Improving Health, Productivity and Fertility of Prairie Soils

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UNIVERSITY OF SASKATCHEWAN

Cropping Systems on Prairies

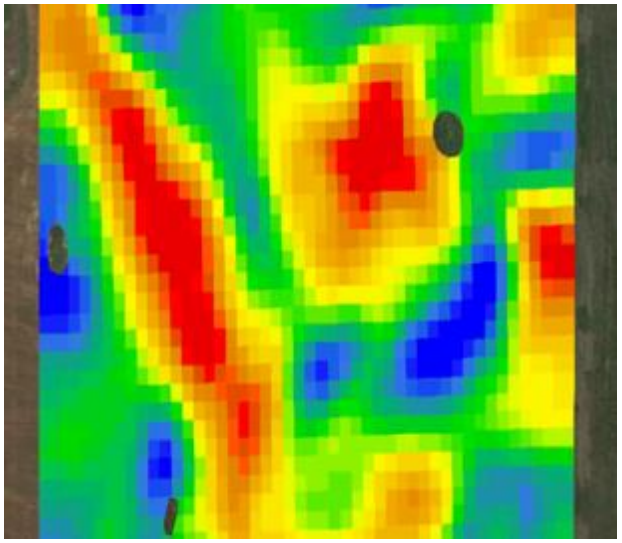
Pre 1980

- Cereal-based rotation dominant

- Tillage to control weeds, fallow

- Wind, water, tillage erosion

We Have Come A Long Way!




sksis.usask.ca


CAUTION
EYE PROTECTION
REQUIRED

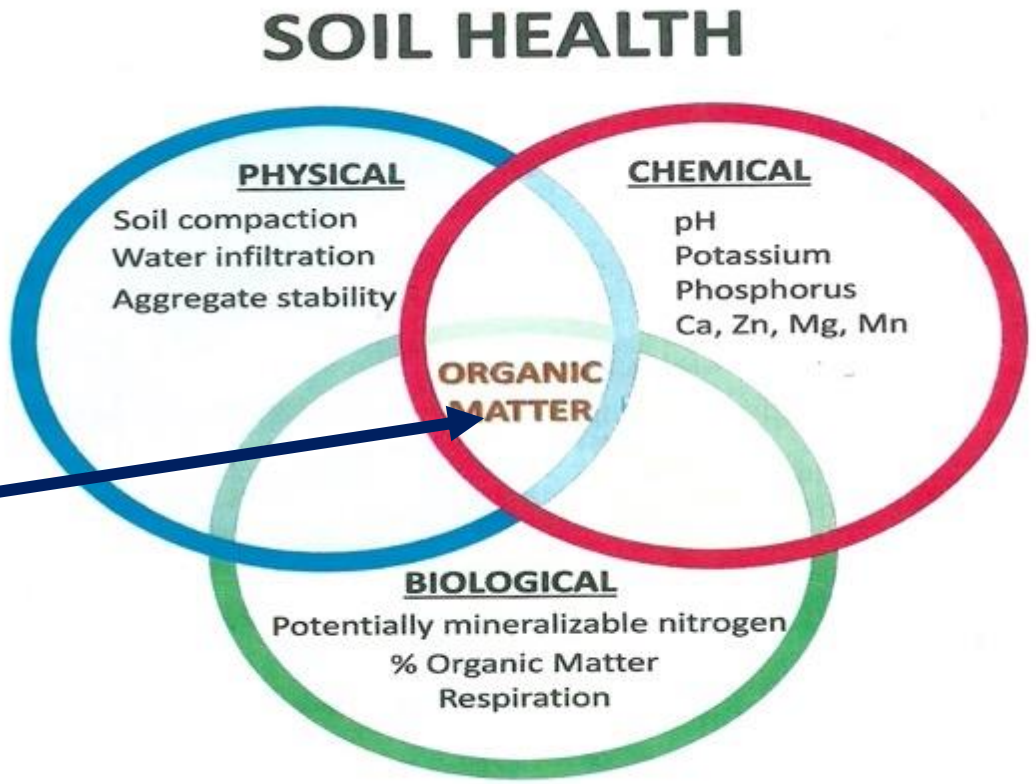
Too little, too much water and heat, extreme year to year variations in moisture and temperature is main threat to agricultural production in Saskatchewan

Good Soil Health Provides Resilience

What Contributes to Healthy Soils?

Soil Quality and Health

Soil organic matter is the key!



Soil Health → Plant Health → Human Health

Soil Quality and Health

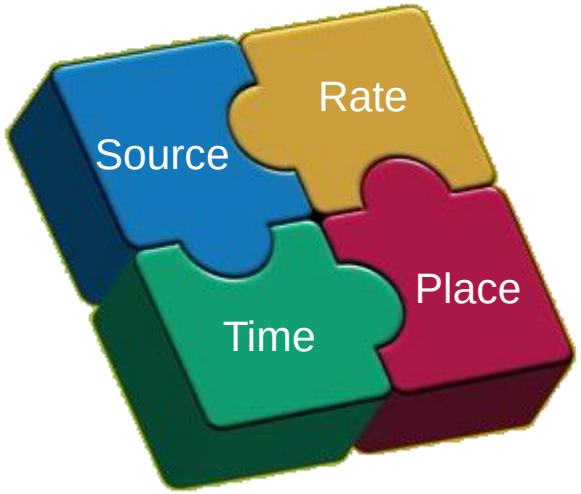
Soil organic matter, fertility is the key!

- **Multi-crop with legumes, forages, use of fertilizer, manure at recommended rates, reducing or eliminating tillage, enhances soil organic matter content.**
- *Microbial activity, nutrient supply power and recycling is increased*
- *Water storage and conservation improved by increasing soil humus and maintenance of protective surface residue cover*

- Fertilizers are major input cost, want to get the most out of them: right rate, source, time, and placement

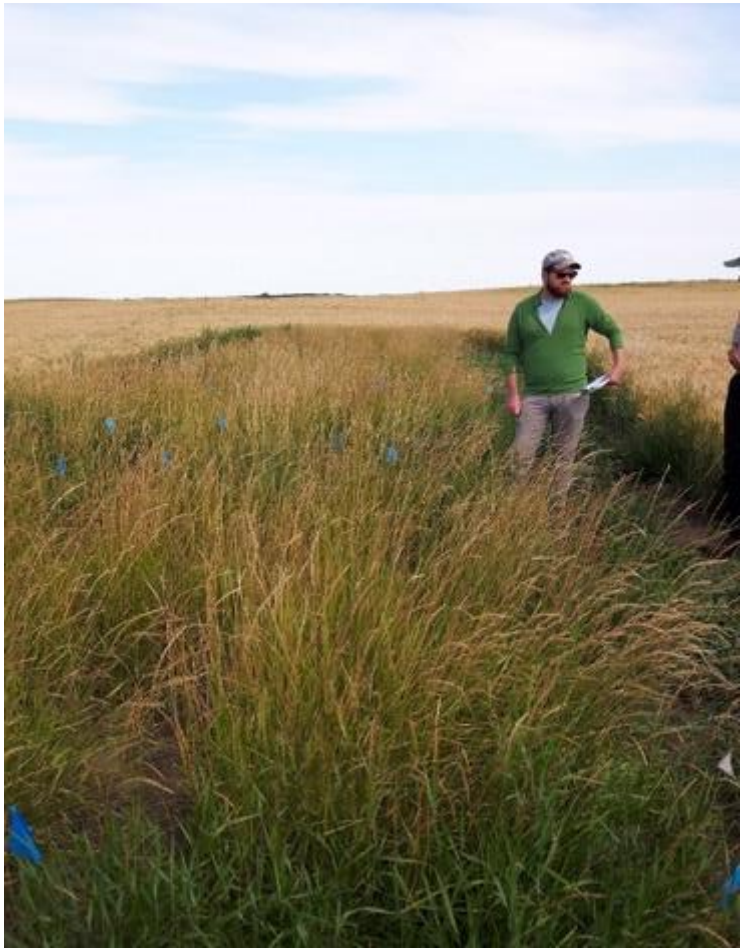
4R's

For Nutrient Stewardship



Fertilizer nutrients: use `em, don't lose`em!

How can conservation management, soil improvement practices affect health, productivity and fertility of our prairie soils?



Organic Carbon Pools Before and After 21 Years of Conservation Management in Prairie Soils

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Viresco Solutions
End-to-end sustainability

Agriculture and Agri-Food Canada | Agriculture et Agroalimentaire Canada

Objective

To assess the nature of soil organic matter, in contrasting Saskatchewan soils, after 21 years of conservation agriculture management practices:

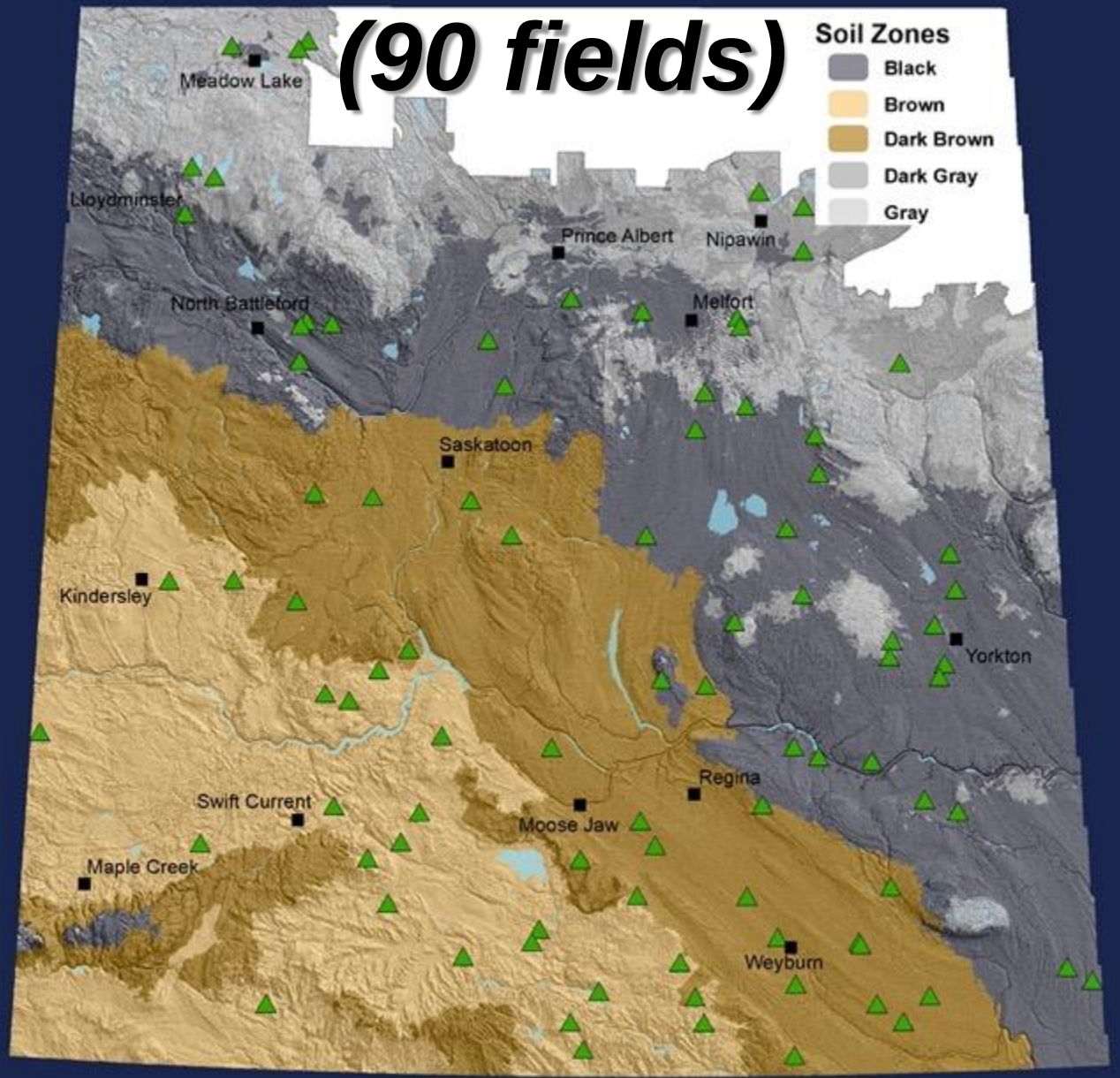
No-till, Multi-crop rotation, Recommended fertilizer rates

MEASURE SOIL ORGANIC MATTER BY MEASURING SOIL CARBON:

Half of Soil Organic Matter is Carbon

Soil Collection

(90 fields)

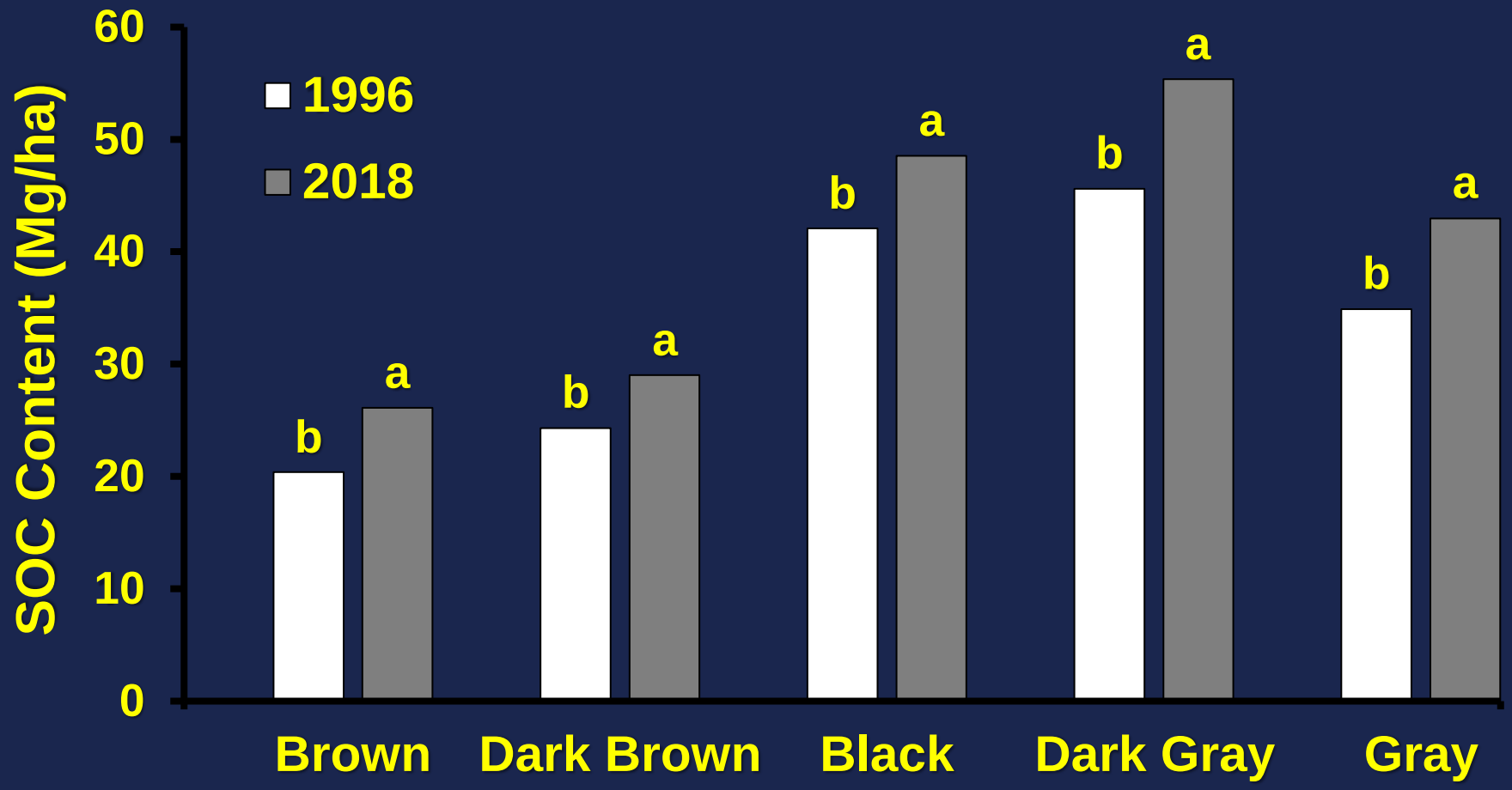


Soil Collection

Total Organic Carbon Measurement

Total Soil Organic Carbon

(mass in 0-10cm depth)

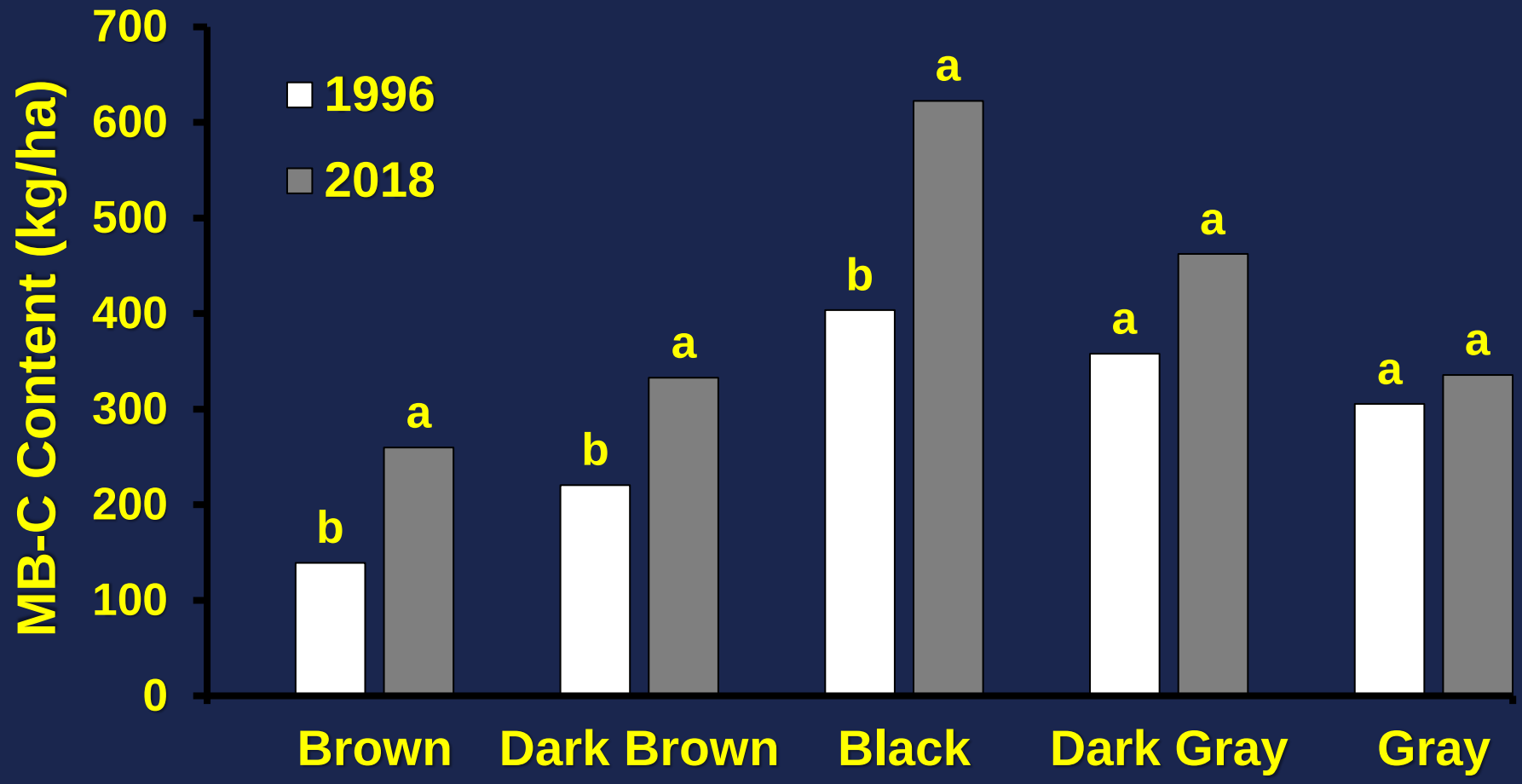


**For each soil type, bars with the same letters are not significantly different (P >0.05) using LSD.*

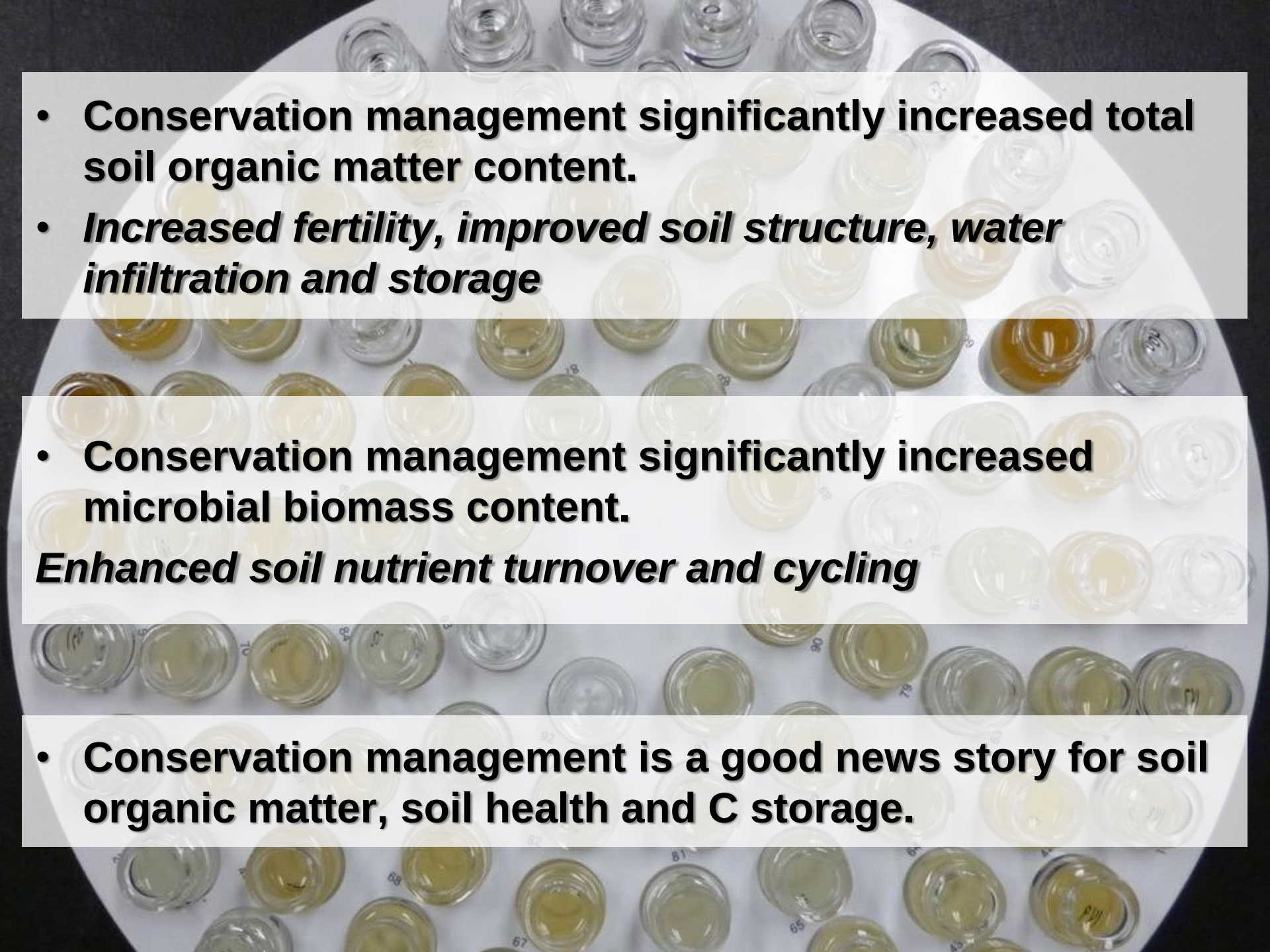
Microbial Biomass Carbon Measurement

Microbial Biomass Carbon

0-10cm depth



**For each soil type, bars with the same letters are not significantly different (P >0.05) using LSD.*



- **Conservation management significantly increased total soil organic matter content.**
- ***Increased fertility, improved soil structure, water infiltration and storage***

- **Conservation management significantly increased microbial biomass content.**

Enhanced soil nutrient turnover and cycling

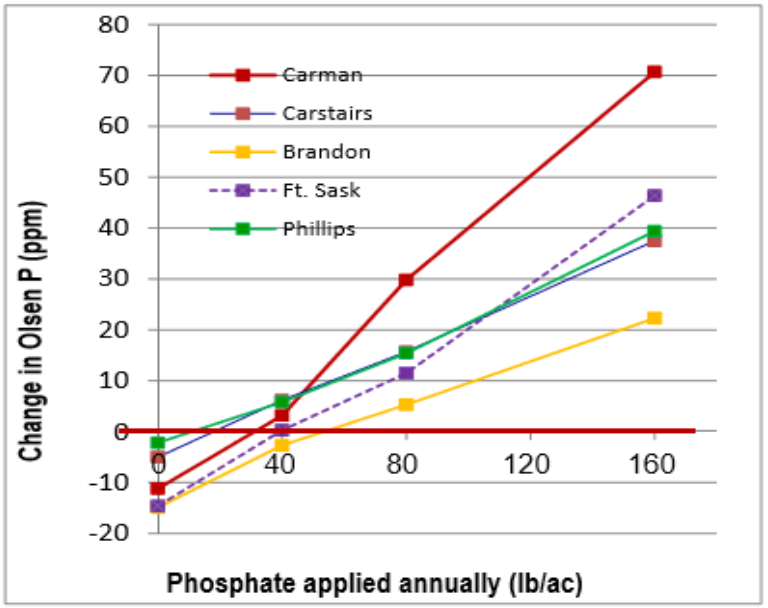
- **Conservation management is a good news story for soil organic matter, soil health and C storage.**

Much of the “conservation management practices” already implemented, wide-spread.

What other things can we do?

Make Sure We Are Replacing What We Are Removing!

Without addition of P fertilizer to replace P removed in crop harvest over a number of years, soil P fertility, as reflected in soil test P, decreases:



Change in Olsen P values with annual P application after 8 years of cropping on five soils in Western Canada (Grant 2012 from Grant and Flaten, 2019).

- ✓ Recommendations with maintenance considerations,
- ✓ Prairie Crop Nutrient Removal Calculator; SMA Forage and Crop Nutrient Removal Calculator Tools

can help in managing P and K fertility over long-term.

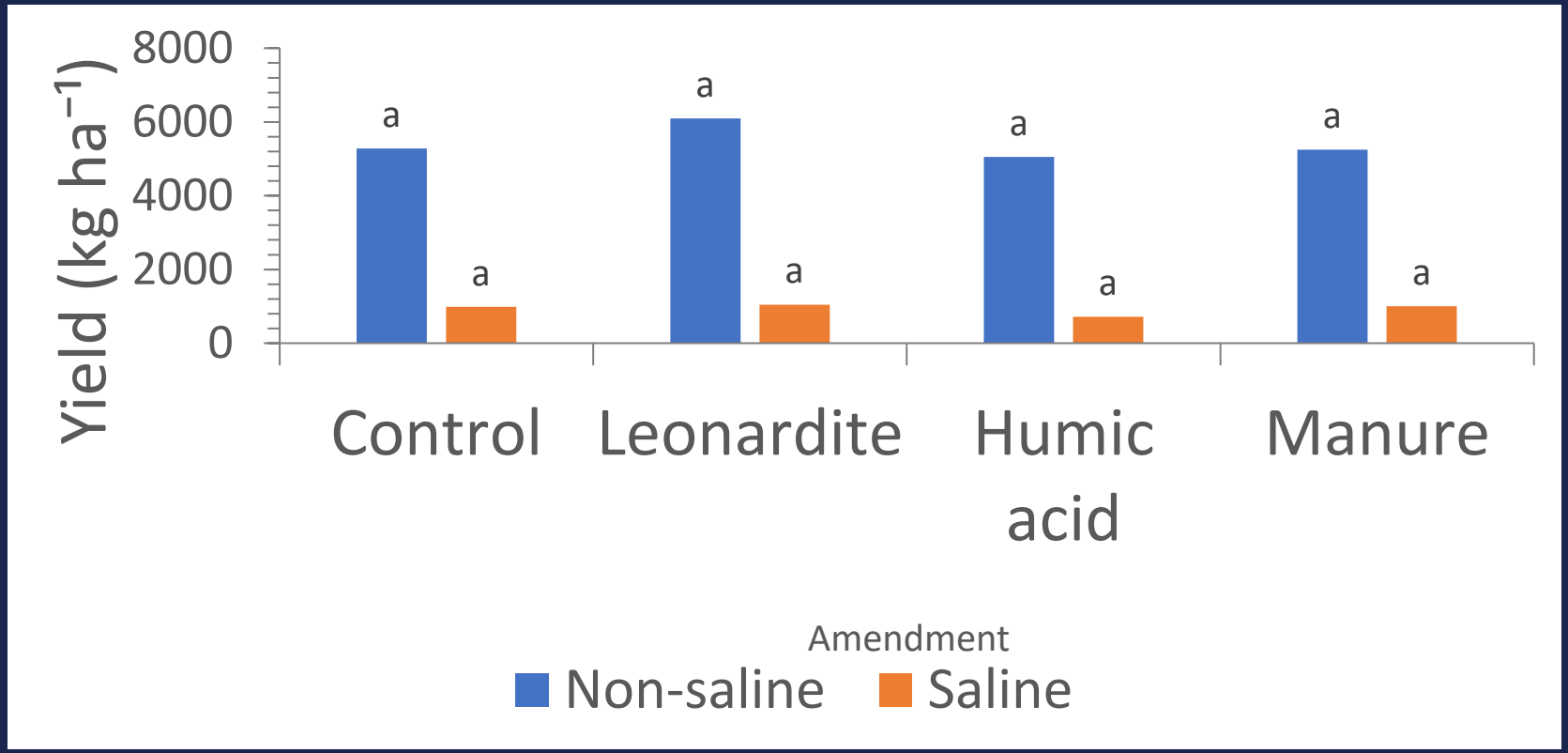
Improve productivity of marginal soils

- *Grow salt - tolerant forages on salt affected soils*

Field Study (P. Hrycyk MSc)

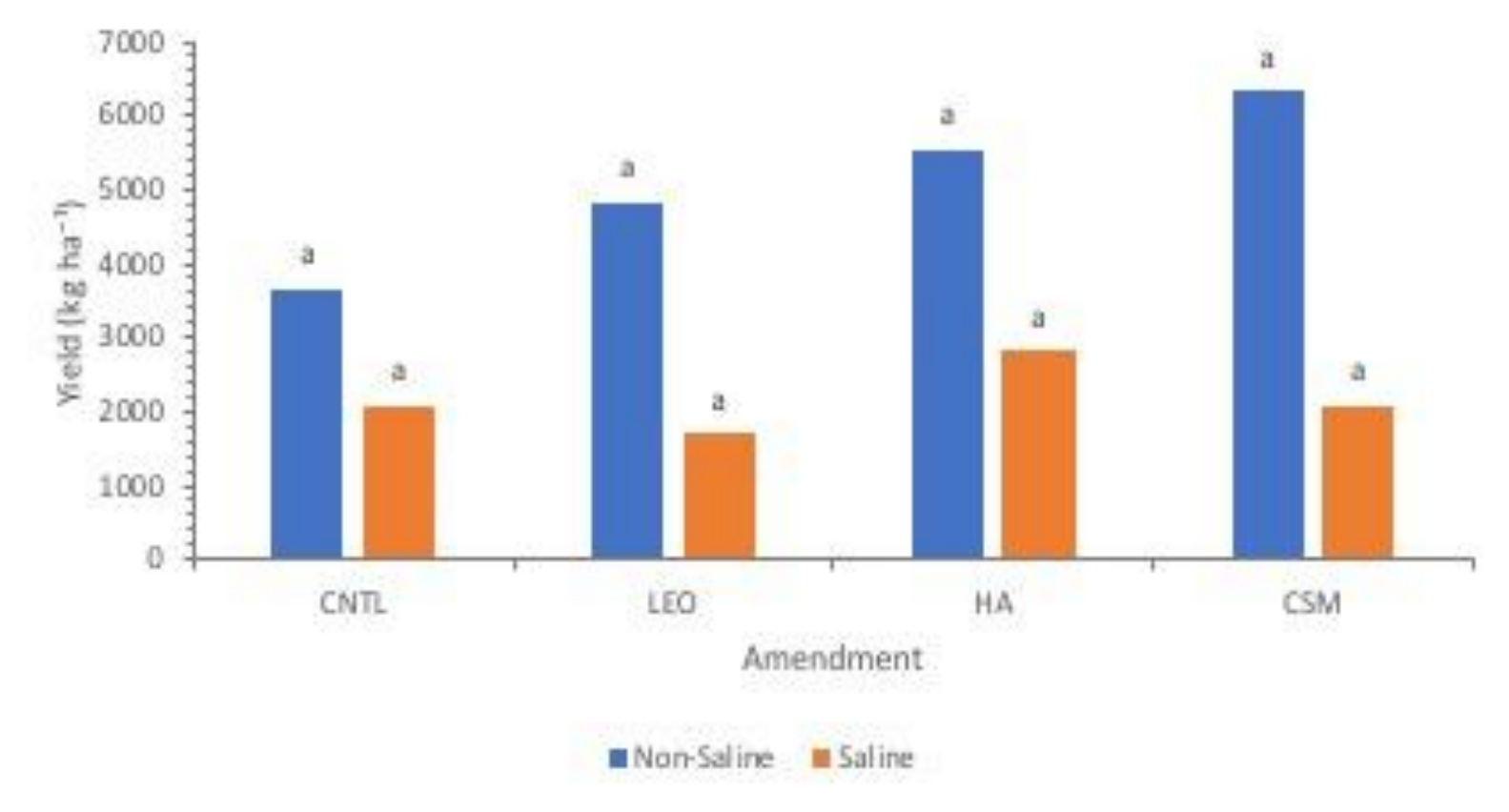
started in spring of 2017 with amendment application and seeding AC Saltlander Green Wheatgrass

AC Saltlander Green Wheatgrass YIELD in Fall of 2017

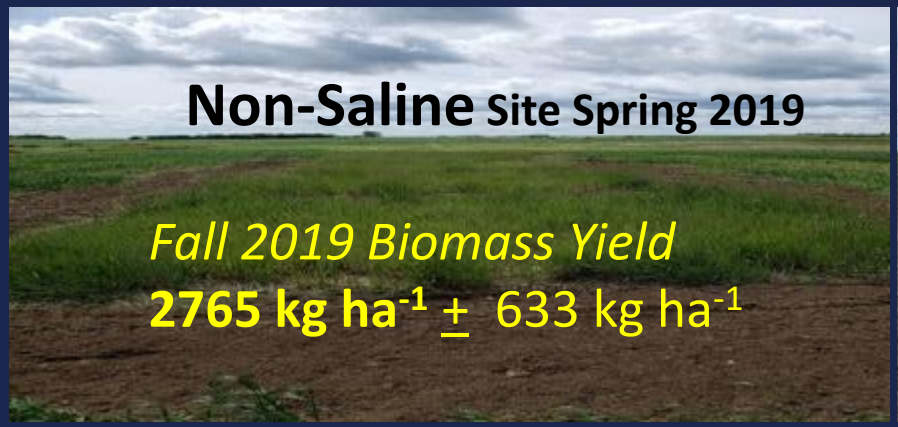


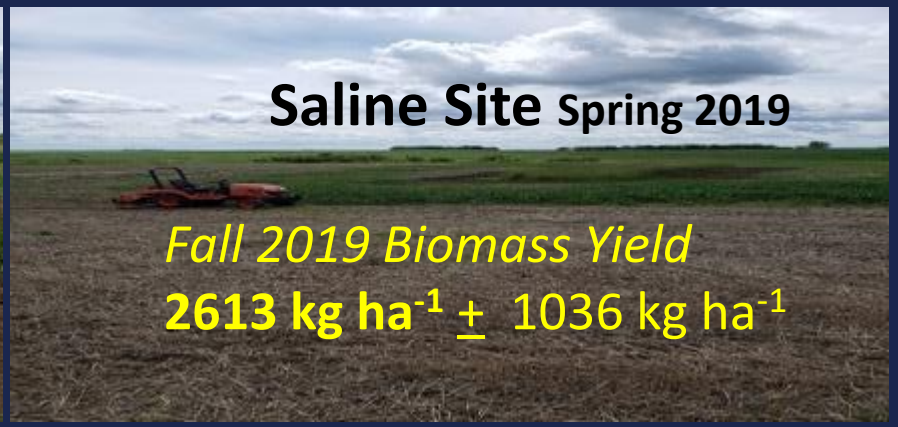
AC Saltlander Green Wheatgrass on June 3 2018 (one yr after seeding)
Non-saline (left) and Saline (right) Plots

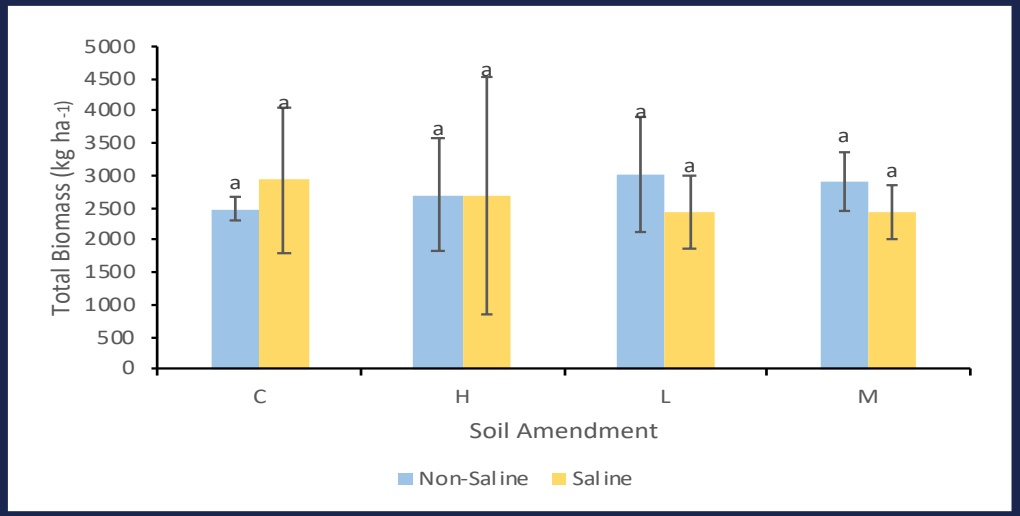
AC Saltlander Green Wheatgrass YIELD in Spring of 2018



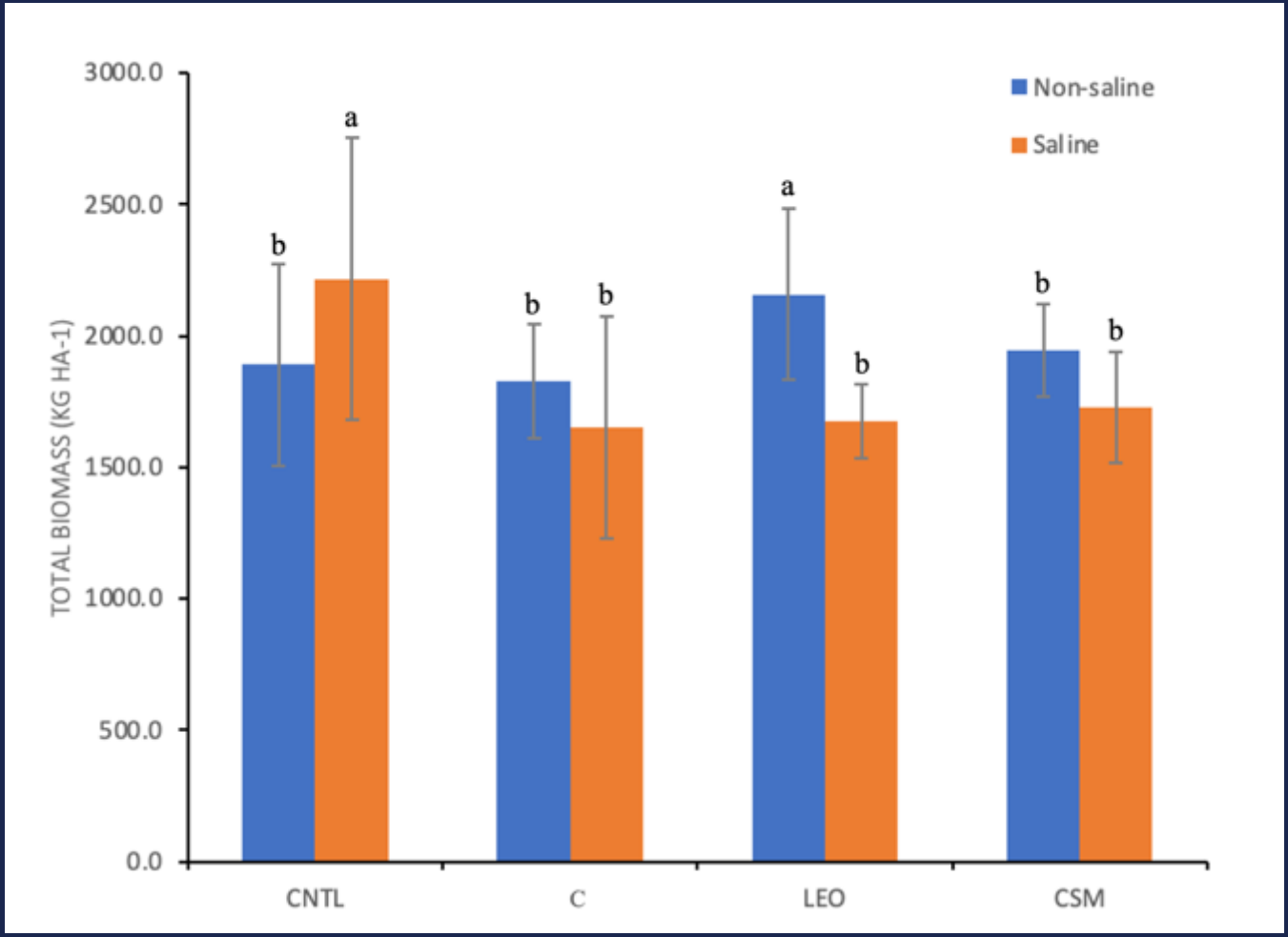
2019 Season: Very Dry Spring







Biomass yield of AC Saltlander green wheatgrass in the fall of 2020 in the **saline and non-saline sites** at **Central Butte**. Means within each site followed by a different letter are significantly different (P<0.05).



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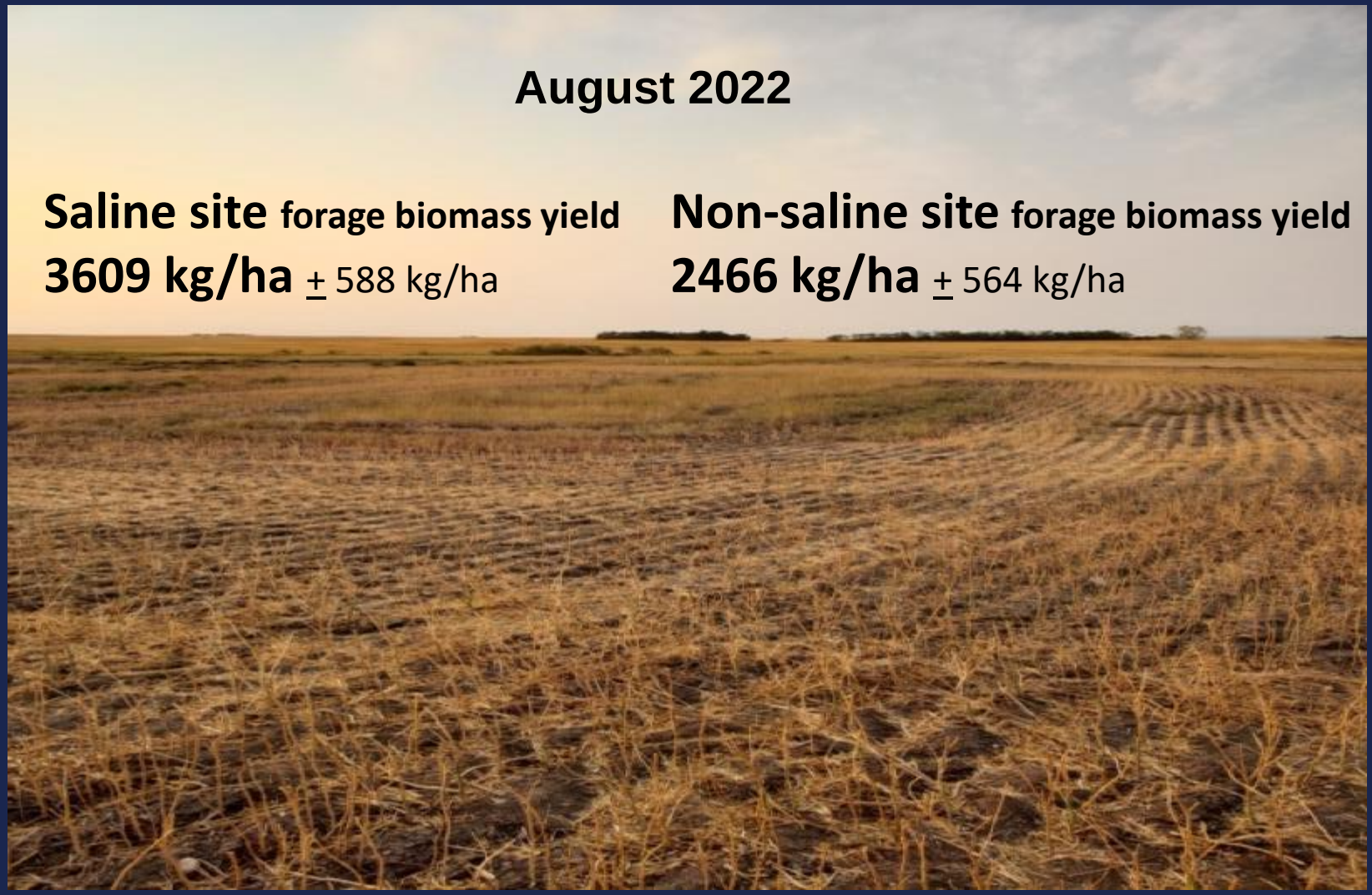
Difference in forage growth on non-saline and saline soils diminishing over time: green wheat grass "catching up" on saline site. ***We are getting a palatable forage to grow well on salt affected land!***

Roots of salt tolerant grass, once established, can use shallow ground water and residual nutrients

June 2022


August 2022
Saline site forage biomass yield
3609 kg/ha ± 588 kg/ha
Non-saline site forage biomass yield
2466 kg/ha ± 564 kg/ha

Water Infiltration: Saturated Hydraulic Conductivity K_s

	K_s (m s^{-1})
CNTL	1.42E-06[b]
BC4000	3.18E-06[a]
LEO	3.19E-06[a]
CSM	4.74E-06[a]

Saturated hydraulic conductivity in LFCE site near Clavet. Measured in August 2020.

- All amendments significantly increased the saturated hydraulic conductivity after the application.
- Composted manure was most effective in improving soil permeability.
- Extensive root systems of forage contribute to improved permeability of soil.

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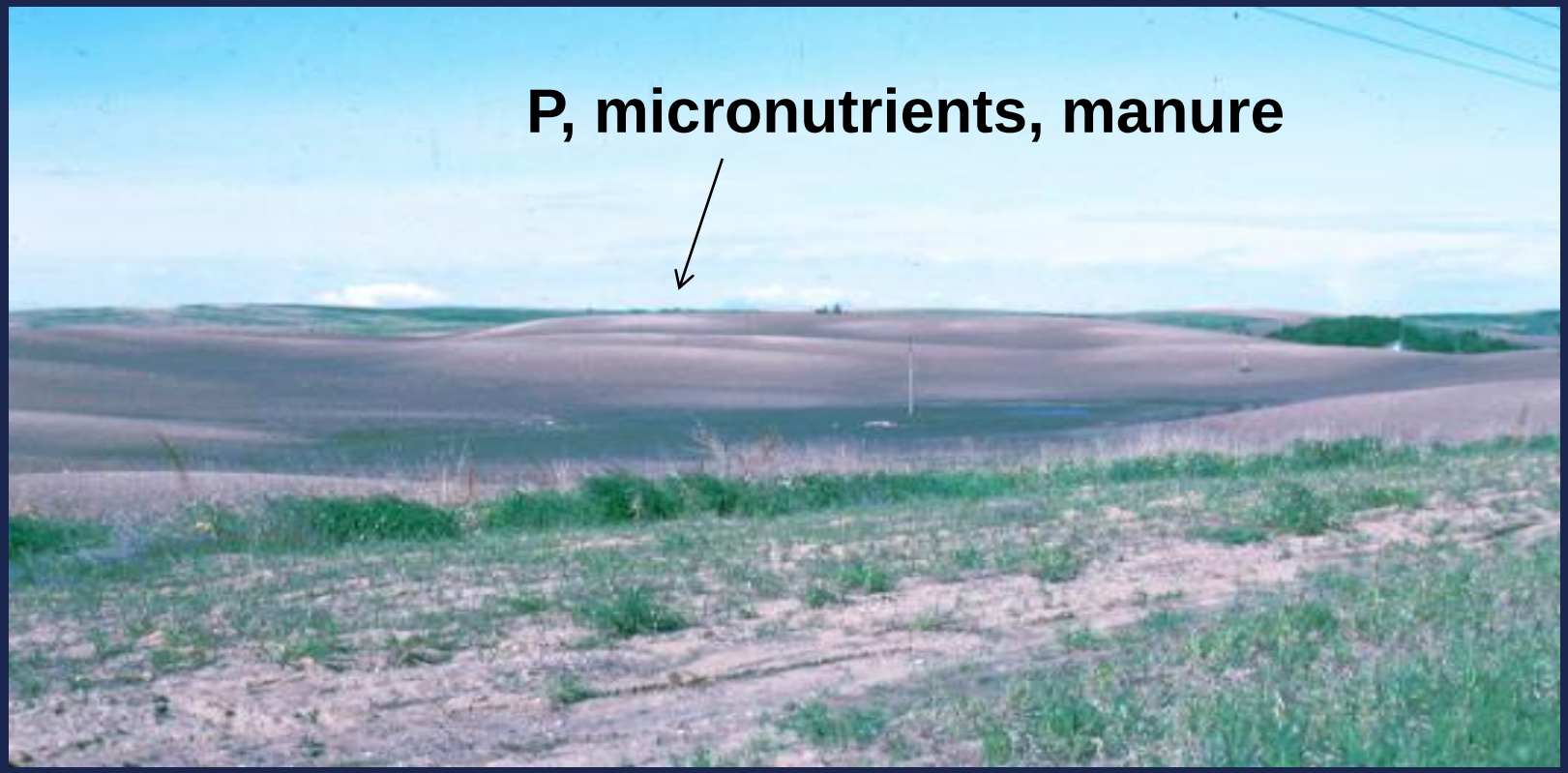
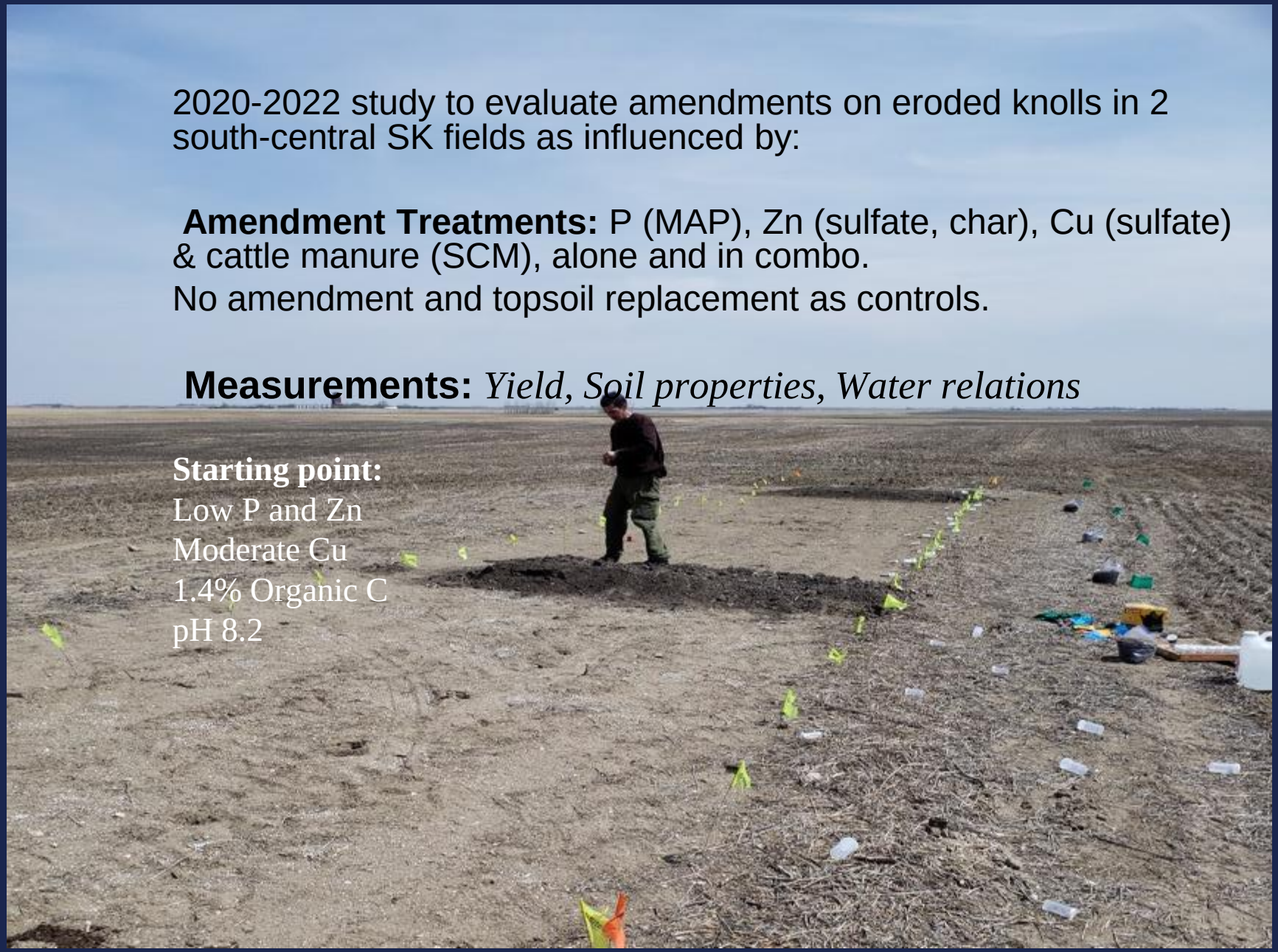
Can we restore productivity of specific field zones (eroded knolls) through selective addition of amendments?



Rebuilding the Fertility and Productivity of Eroded Knoll Soils

R. Hangs and J. Schoenau

- Historical erosion that has occurred on upper slope knolls in hummocky fields has created soils with low OM, poor fertility and structure, poor water relations



2020-2022 study to evaluate amendments on eroded knolls in 2 south-central SK fields as influenced by:

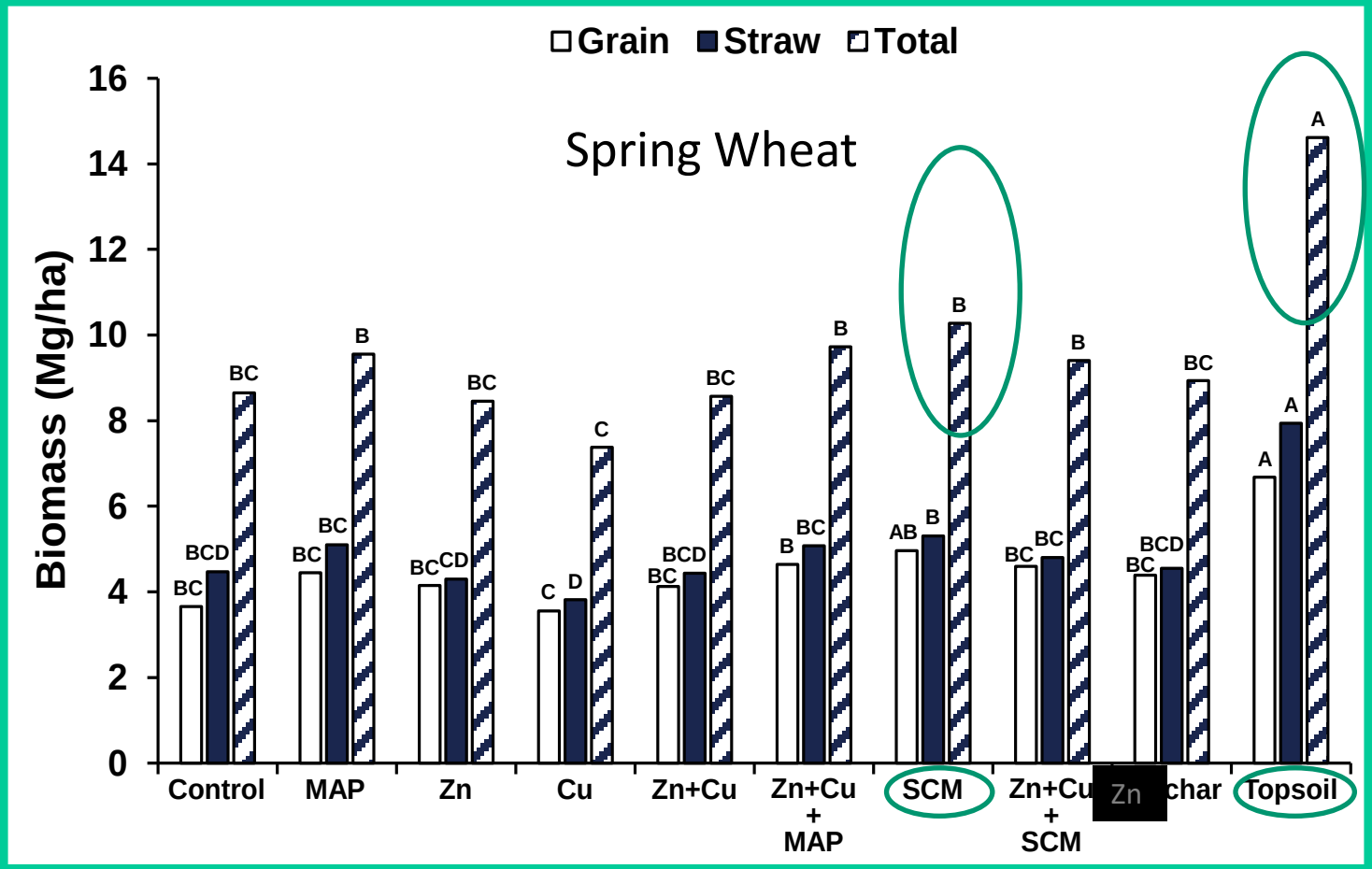
Amendment Treatments: P (MAP), Zn (sulfate, char), Cu (sulfate) & cattle manure (SCM), alone and in combo.

No amendment and topsoil replacement as controls.

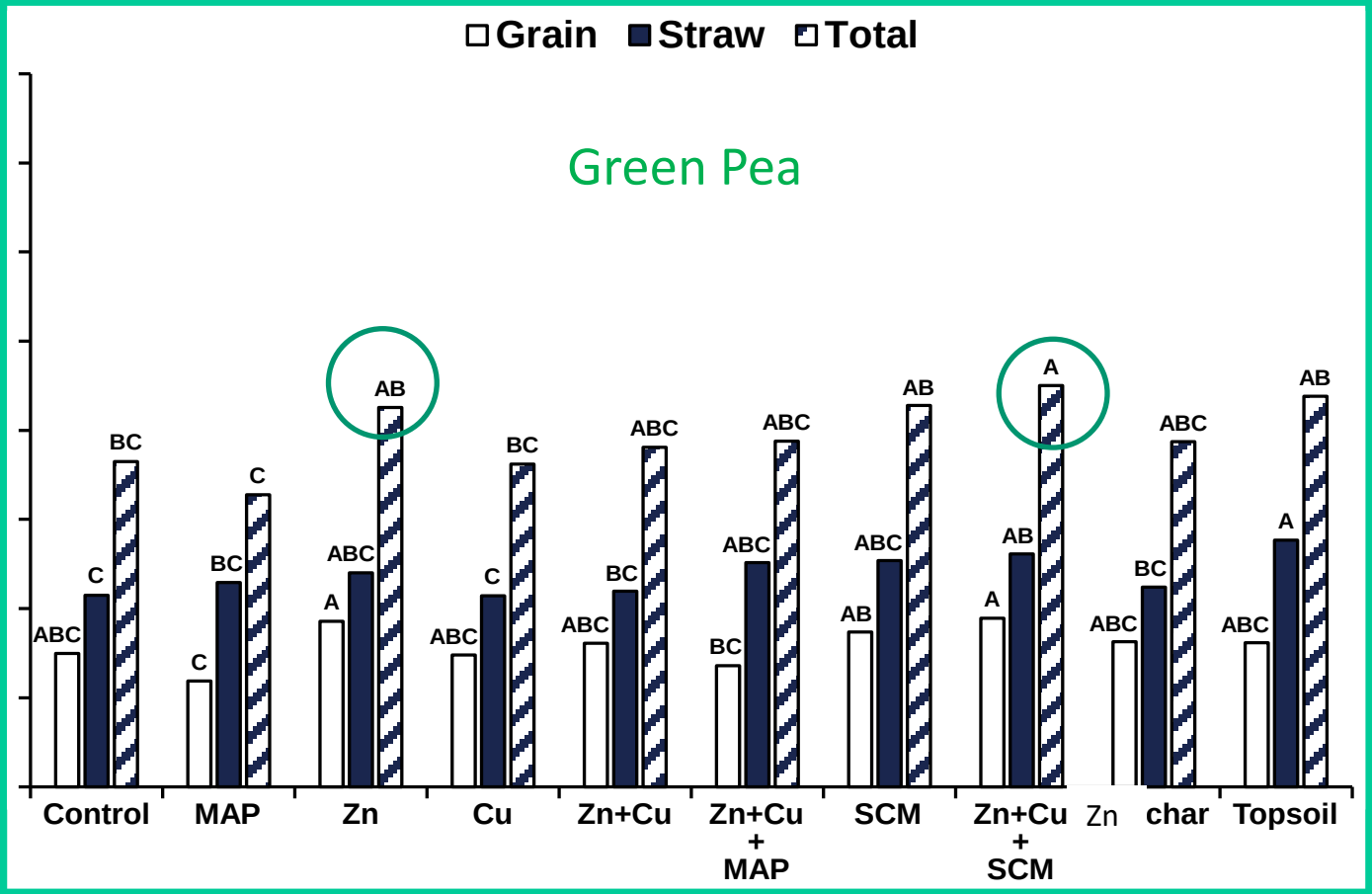
Measurements: *Yield, Soil properties, Water relations*

Starting point:
Low P and Zn
Moderate Cu
1.4% Organic C
pH 8.2

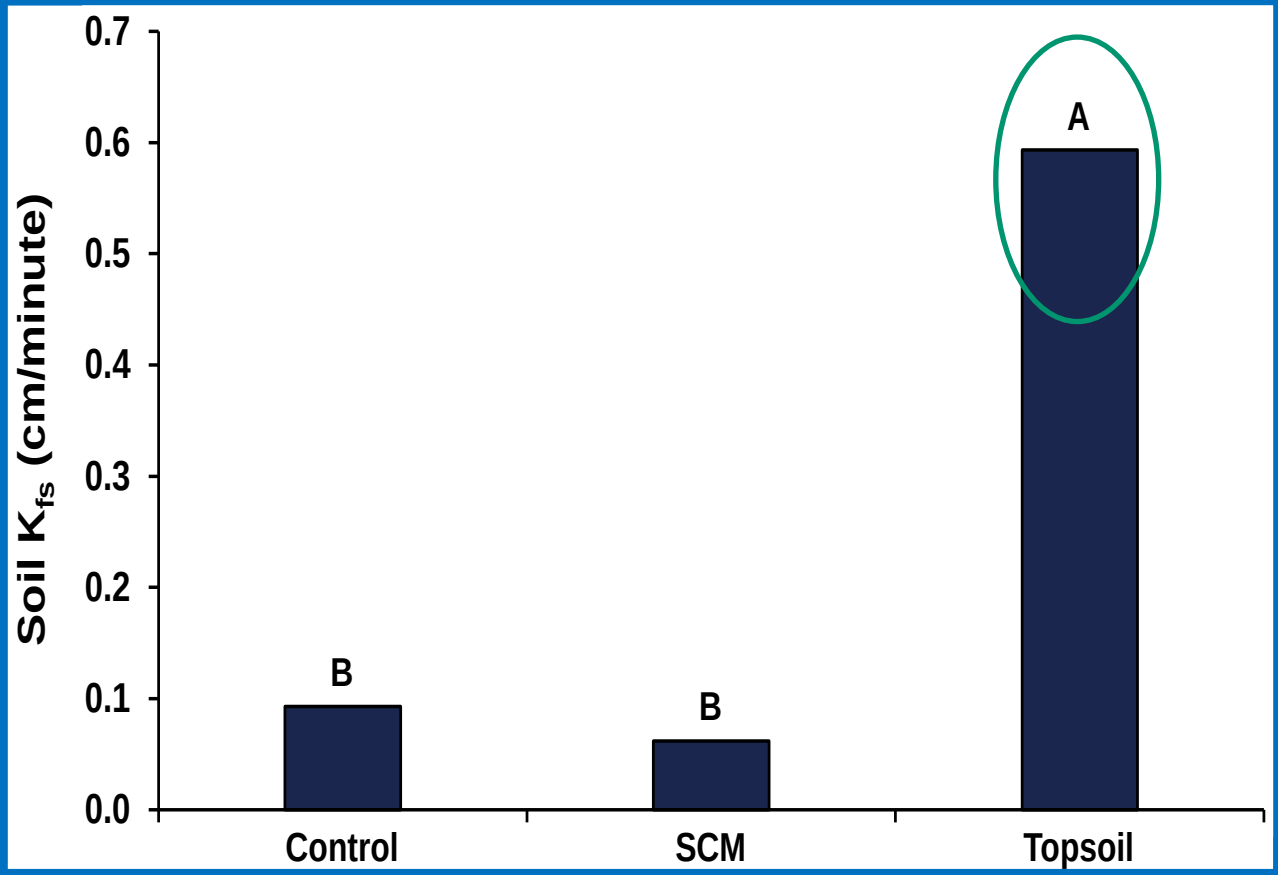
2020 Wheat Yields



2020 Pea Yields

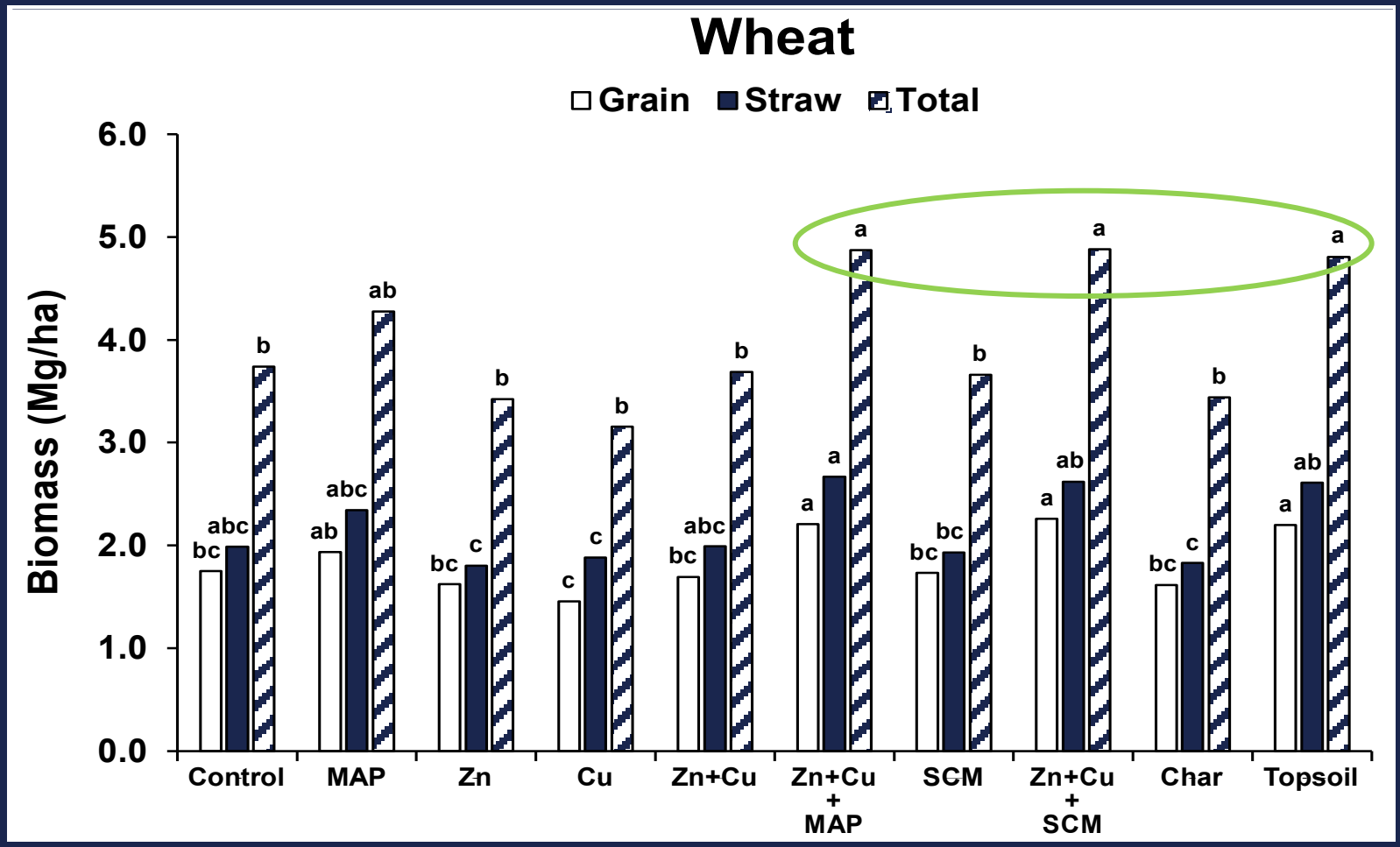


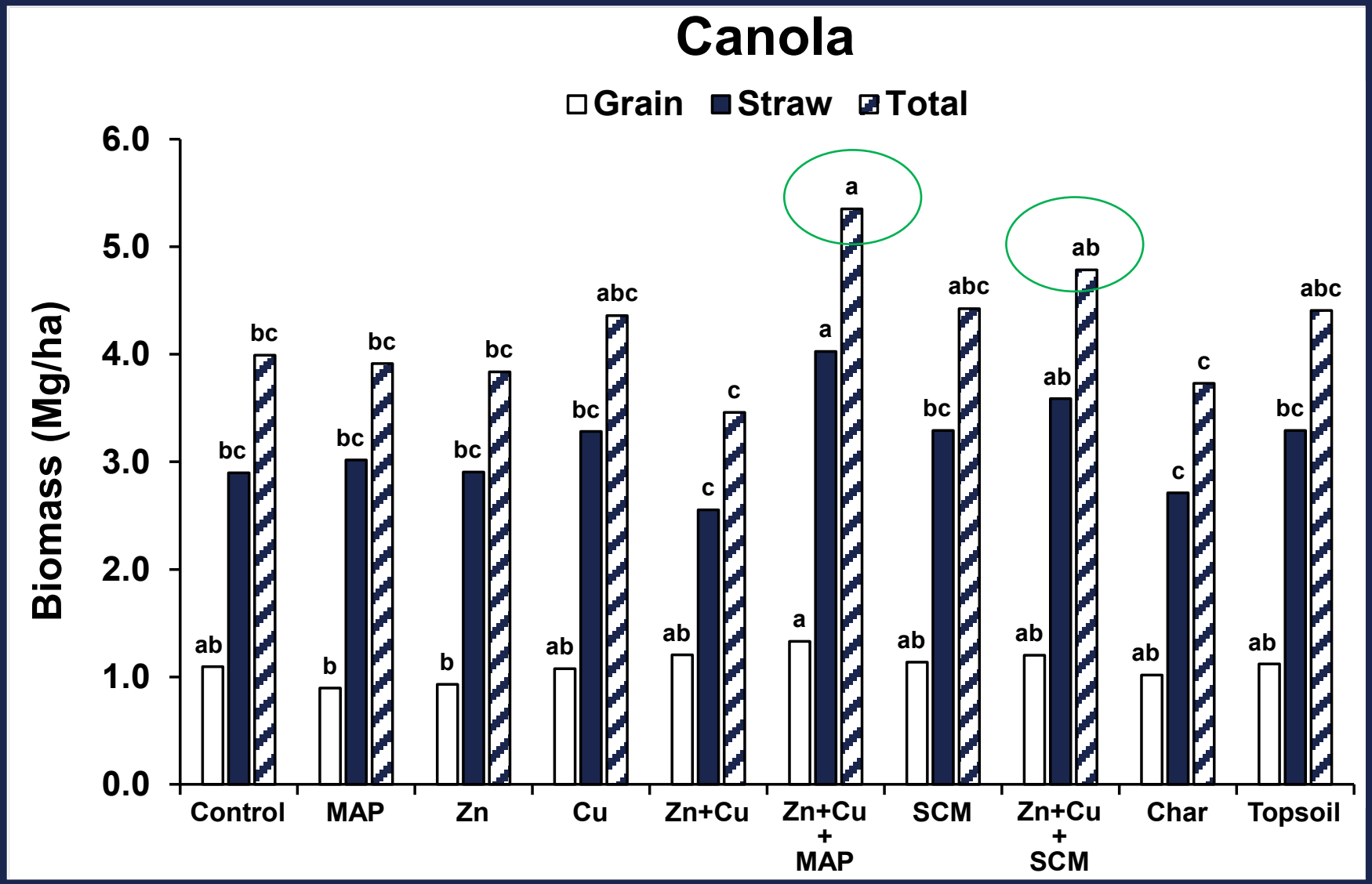
Saturated hydraulic conductivity (Water Infiltration) Fall 2020



2021: Severe Drought

3rd Year (2022) Crop Responses




Canola
Grain
Straw
Total
Biomass (Mg/ha)
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Control
MAP
Zn
Cu
Zn+Cu
Zn+Cu + MAP
SCM
Zn+Cu + SCM
Char
Topsoil

Conclusions from eroded knoll study

Amendments:

- **Depending on the crop, positive growth responses to applied MAP, Zn, and Manure in first year, with good response to combinations of Zn + Cu + MAP or Manure in year three.**

- **Indicates potential short- and longer-term benefits from these amendments to restoring productivity of eroded knolls.**

- **Combinations that provided balanced availability of macros and micros worked best.**

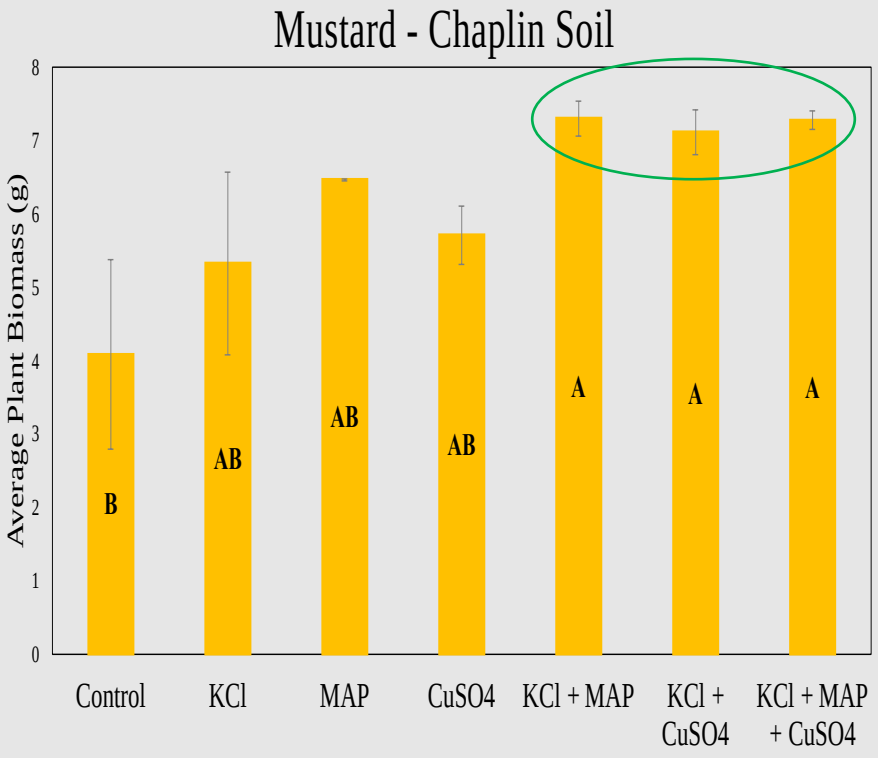
Macro-Micro Balance

- Antagonisms among phosphorus, zinc and copper can exist for crops such that fertilization of one without the other may induce negative interaction (Rahman et al., 2022 Can. J. Soil Sci. 102: 797-809).

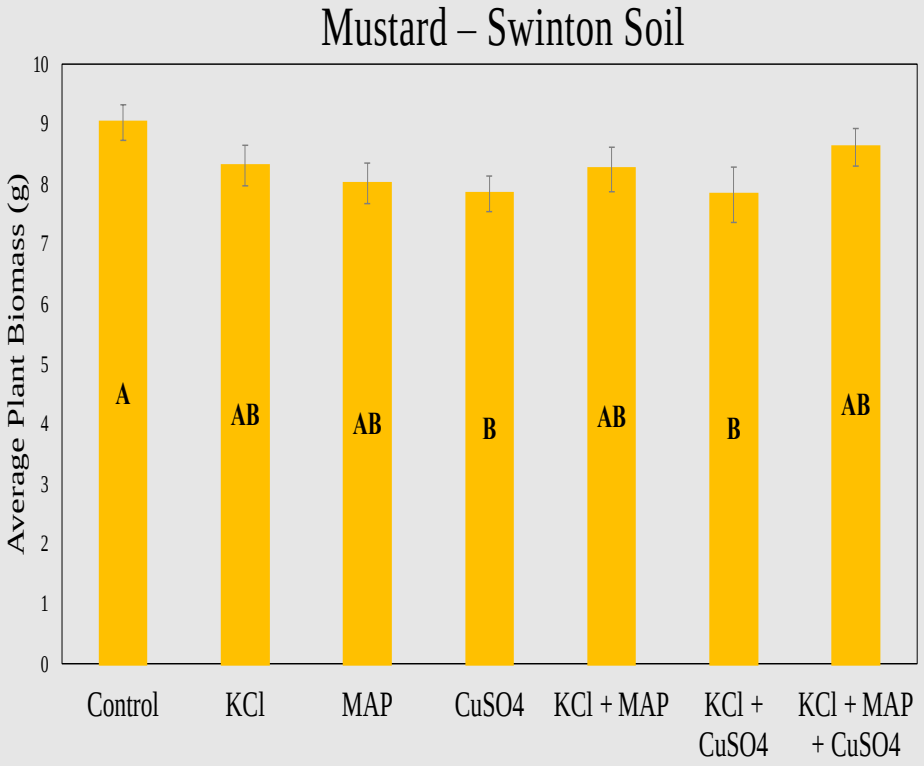
- Balanced availability of macros and micros required for best response.

Effect of KCl, MAP, and $CuSO_4$ Fertilization on Plant Biomass in Durum, Mustard, and Chickpea Grown Under Controlled Environment Conditions (T. Chambers 2023 MSc project)

Sandy


Mustard - Chaplin Soil
Average Plant Biomass (g)
0
1
2
3
4
5
6
7
8
B
AB
AB
AB
A
A
A
Control
KCl
MAP
CuSO4
KCl + MAP
KCl + CuSO4
KCl + MAP + CuSO4

Silty


Mustard – Swinton Soil
Average Plant Biomass (g)
0
1
2
3
4
5
6
7
8
9
10
A
AB
AB
B
AB
B
AB
Control
KCl
MAP
CuSO4
KCl + MAP
KCl + CuSO4
KCl + MAP + CuSO4

If we look after our soils, they will look after us!


Thank you for opportunity to participate!