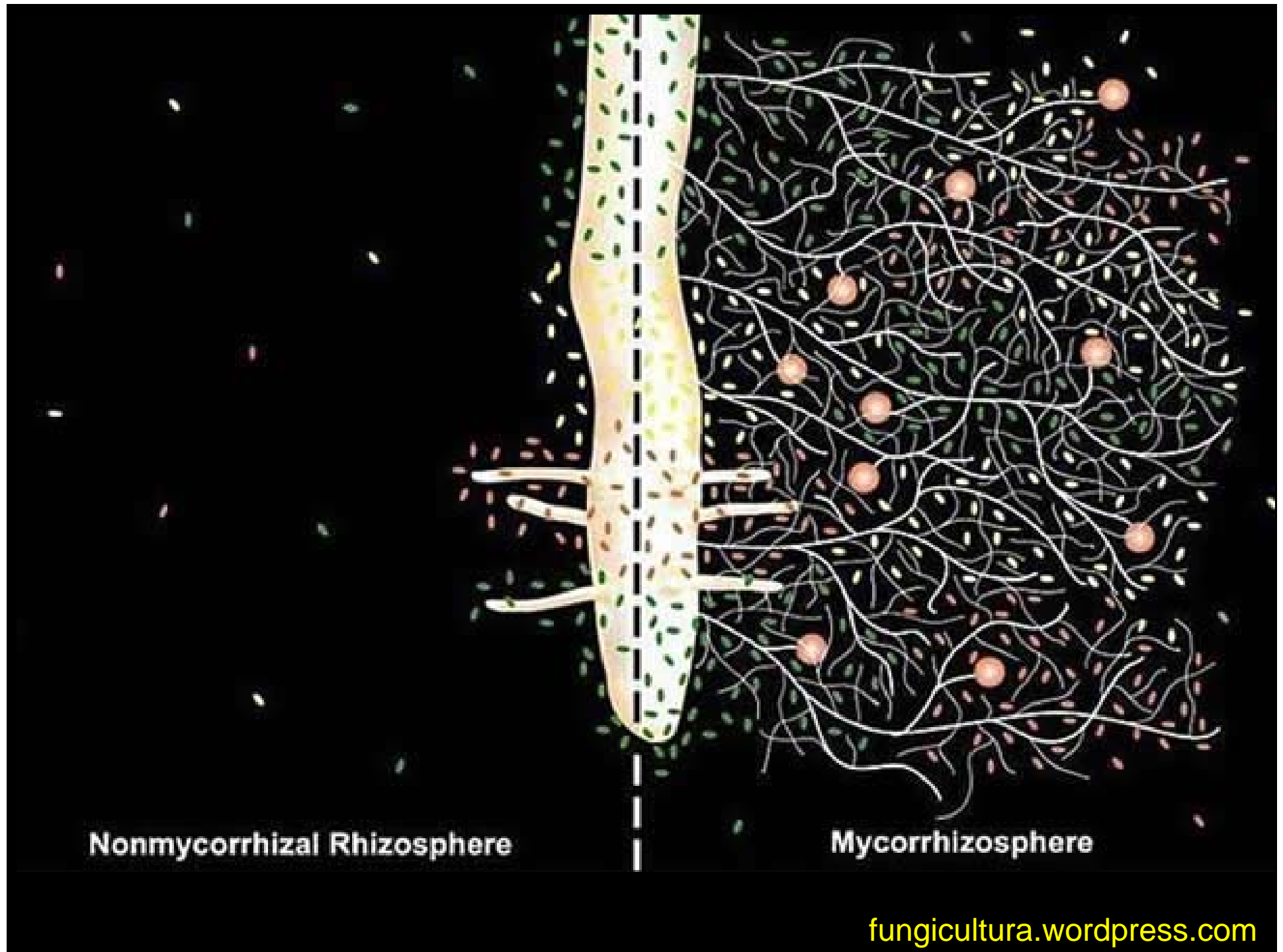


Lehmann et. al. 2008

Soil Organic Matter

- Nitrogen uptake by plants
 - Nitrate
 - Ammonium
 - Amino acids & other organic N???

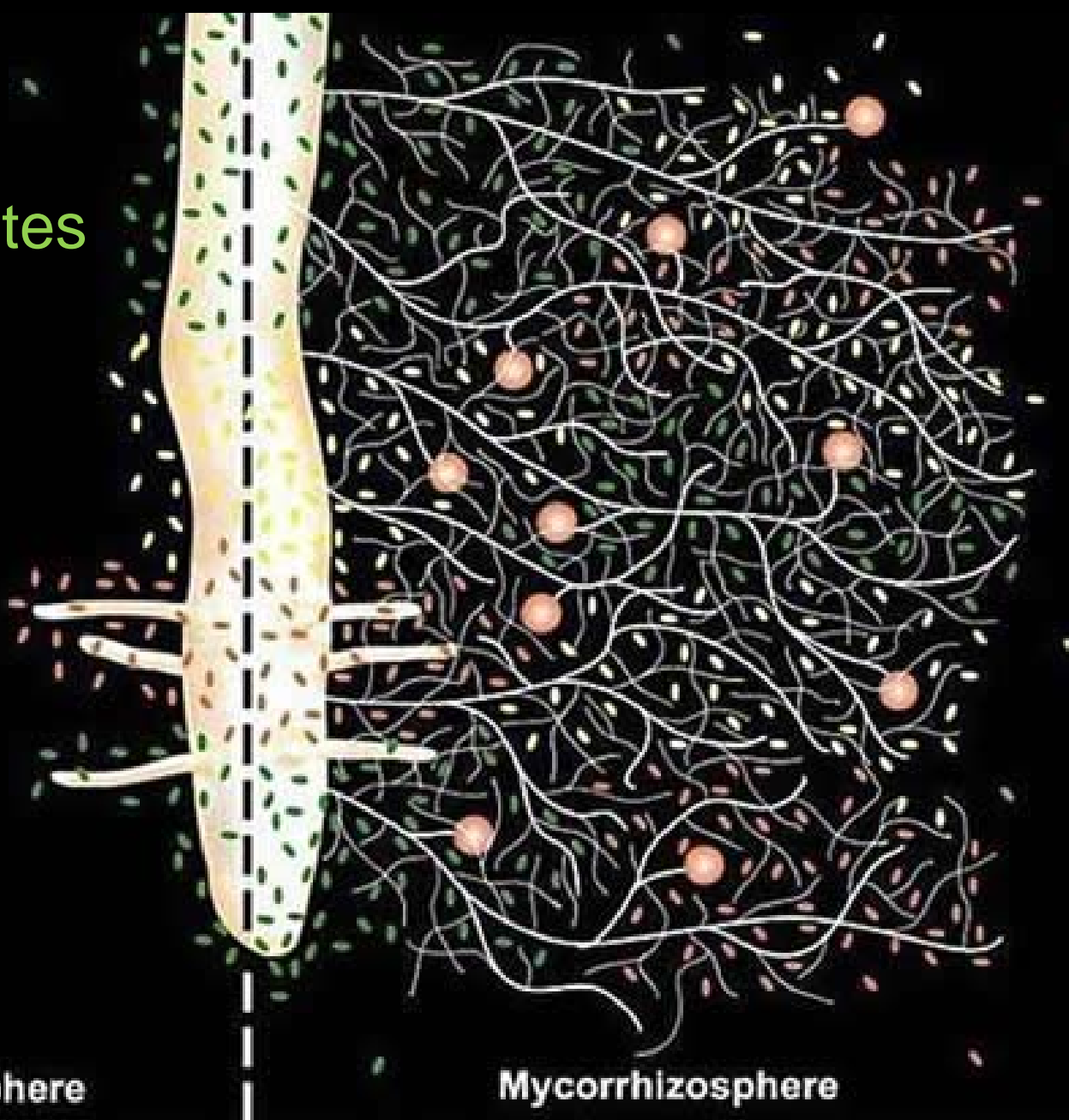




Root Exudates

Nonmycorrhizal Rhizosphere

Mycorrhizosphere



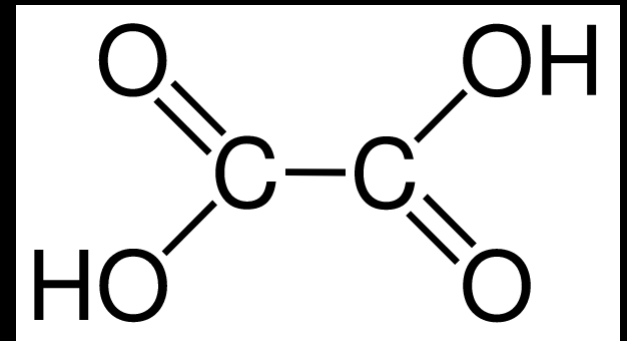
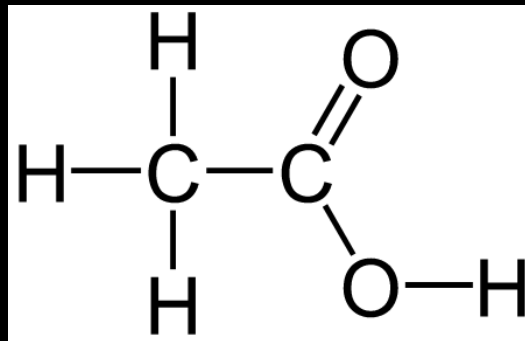
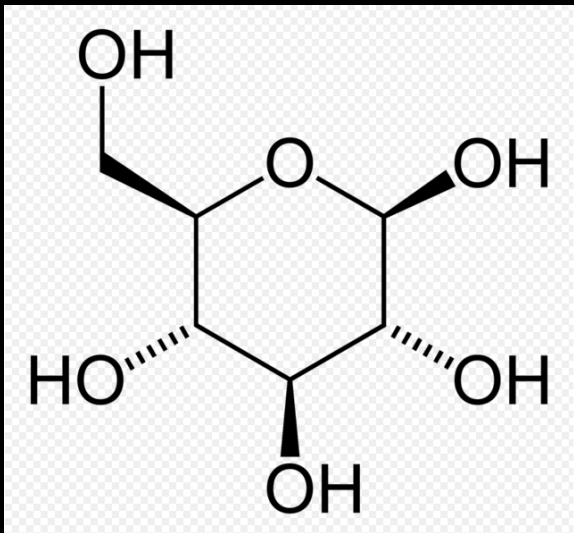
Soil Organic Matter

- Theory: In the rhizosphere, bioavailable exudate compounds induce greater microbial activity and enzyme production because they serve as 'co-metabolites'
- Promote microbial growth; more microbes, therefore greater SOM breakdown

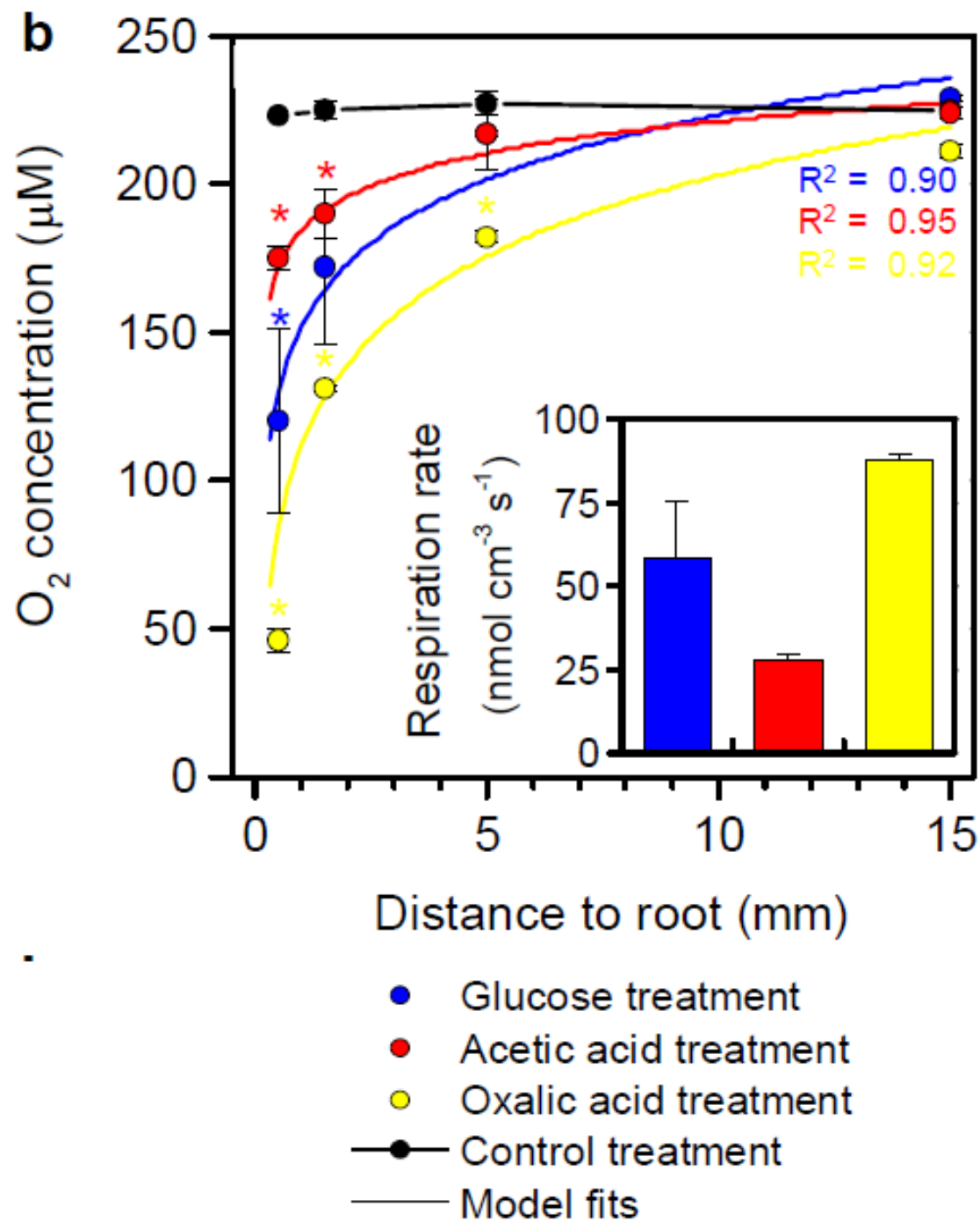


Root Exudates & Soil Organic Matter

- Experiment (Keiluweit et al. 2015):
 - Compared “artificial exudates”: glucose, acetic acid, oxalic acid

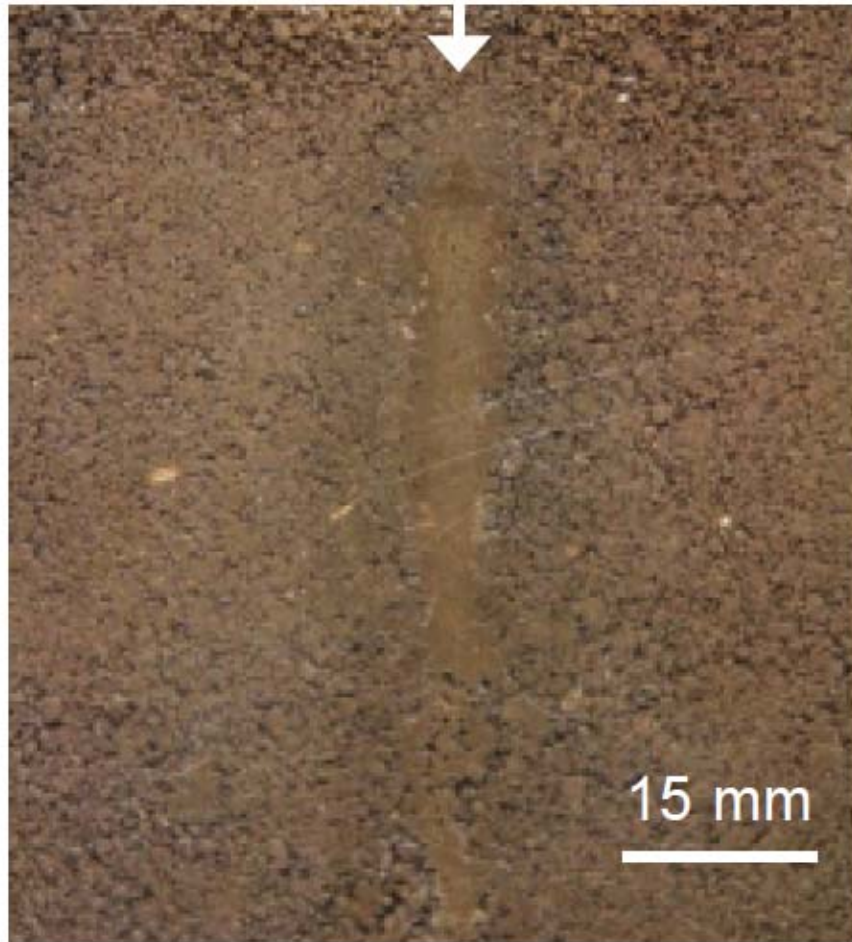


- Which promotes soil microbes the most?



Exudate treatments

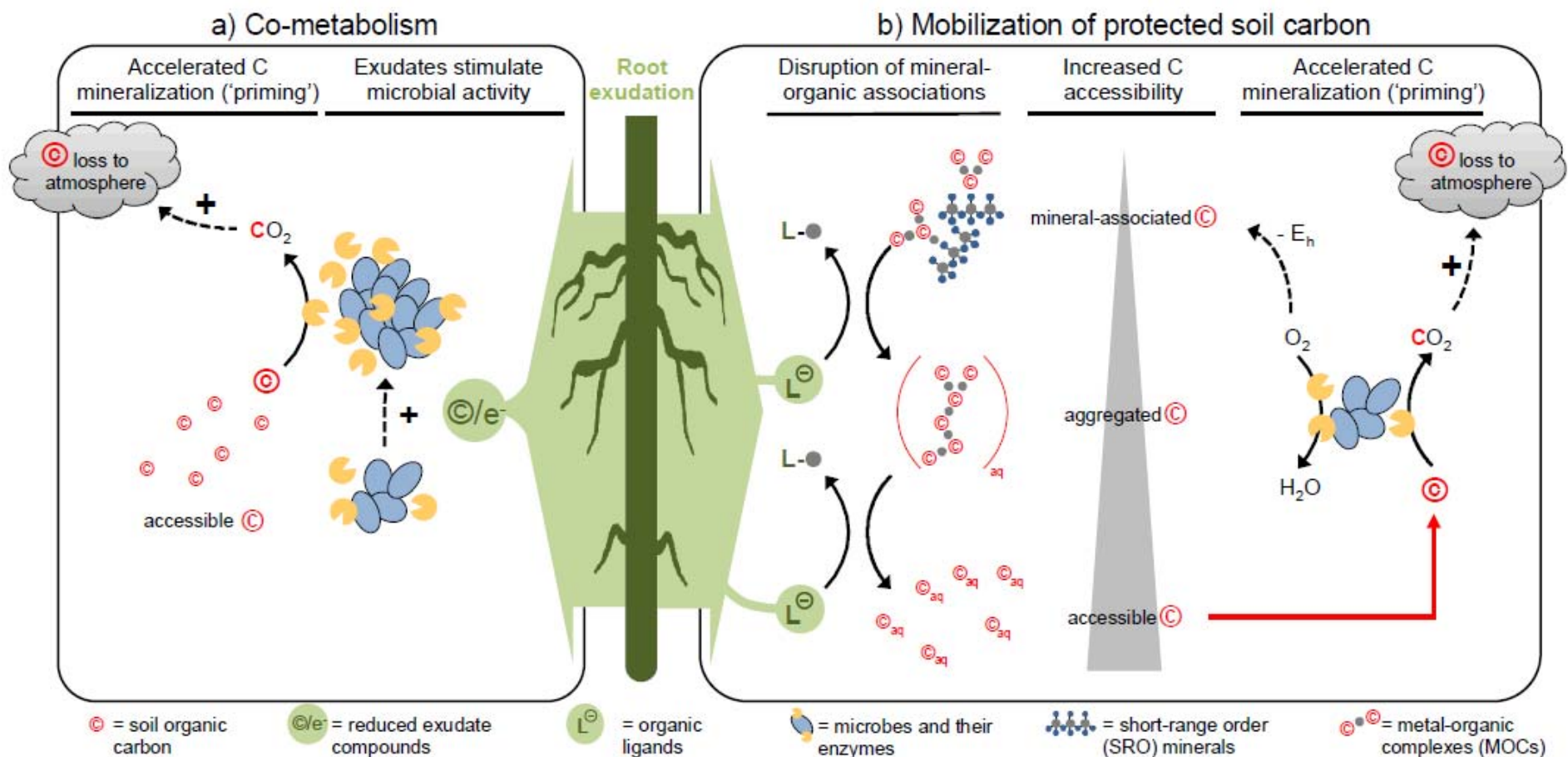
Oxalic acid



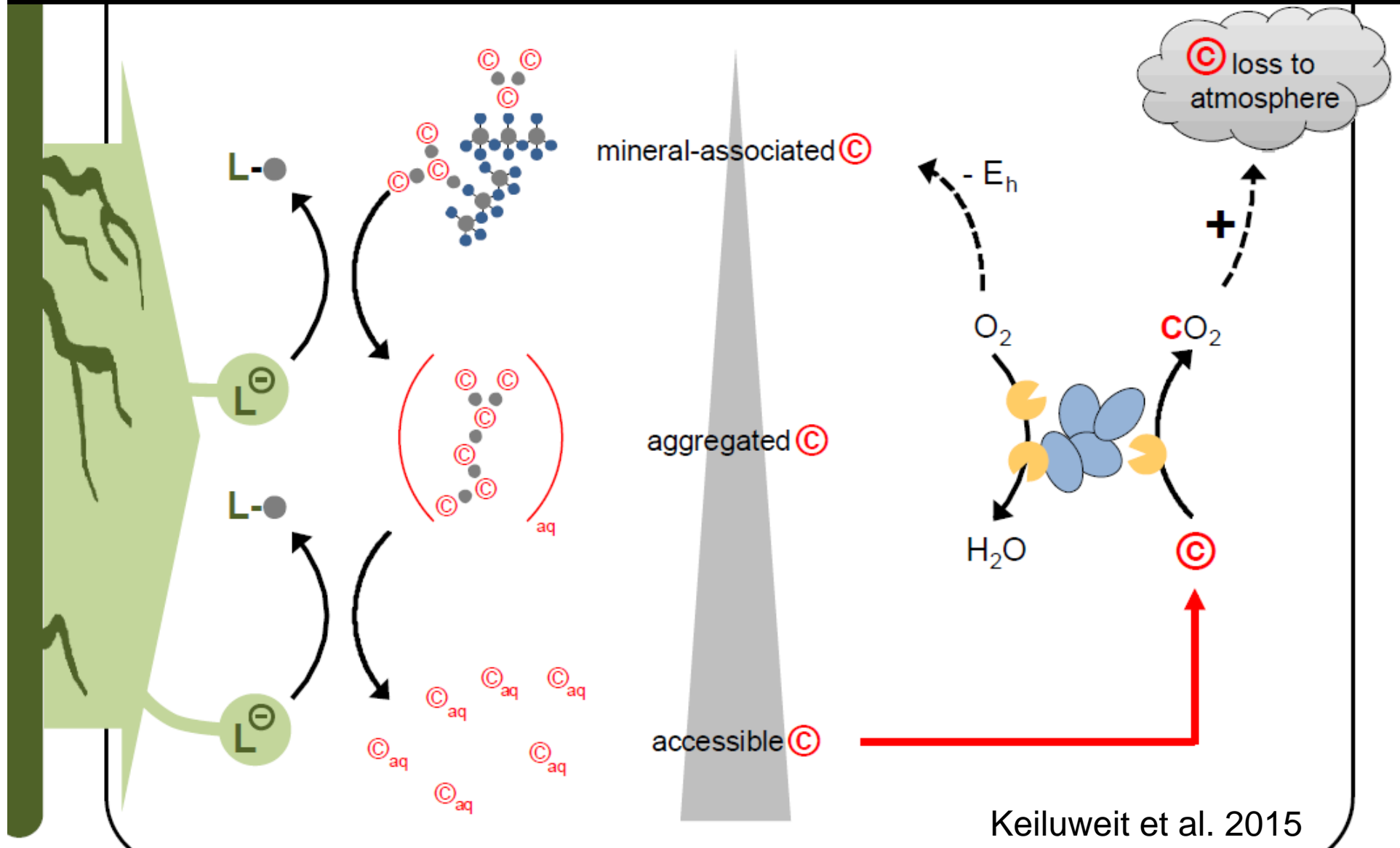
Control



How does oxalic acid promote microbial growth?



How does oxalic acid promote microbial growth?





ELSEVIER

Soil Biology and Biochemistry

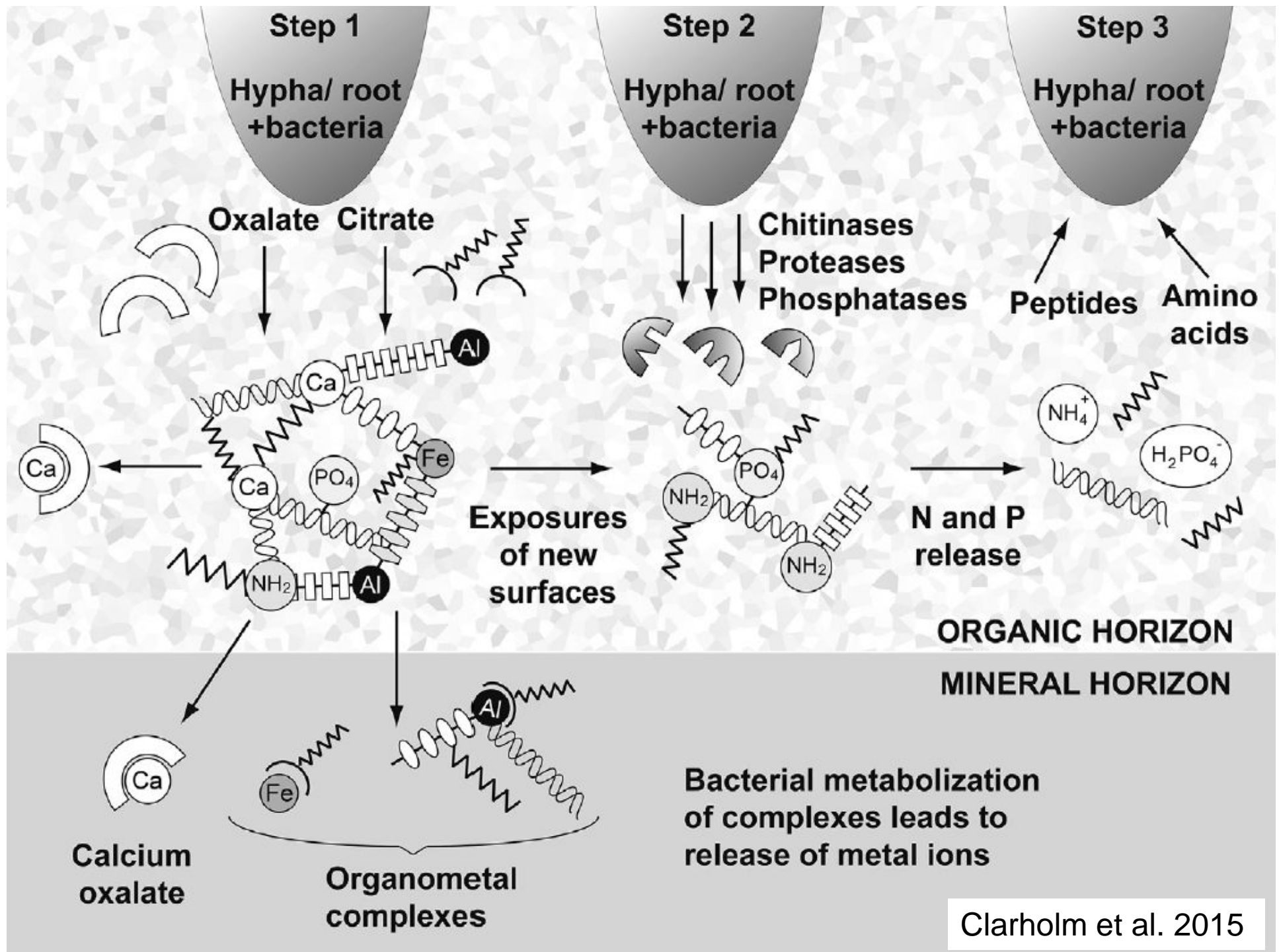
Volume 84, May 2015, Pages 168-176

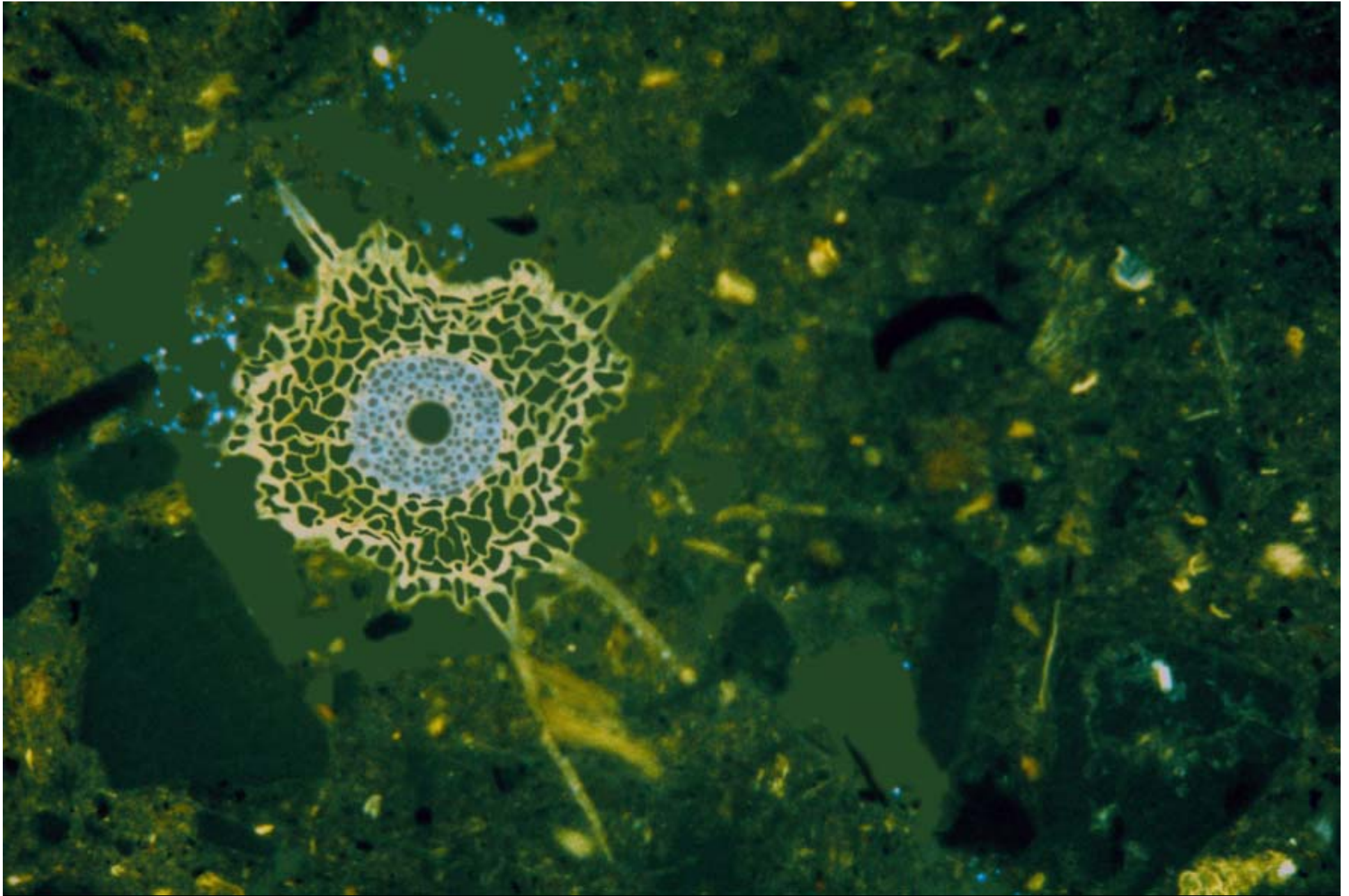


Review paper

Organic acid induced release of nutrients from metal-stabilized soil organic matter – The unbutton model

Marianne Clarholm ^a  , Ulf Skyllberg ^b, Anna Rosling ^c





Nitrogen Use Efficiency

Agronomic use efficiency (AEN):

- Most commonly used index by agronomists
- Increase in economic yield per unit N fertilizer applied
- Calculation requires establishment of a research plot without N input (control plot)



Nitrogen Use Efficiency

Agronomic use efficiency (AEN):

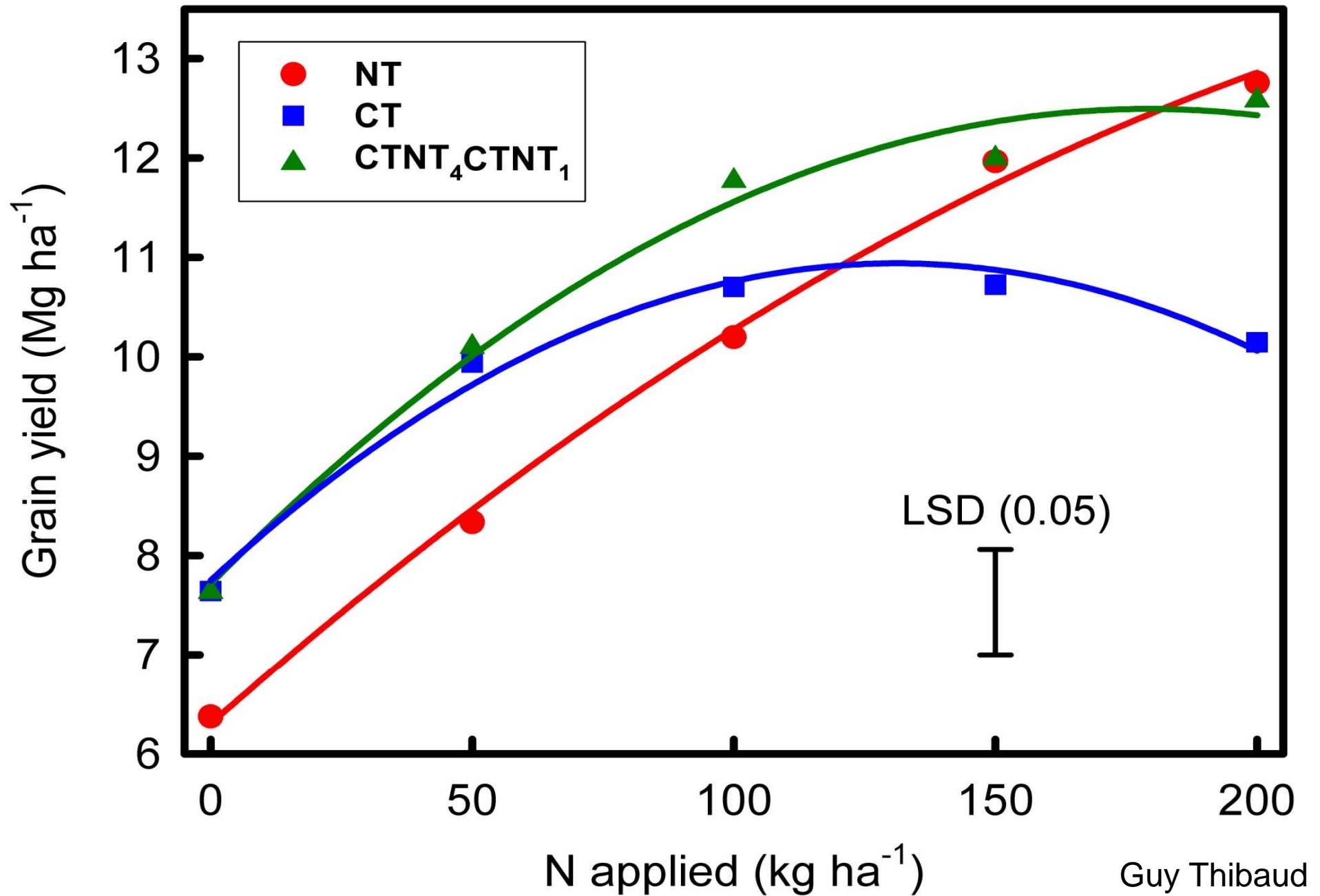
- Most commonly used index by agronomists
- Units increase in economic yield per unit N fertilizer applied

Calculated by: $AEN \text{ (kg kg}^{-1}\text{)} = G_f - G_u / N_a$

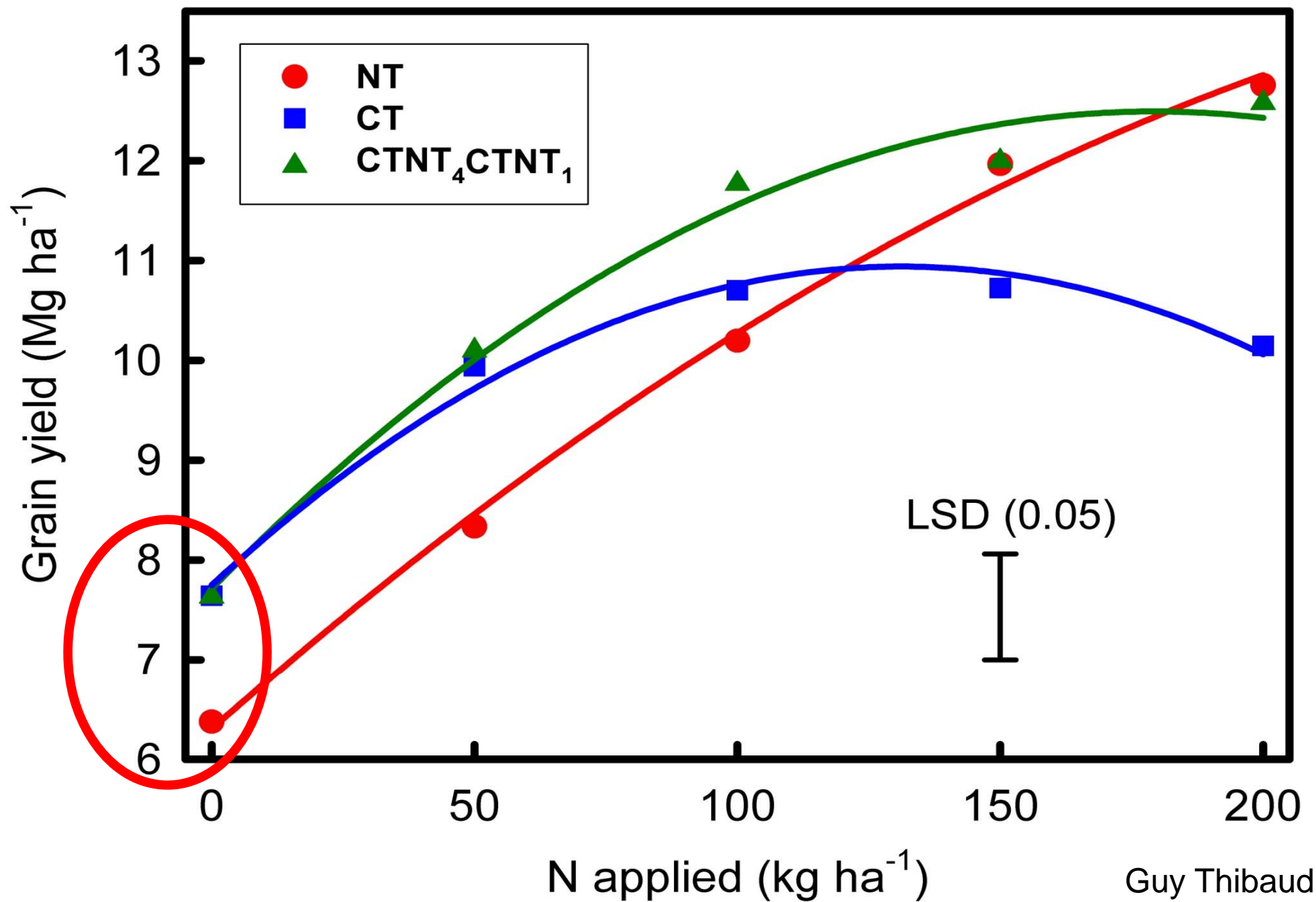
- G_f is the grain output from N fertilized plot (kg)
- G_u is the grain output from the control plot
- N_a is the quantity of nitrogen applied (kg)



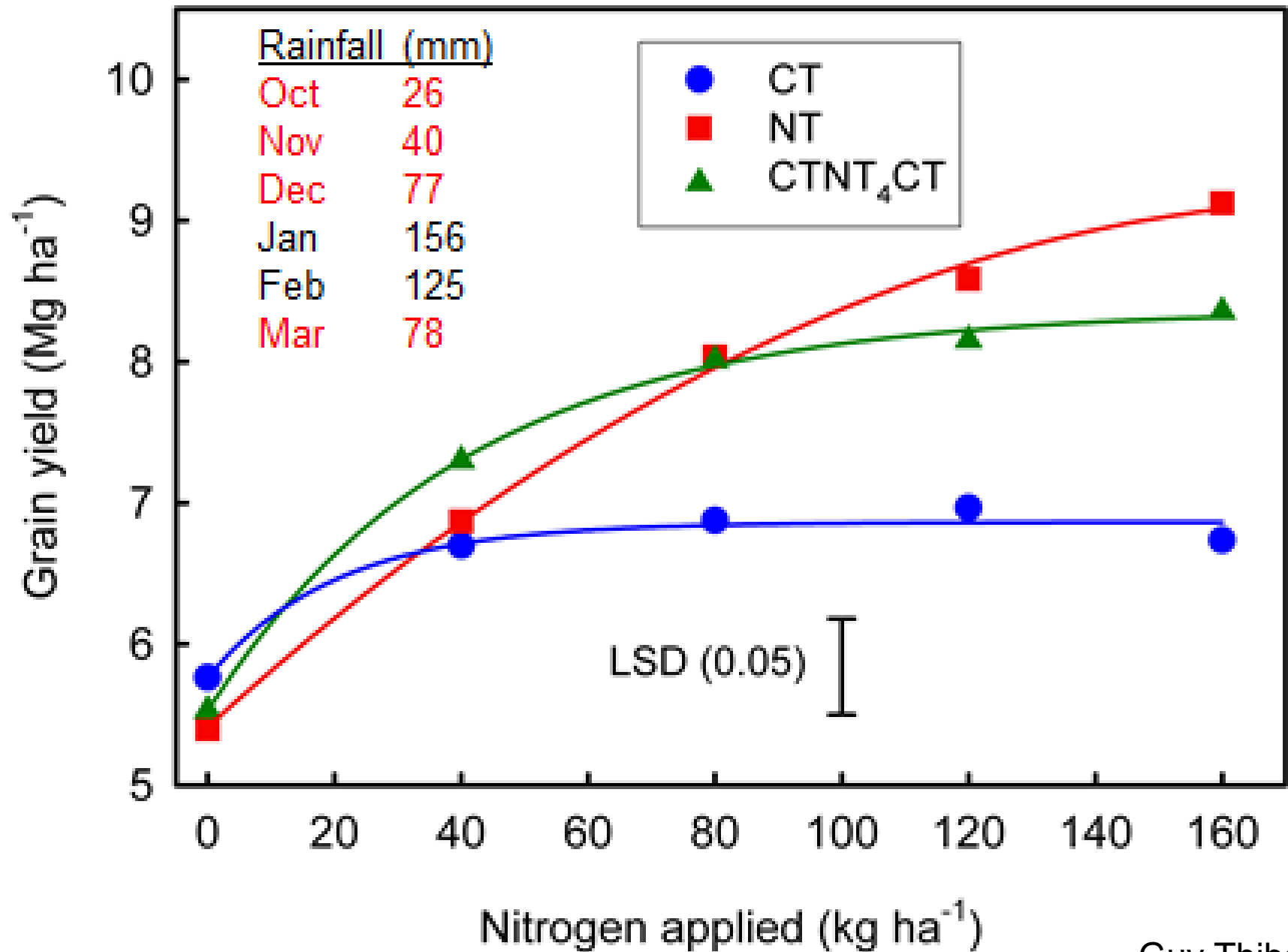
2009/2010



2009/2010



LOSKOP 2015/2016



Does Soil Organic Matter Matter?

Does Soil Organic Matter Matter?

- SOM releases N when sugarcane needs it most
- N from SOM offers insurance against loss of fertilizer N

Building Soil Organic Matter

- What increases long-term storage of SOM the most?
 - Lignin (tough to break down) or
 - Glucose (easy to break down)
- Lignin remnants form humus (humification)
 - Accepted wisdom 20 years ago

Building Soil Organic Matter

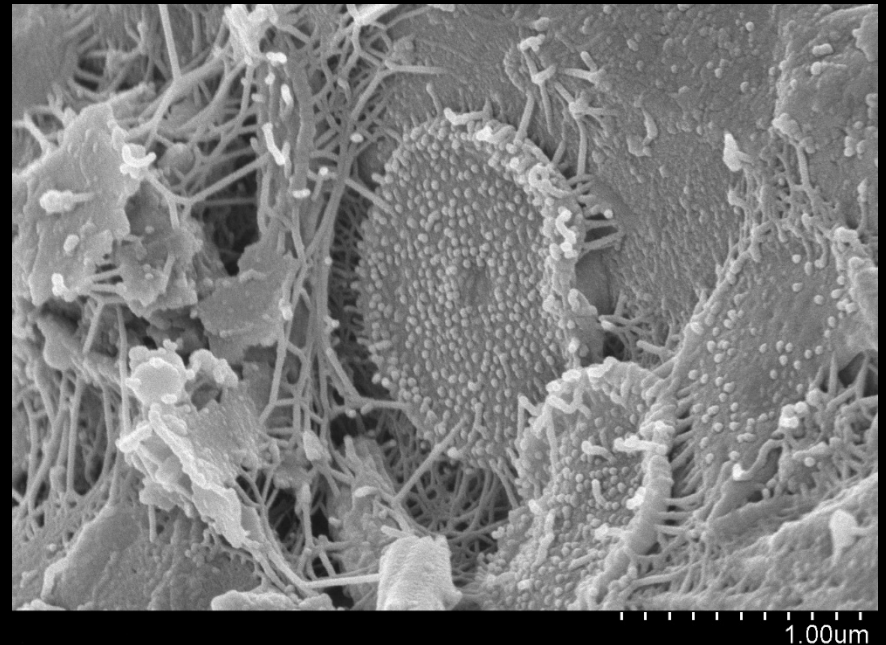
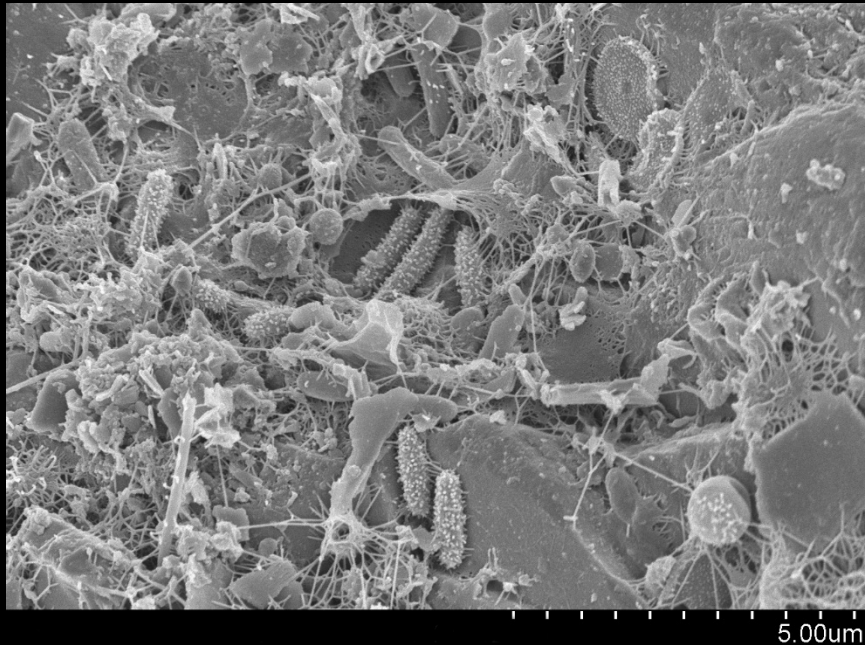
- What increases long-term storage of SOM the most?
 - Lignin (tough to break down) or
 - Glucose (easy to break down)
- Many experiments show that the reverse is true
 - Both lignin and glucose are metabolised within about 10 years
 - Added glucose increases SOM more!

Building Soil Organic Matter

- Added glucose increases SOM more than added lignin
- Lignin is tough to break down, so microbes need more energy to use it as food – more of the C is oxidised to CO₂
- Glucose is easily broken down, and more of its C is retained in microbial cells – the cell remnants ('skeletons') form humus

Building Soil Organic Matter

- The cell debris attached to clay minerals is protected from breakdown by other microbes



Flickr.com: Life on a Grain of Sand



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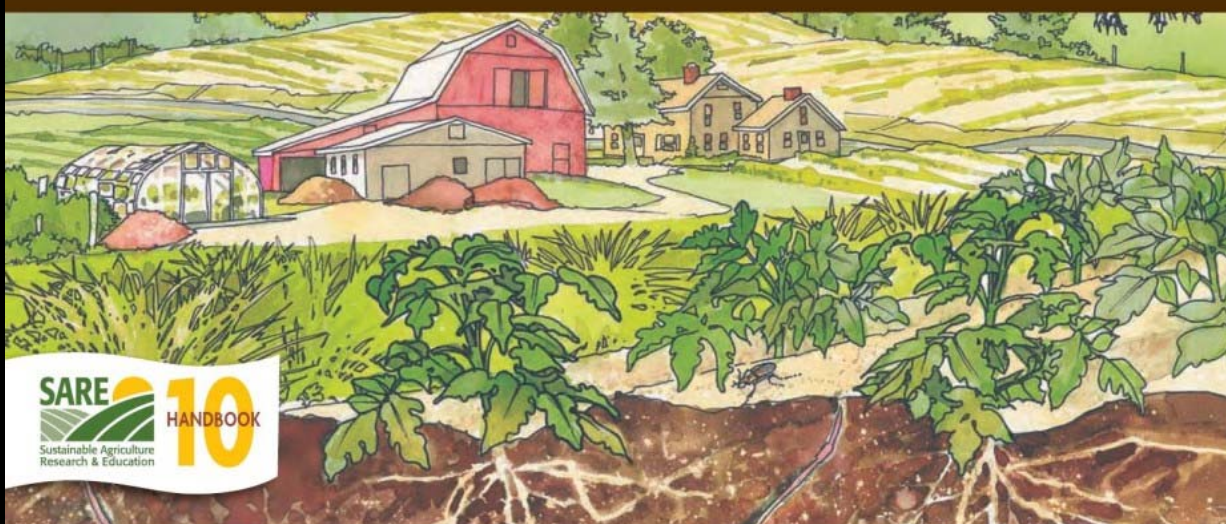
THIRD EDITION



BUILDING SOILS FOR BETTER CROPS

SUSTAINABLE SOIL MANAGEMENT

BY FRED MAGDOFF AND HAROLD VAN ES



SARE
Sustainable Agriculture
Research & Education

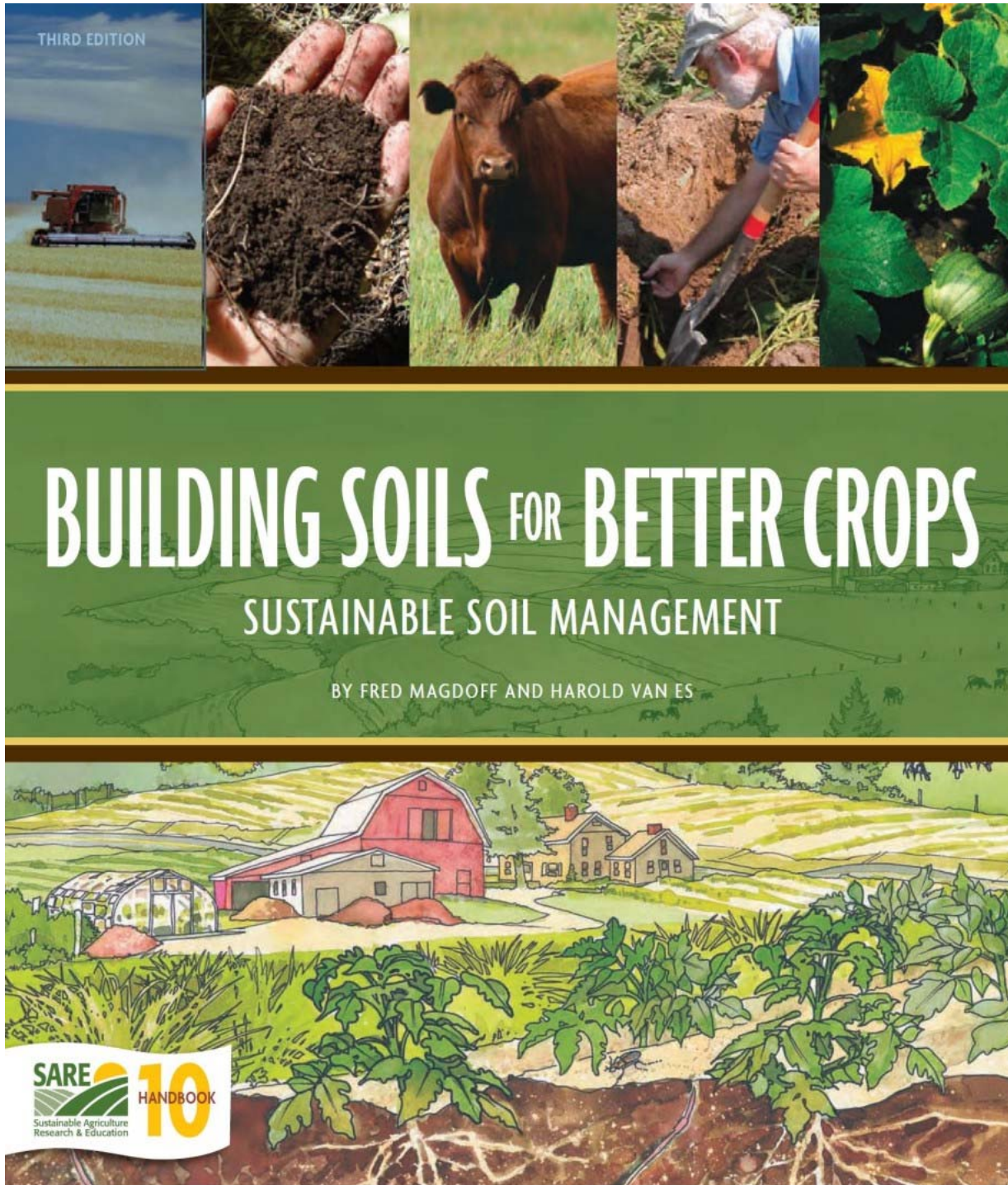
10
HANDBOOK

Building soils

- Add organic materials on a regular basis
 - animal manures, composts, cover crops, rotation crops with large amounts of residue
 - different types of organic materials have different positive effects

Building soils

- Keep soil covered with living vegetation and/or crop residues
 - cover crops, sod crops in rotation, reduced tillage practices
 - encourages water infiltration, reduces erosion, encourages beneficial organisms



Fred Magdoff &
Harold Van Es
2010

Free at
www.sare.org

Conclusion

- Soil-plant interactions are complex



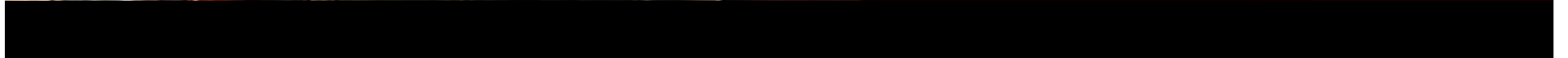
Conclusion

- Soil-plant interactions are complex
- Have fun with soils!





Fun with ~~Flags~~ Soils





Fun with ~~Flags~~ Soils

Thank You



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