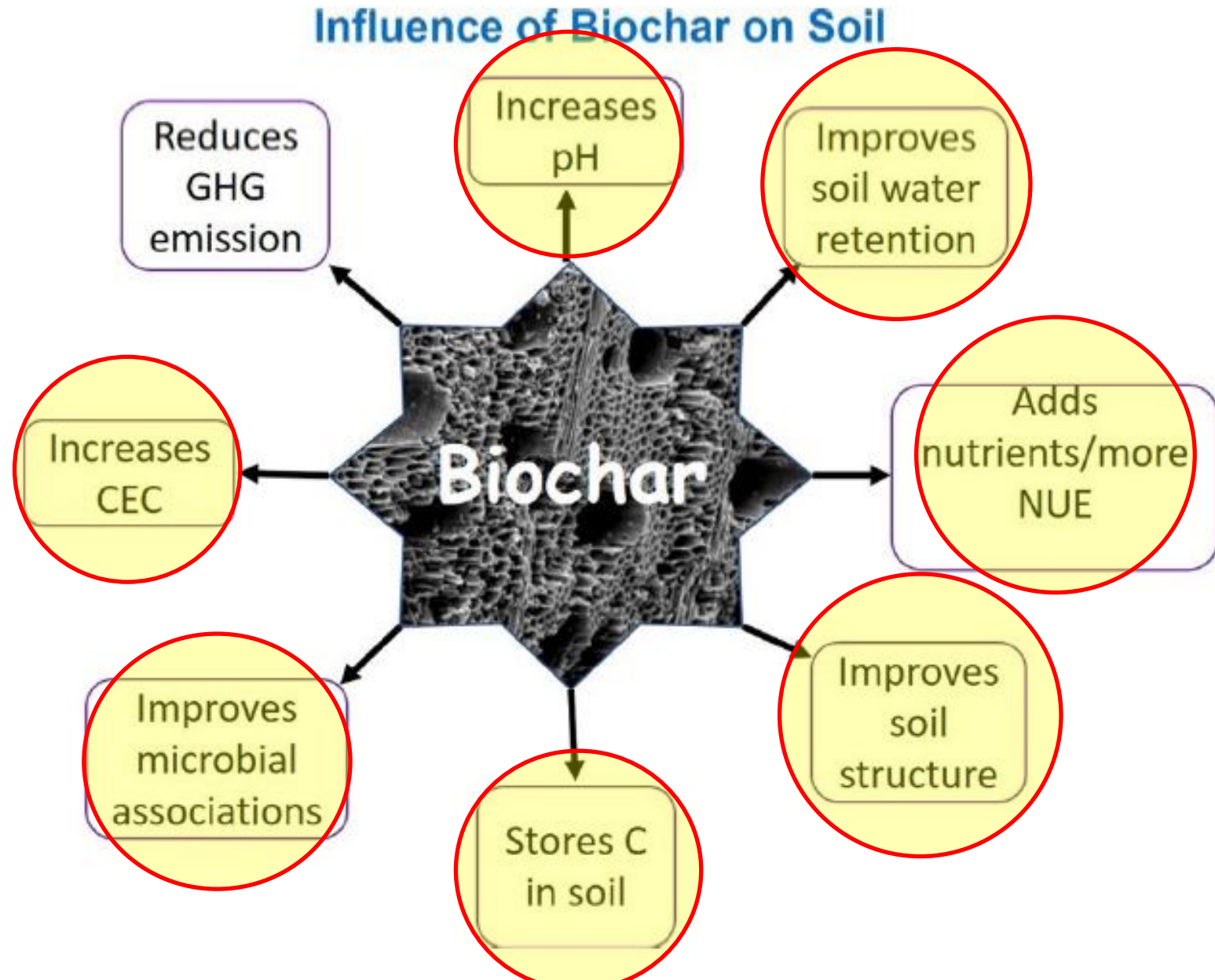


Use of Biochar as Soil Amendment Improve Reclamation Success and site Resiliency

Amir Hass
West Virginia State University

ASRS
42st Annual Meeting
June 2, 2025, Butte MN

Why Biochar?



Reclaimed Mine Study Sites

Farm land (2)

Reclaimed mine sites (3):

- MTRVF reclaimed in early 2000's
- PMLU wildlife habitat

Site Preparation

- Brush hogged
- Ripped (box ripper) to 6-8"
- Disked
- Fertilized (triple 19 @ 300lb acre⁻¹)
- Disked and seeded with 135 lb of wheat and 80 lb of pasture mix per acre

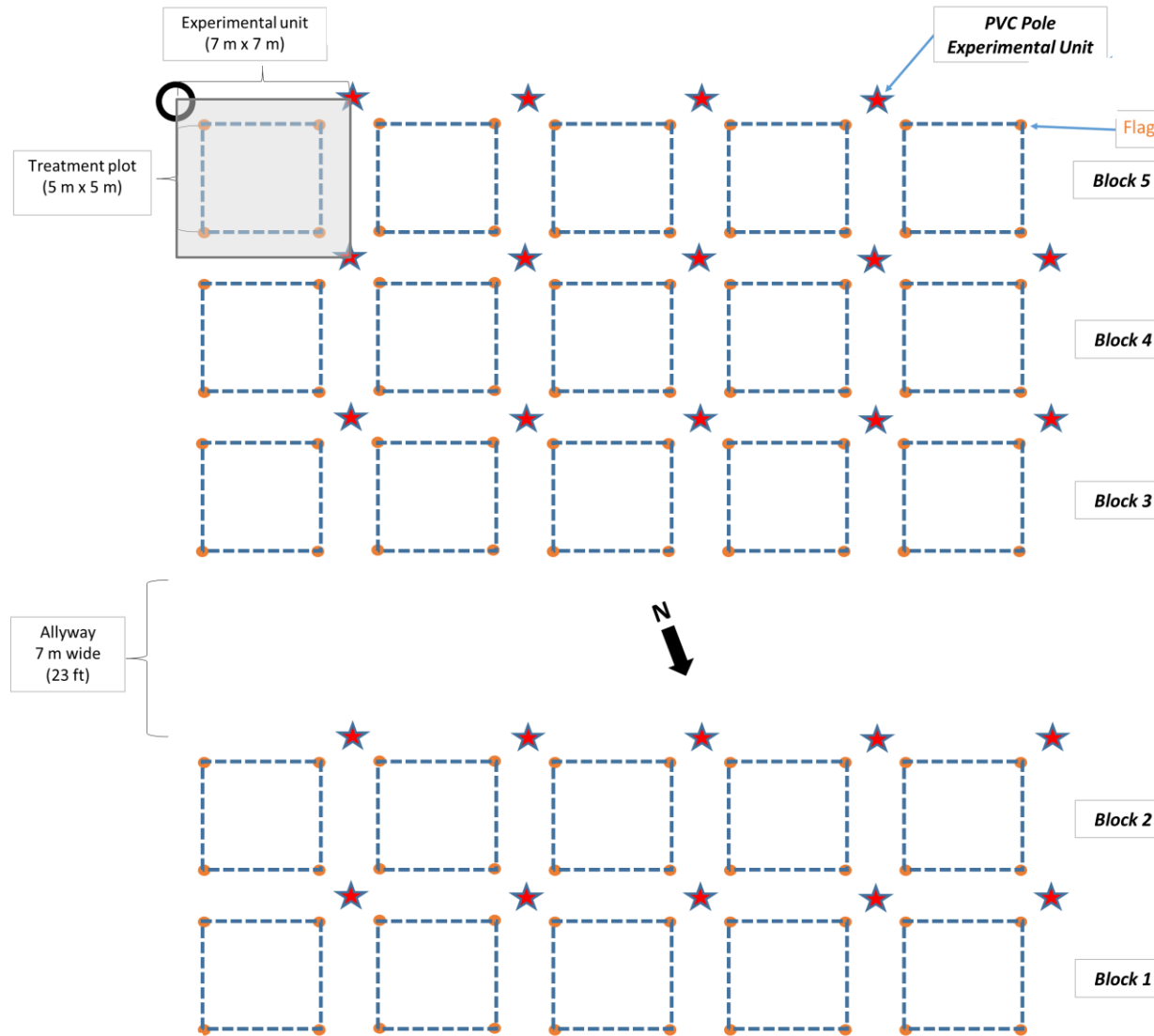
Treatments:

Biochar Application 0, 6, 12, 24, 48, 96 Mg ha⁻¹



Study Sites

Experimental layout:
Complete factorial RCBD



Reclaimed Mine Study Sites



BIO 1

Broom sage
(*Andropogon virginicus*)

pH 5.5
OM 4.0 %
P 5 ppm
K 79 ppm
NO₃⁻ 14 ppm



BIO 2

Lespedeza
(*Lespedeza cuneata*)

pH 4.6
OM 6.7 %
P 13 ppm
K 116 ppm
NO₃⁻ 27 ppm

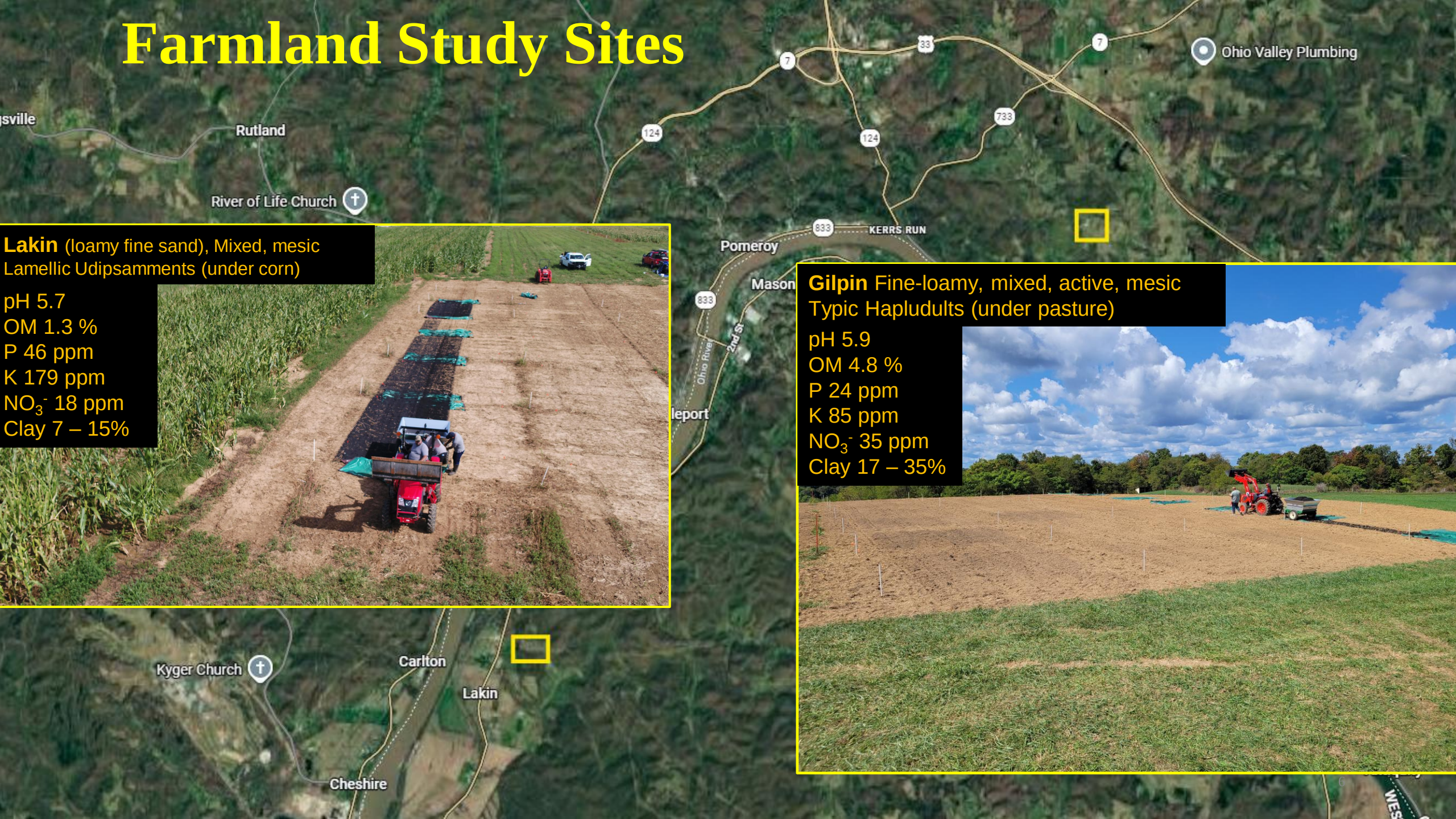
BIO 3

pH 5.5
OM 6.5 %
P 11 ppm
K 118 ppm
NO₃⁻ 36 ppm

Autumn olive
(*Elaeagnus umbellata* Thunb.)



Farmland Study Sites



Lakin (loamy fine sand), Mixed, mesic
Lamellic Udipsamments (under corn)

pH 5.7
OM 1.3 %
P 46 ppm
K 179 ppm
NO₃⁻ 18 ppm
Clay 7 – 15%



Gilpin Fine-loamy, mixed, active, mesic
Typic Hapludults (under pasture)

pH 5.9
OM 4.8 %
P 24 ppm
K 85 ppm
NO₃⁻ 35 ppm
Clay 17 – 35%



Biochar Treatment Instalation









BIO 1



BIO 1







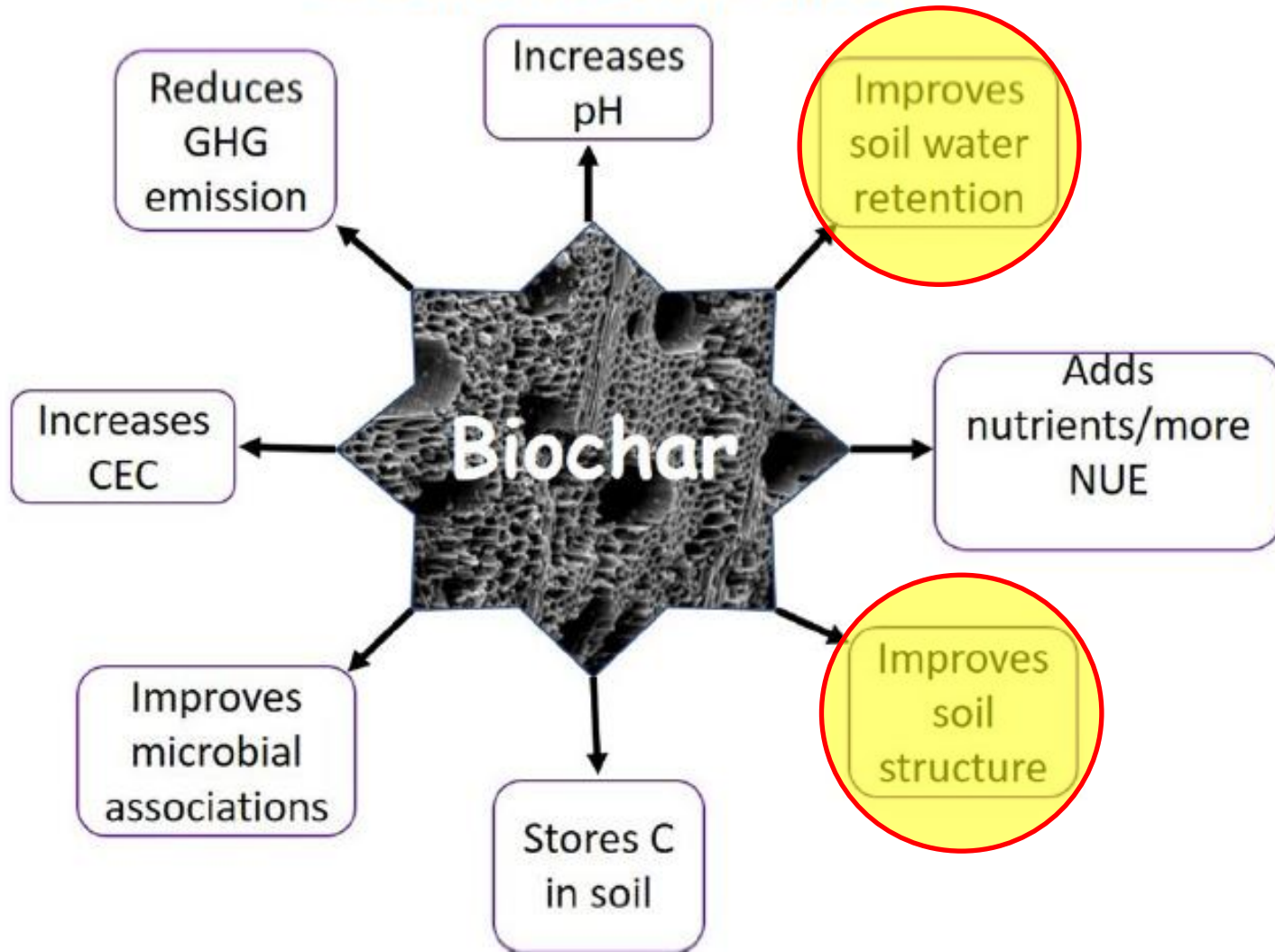




HOBOnet T12
Soil moisture
/temp/EC



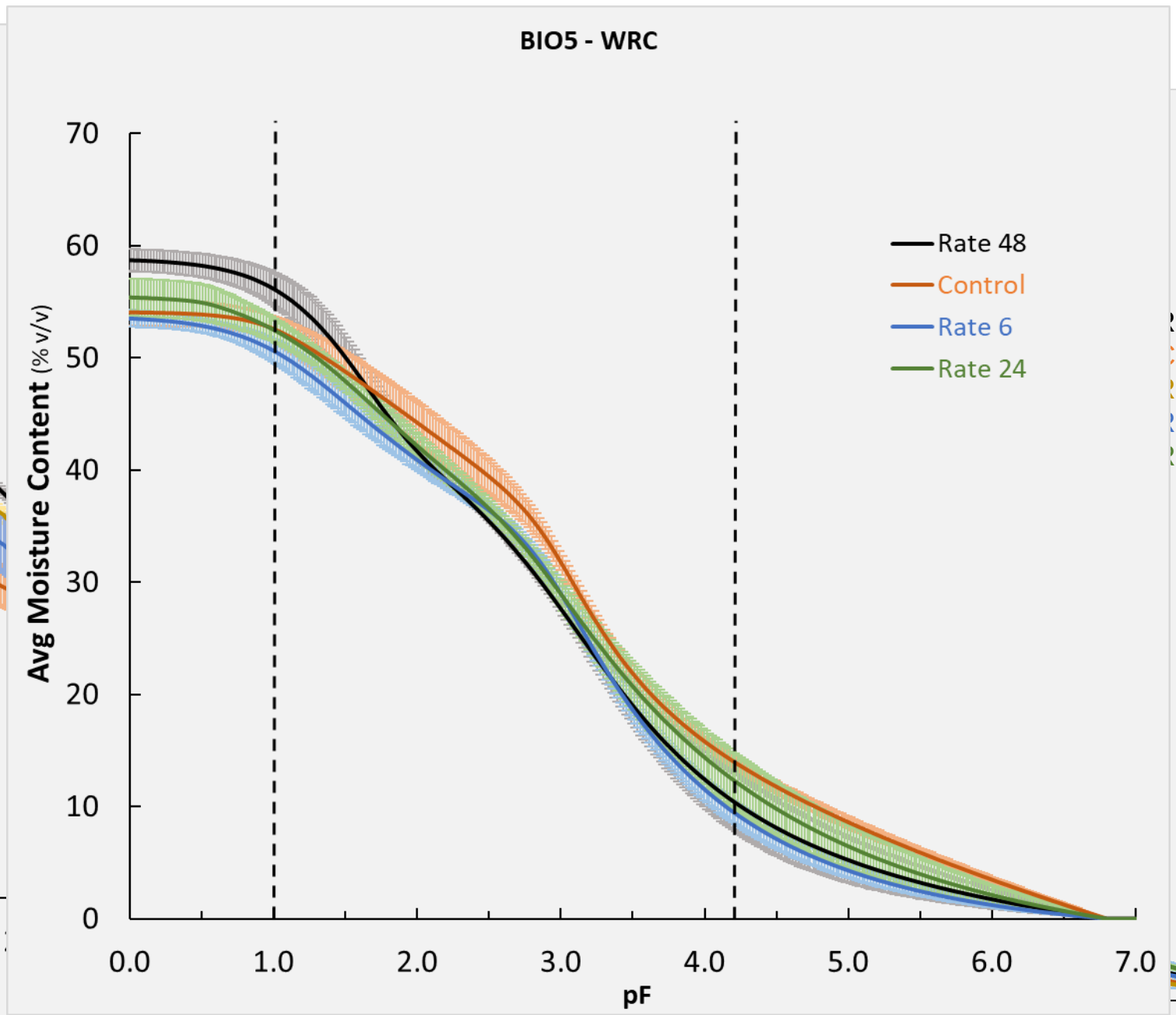
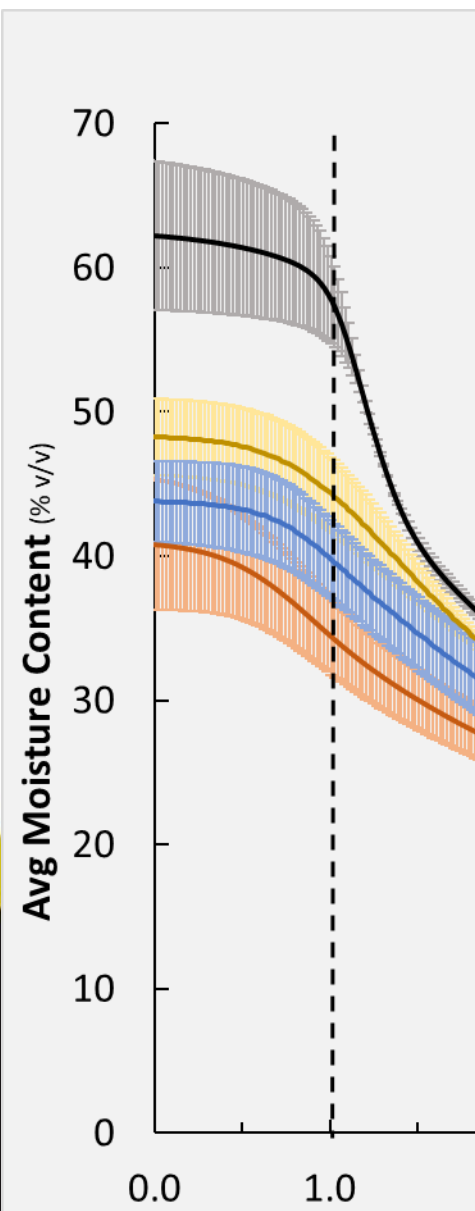
Influence of Biochar on Soil



Soil Moisture Limitation Within Ecoregion:

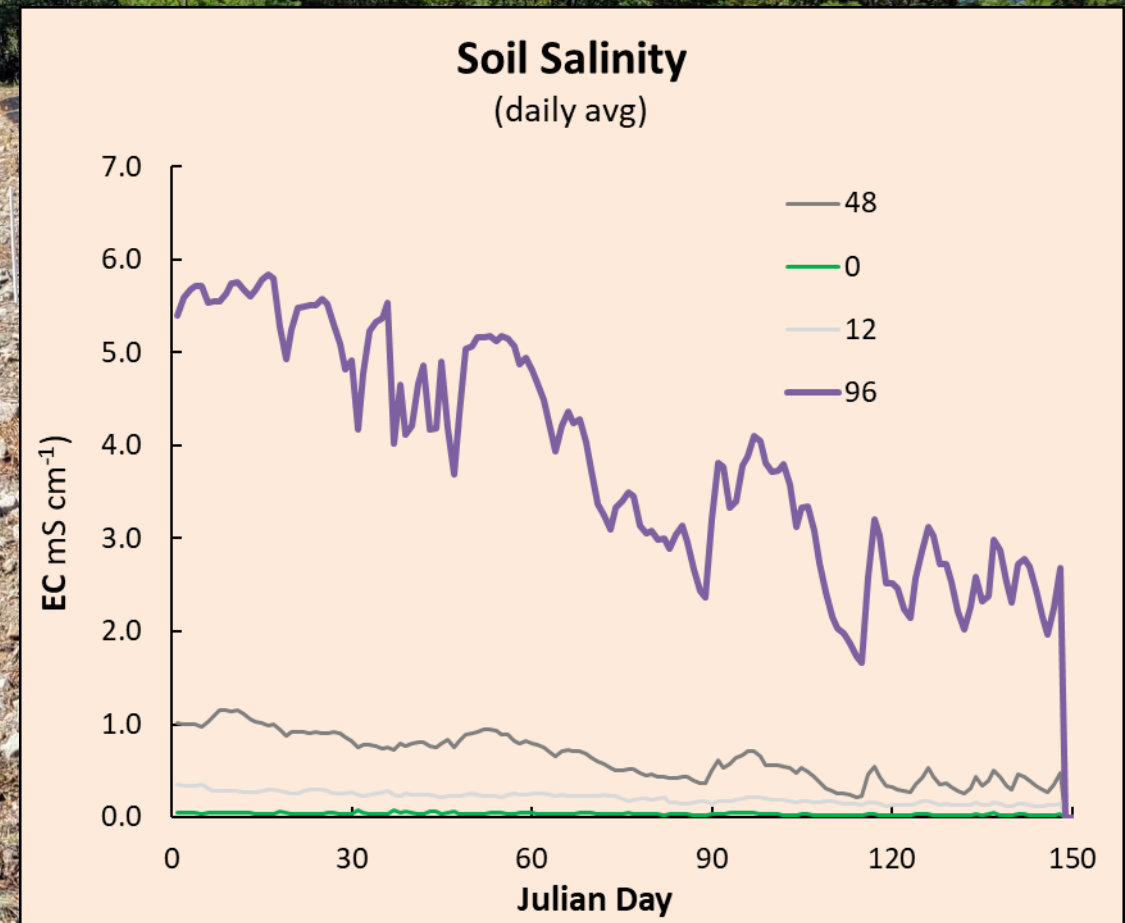
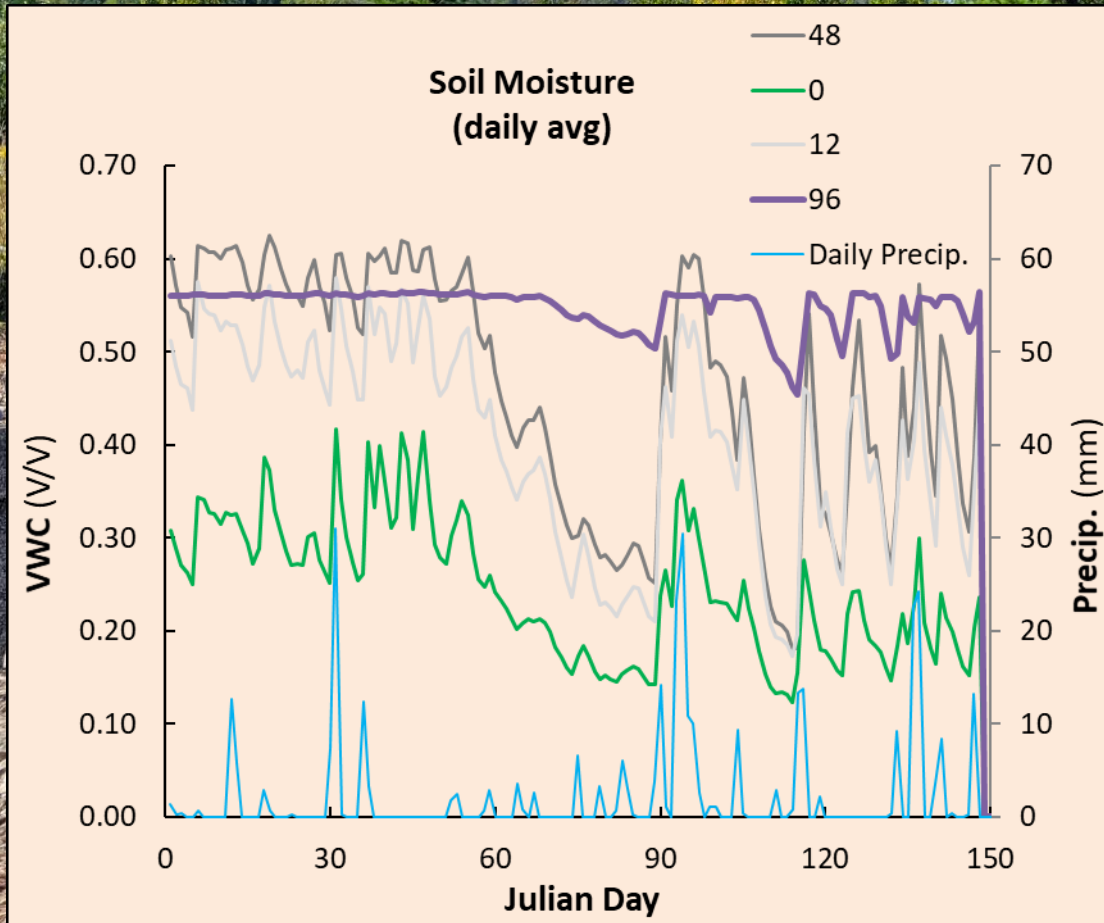
- Infiltration Rate
- Hydraulic Conductivity (percolation)
- Soil Water Storage Capacity
- Evapotranspiration
- Drainage
- Salinity
- Water retention



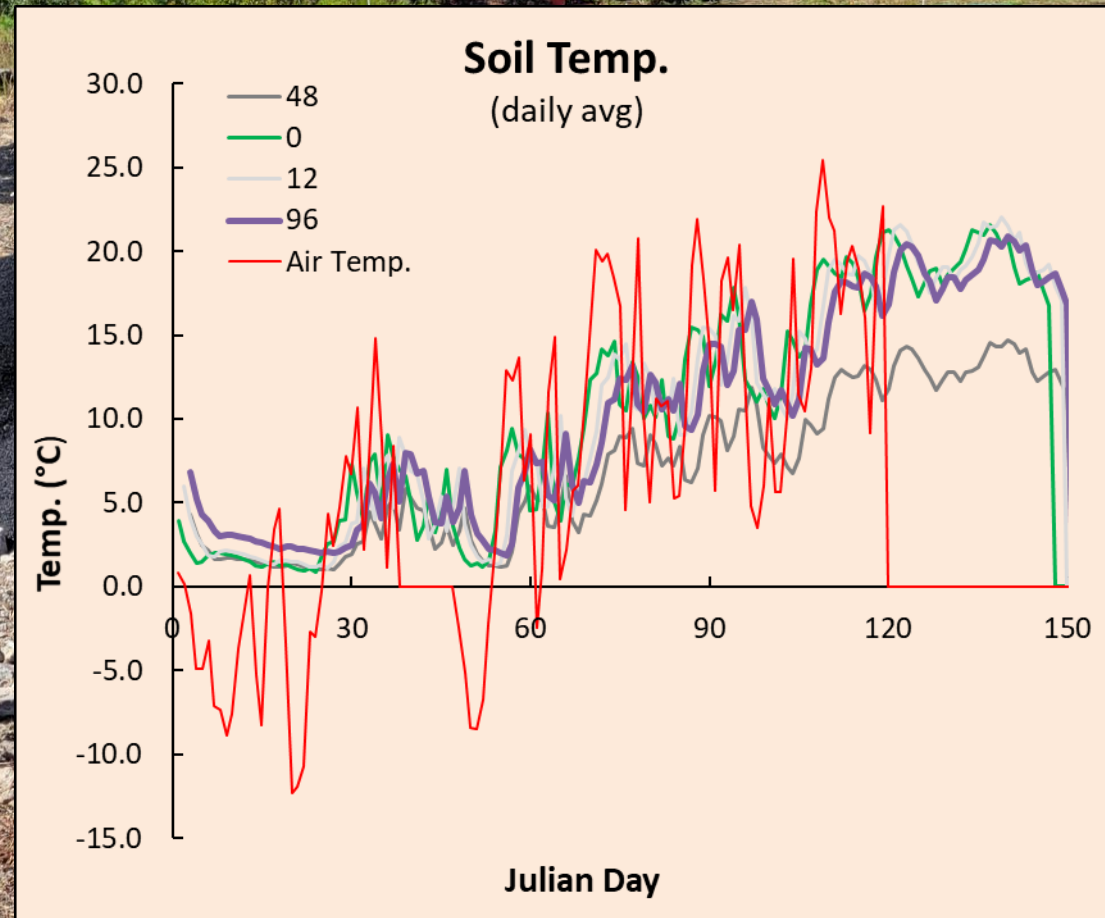


Rate 48
Control
Rate 12
Rate 6
Rate 24

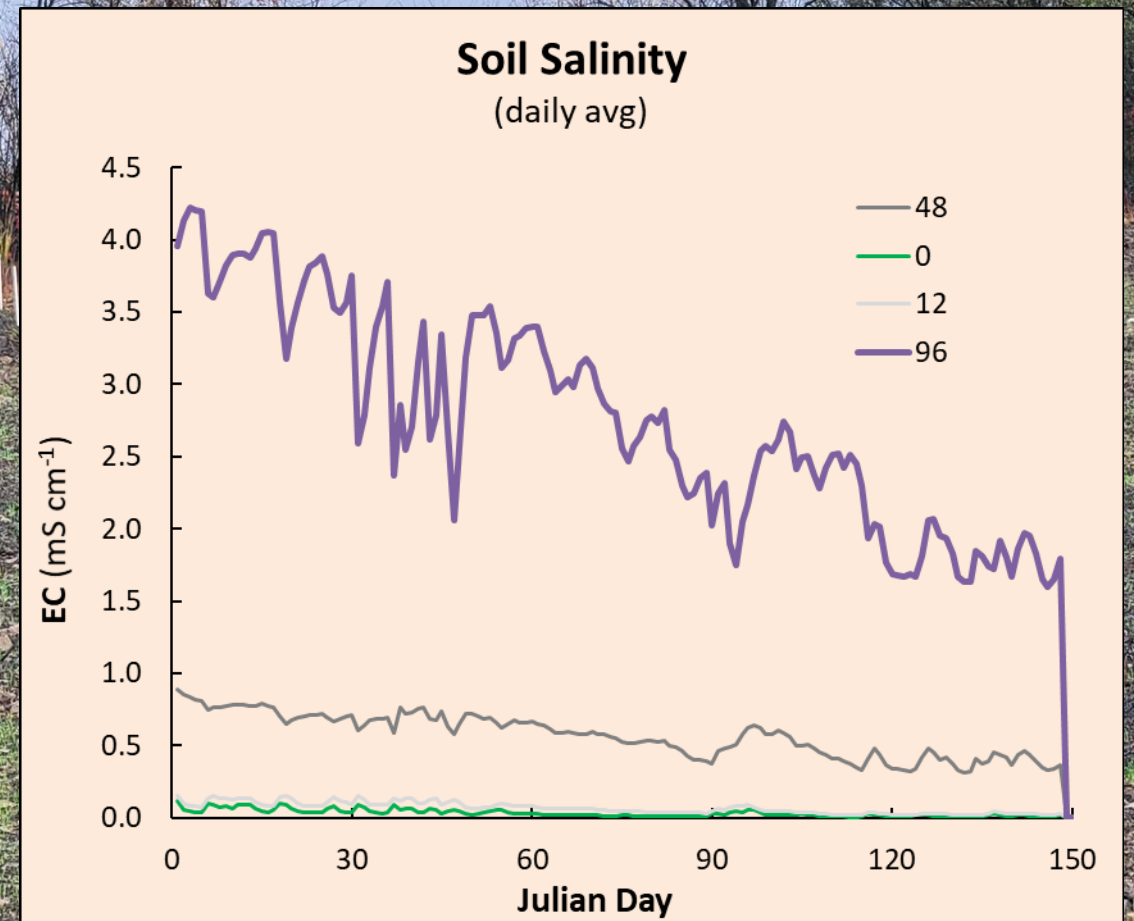
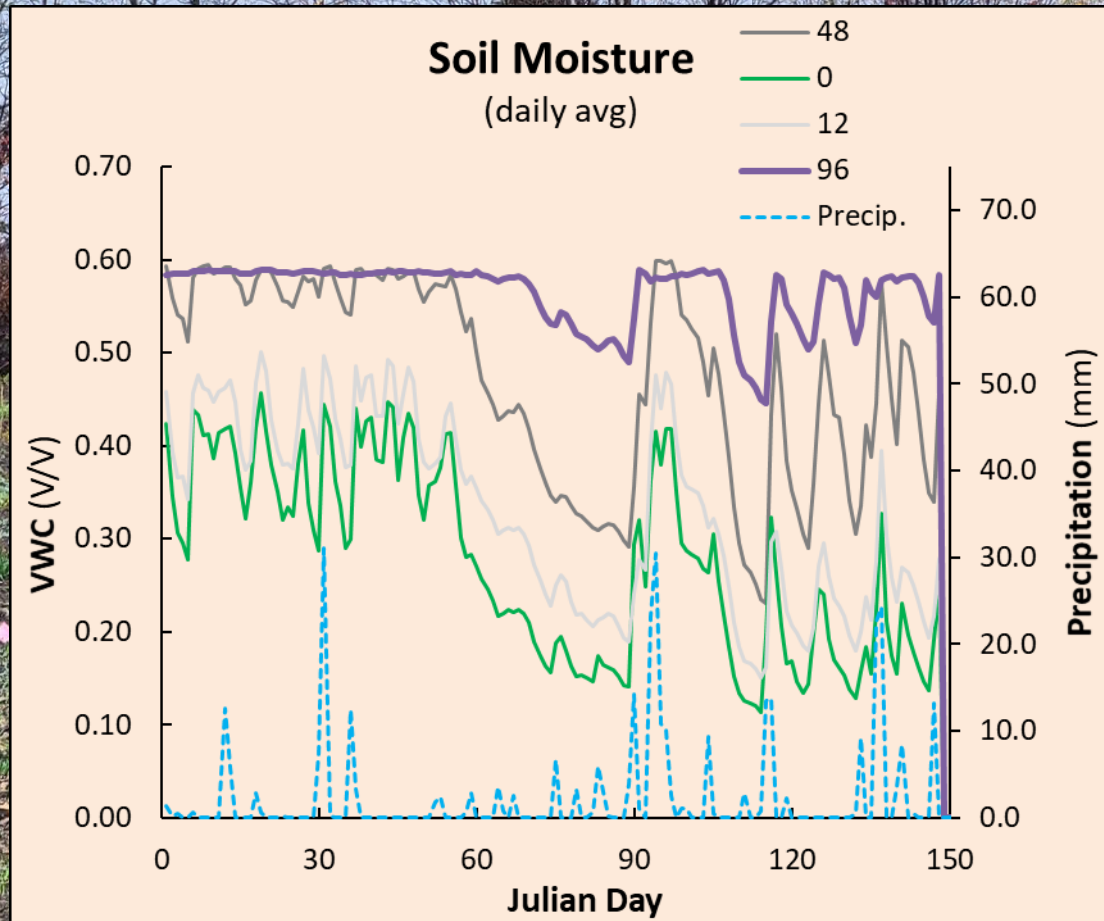
BIO 1



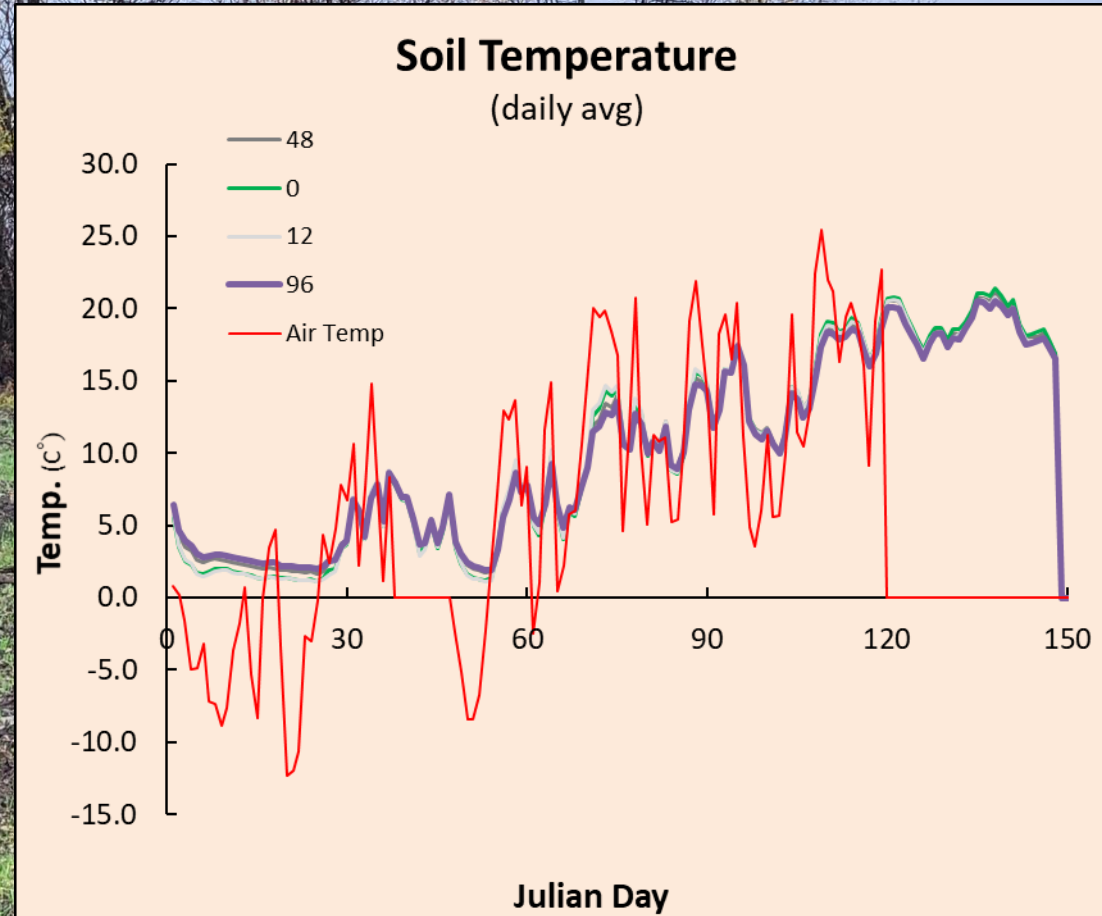
BIO 1



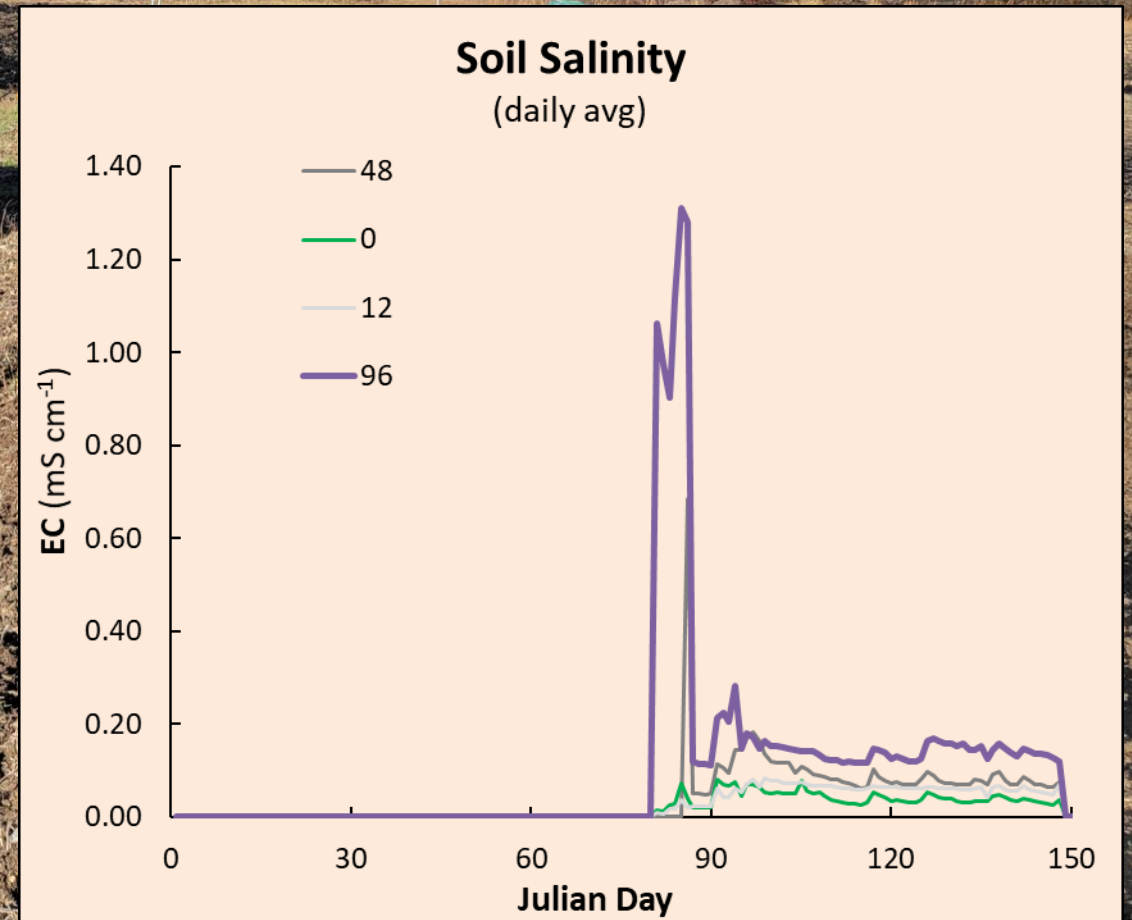
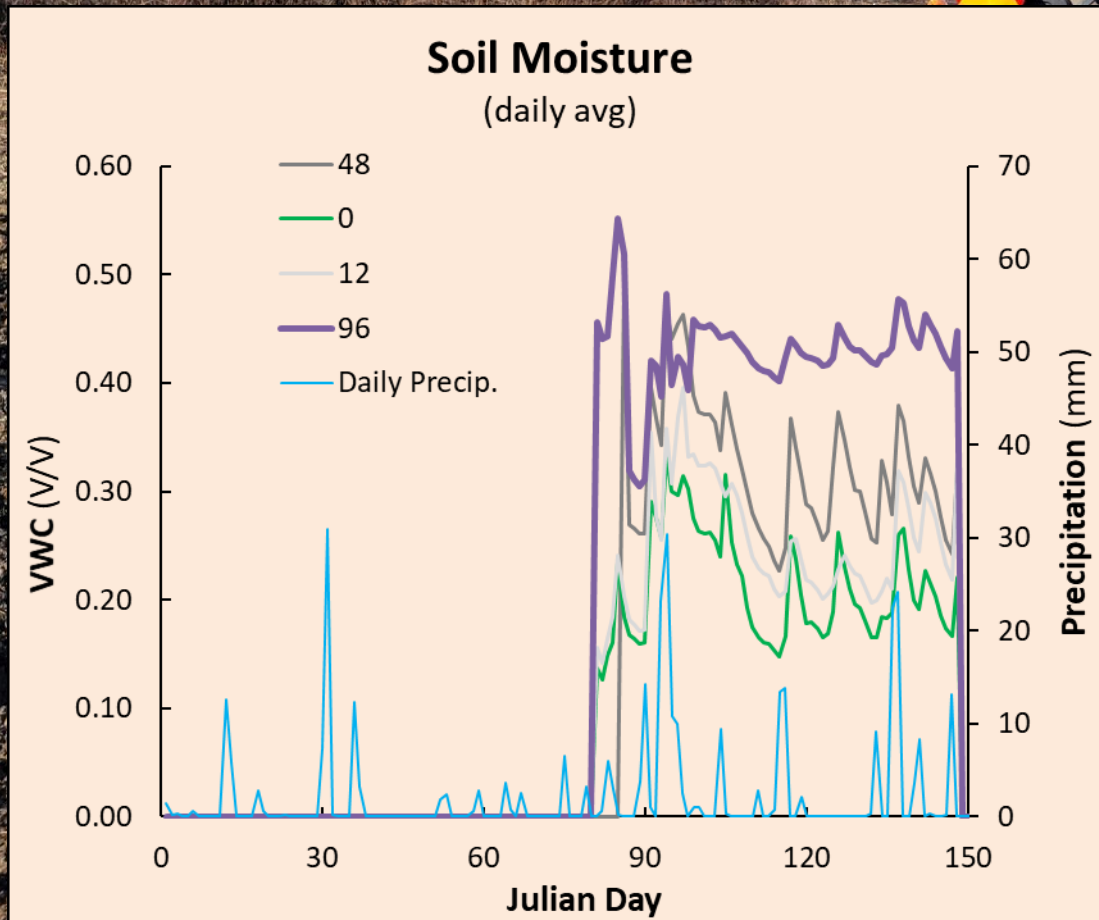
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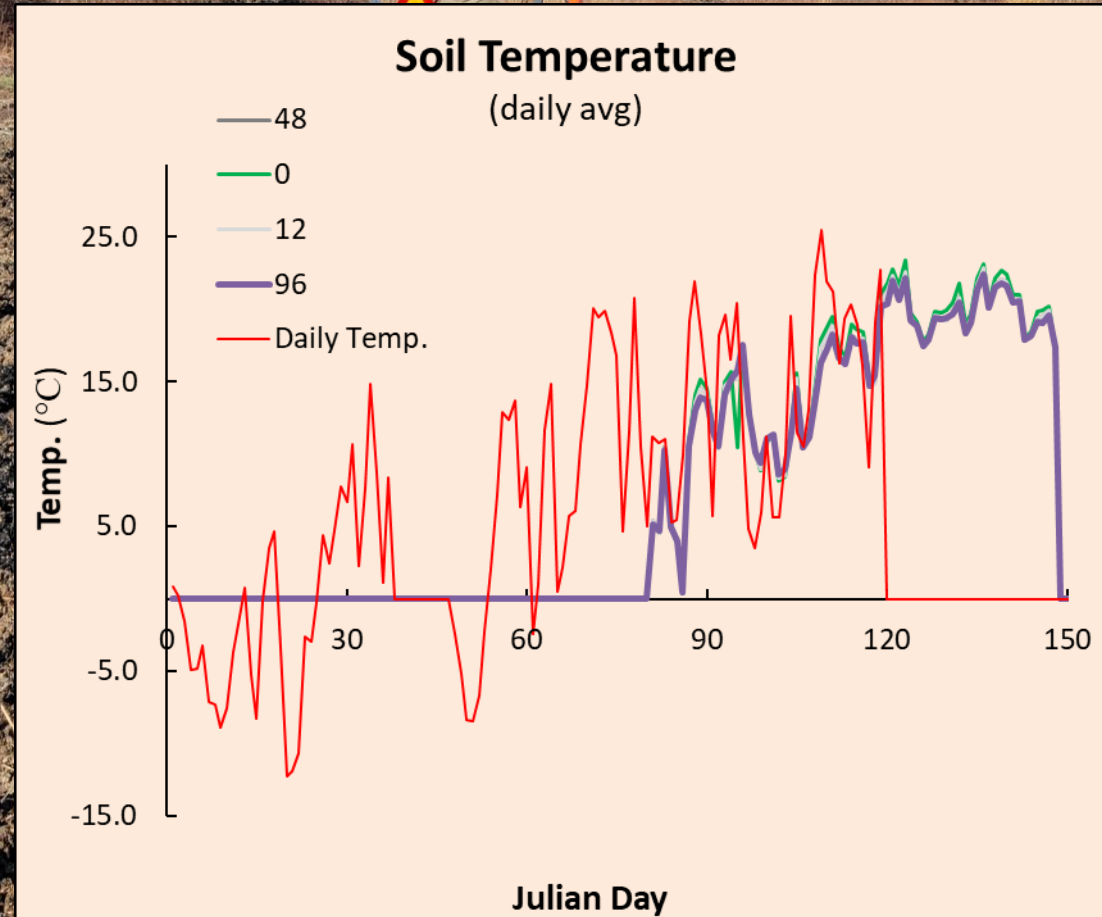
BIO 2



BIO 3

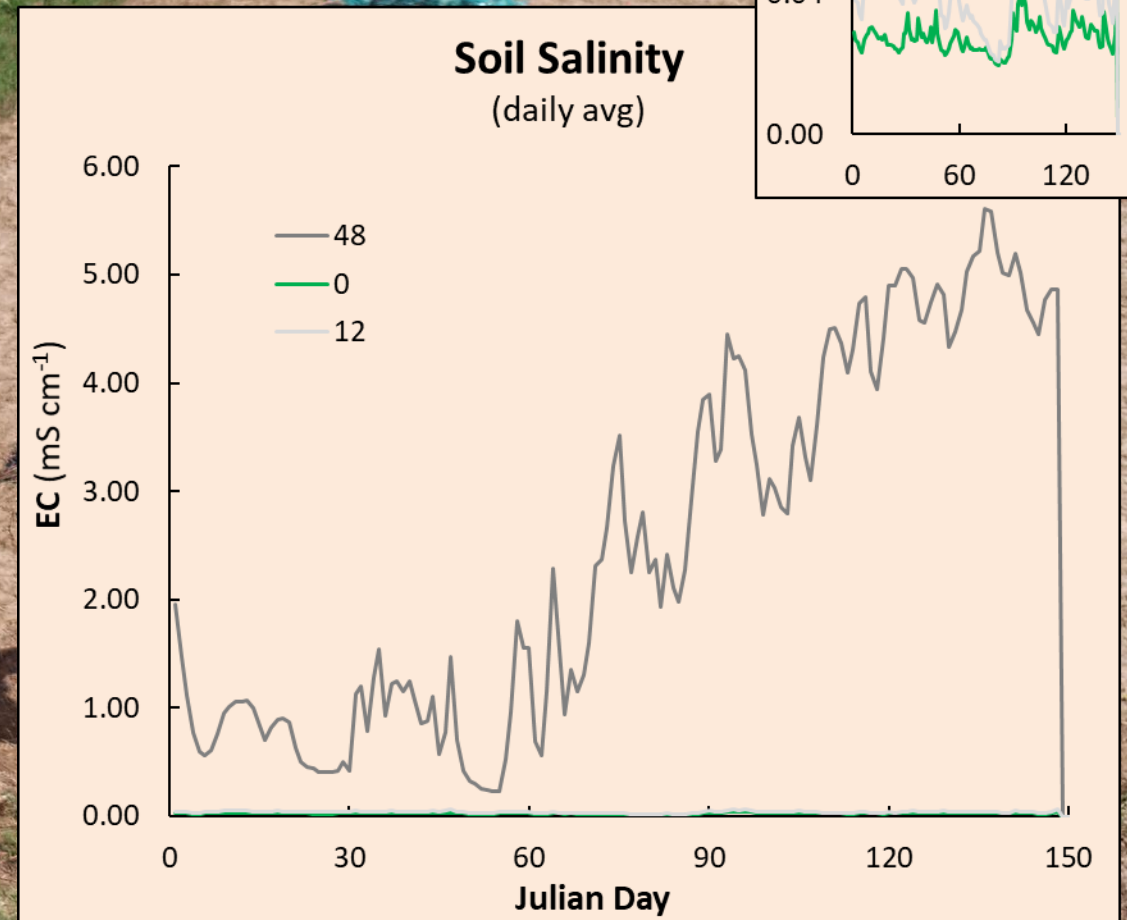
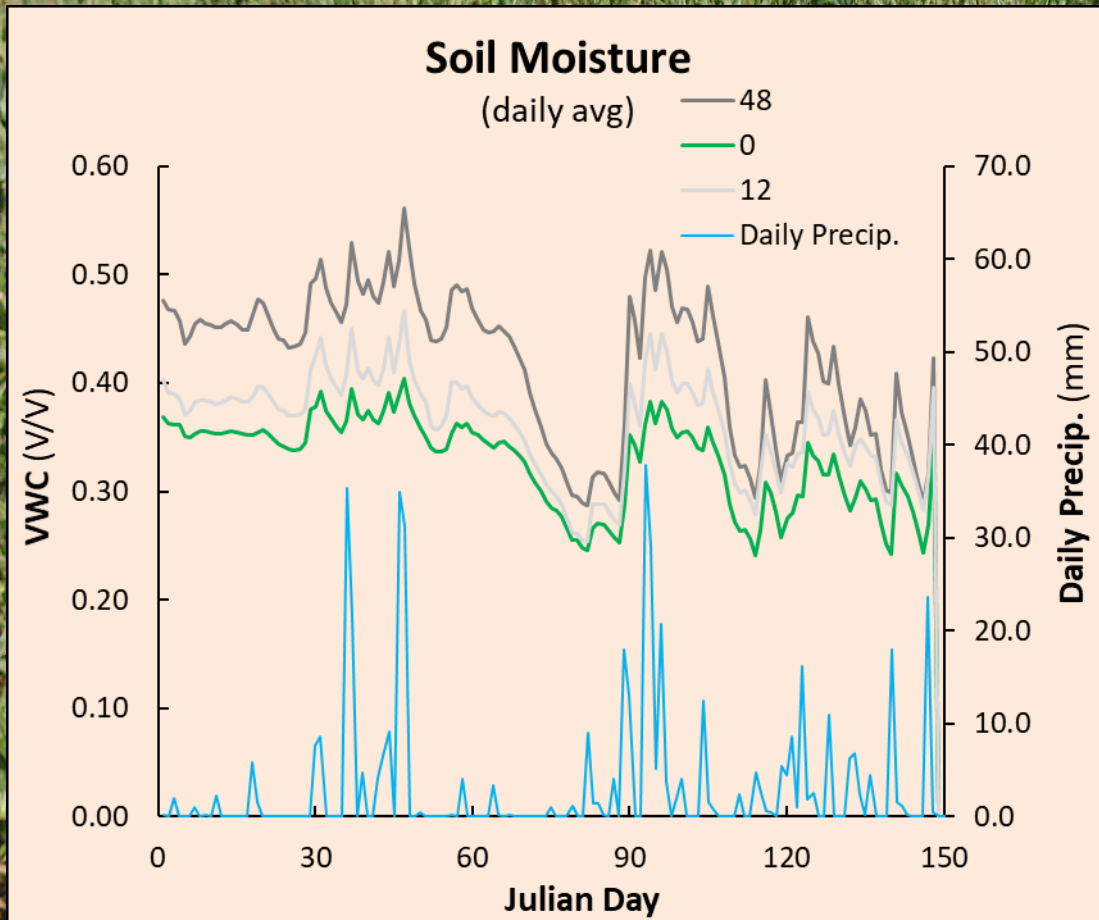


BIO 3



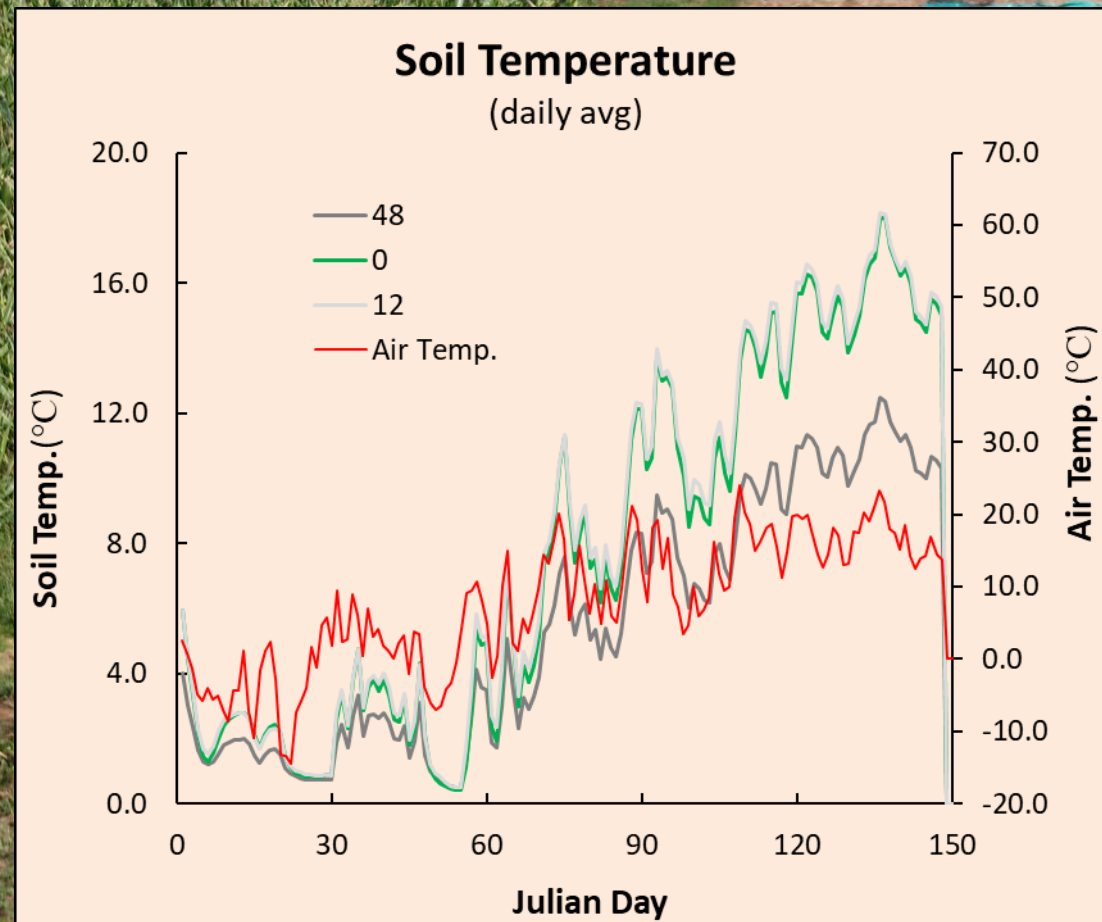
BIO 4

(Farm Land (acid, sandy, Lakin Soil Series))



BIO 4

(Farm Land (acid, sandy, Lakin Soil Series))

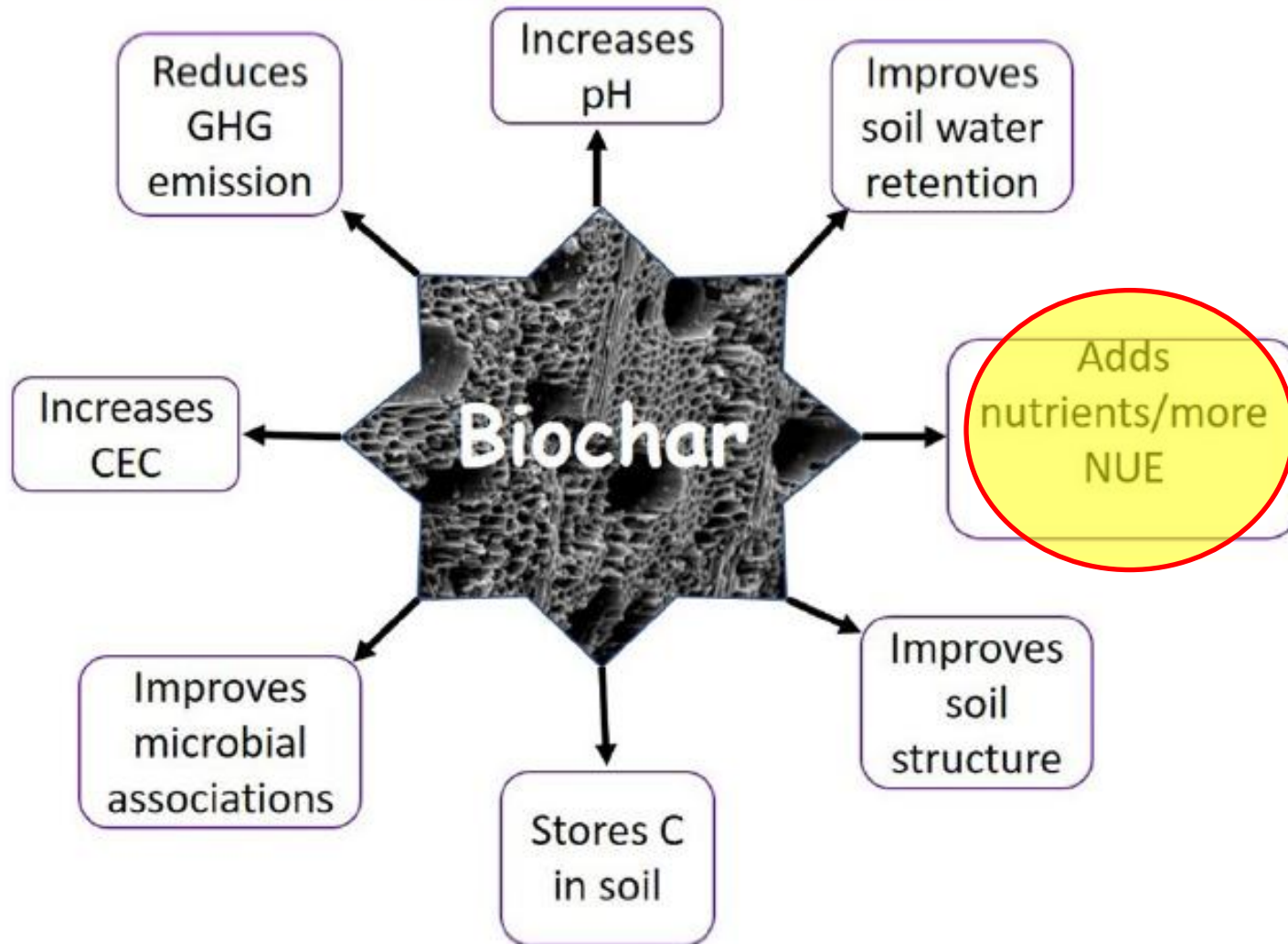


BIO 1

(11/01/2025)



Influence of Biochar on Soil



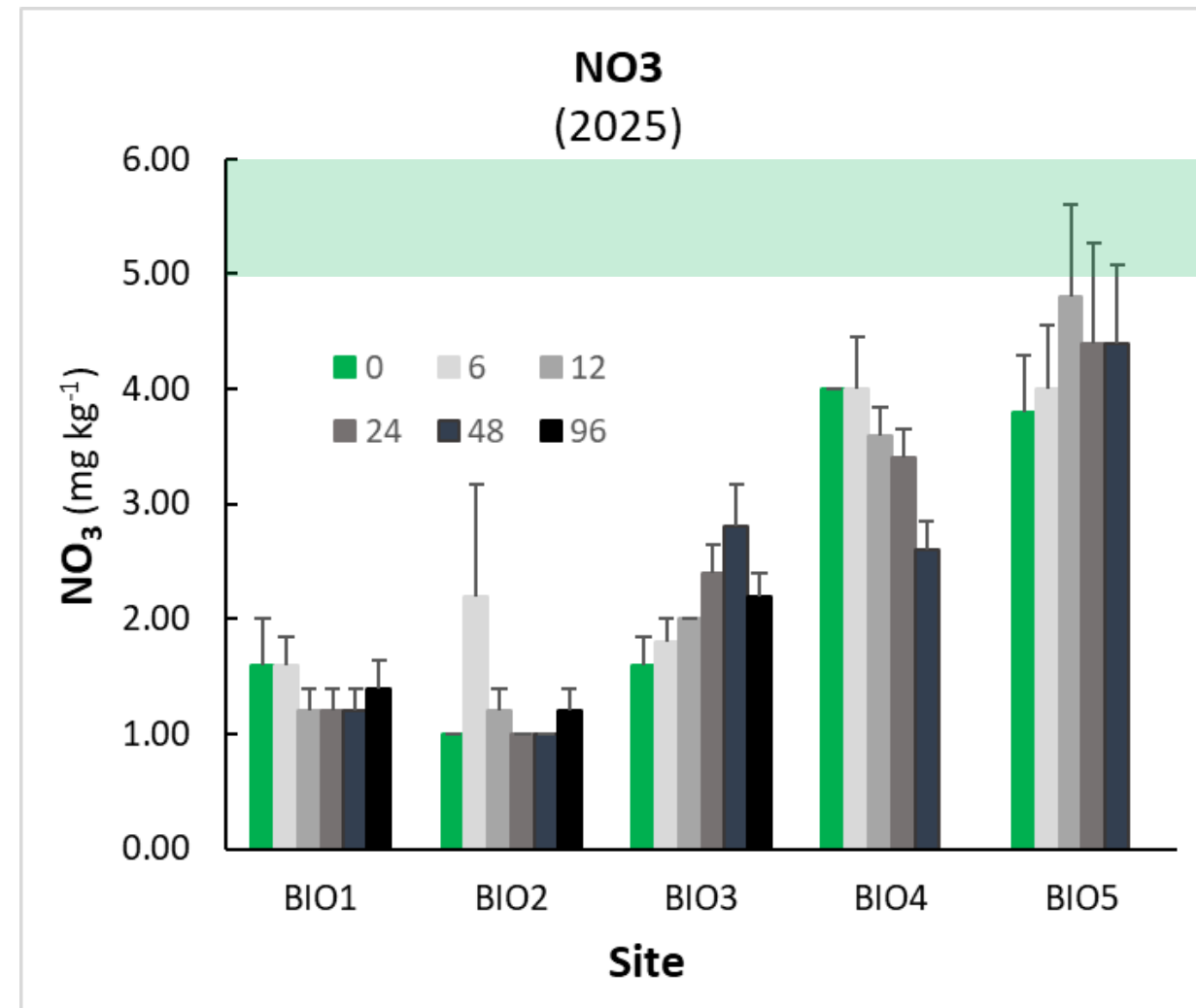
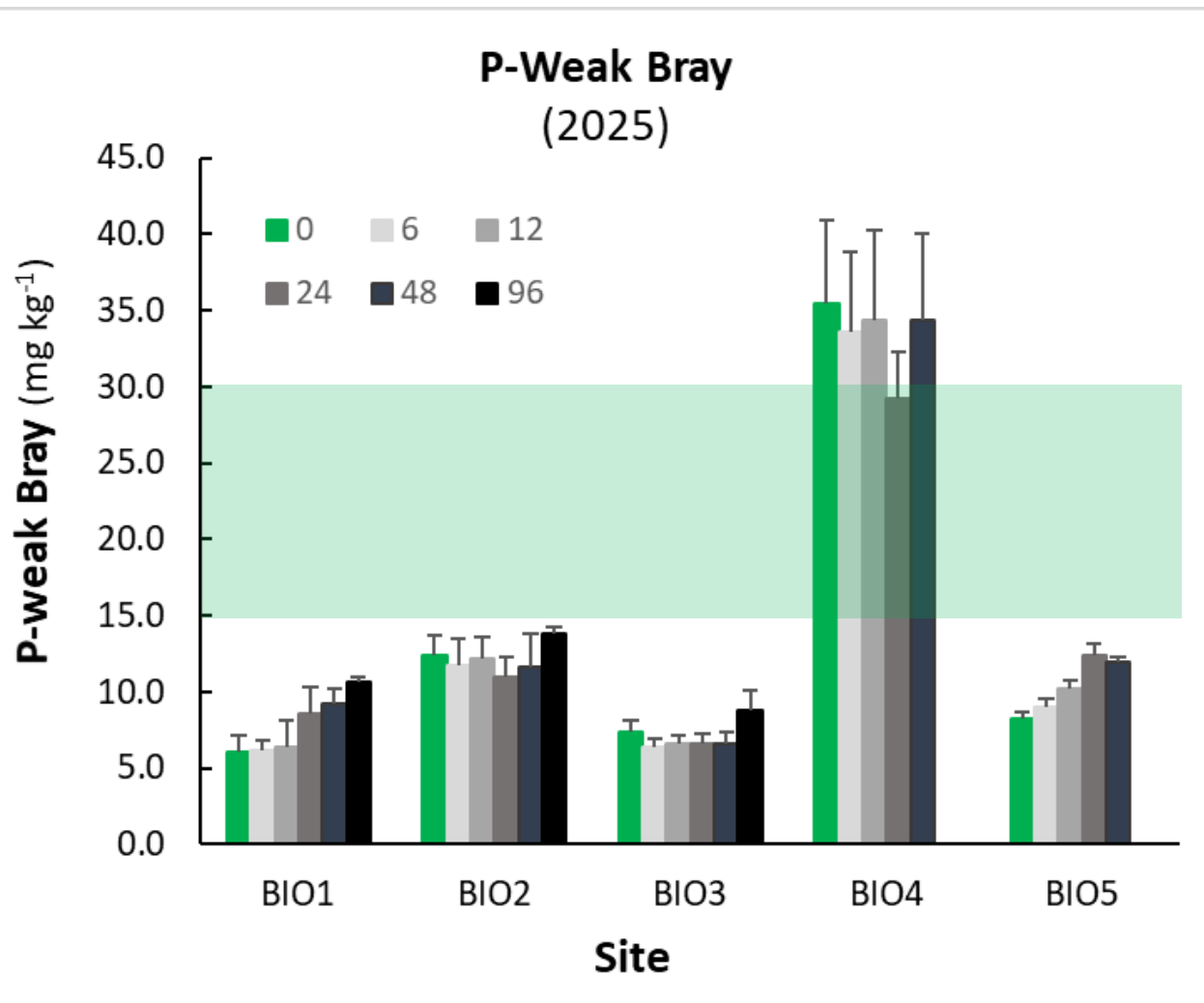
Mixed Hardwood forest Biochar Laboratory Analysis

International BioChar Initiative (IBI) Laboratory Tests for Certification Program

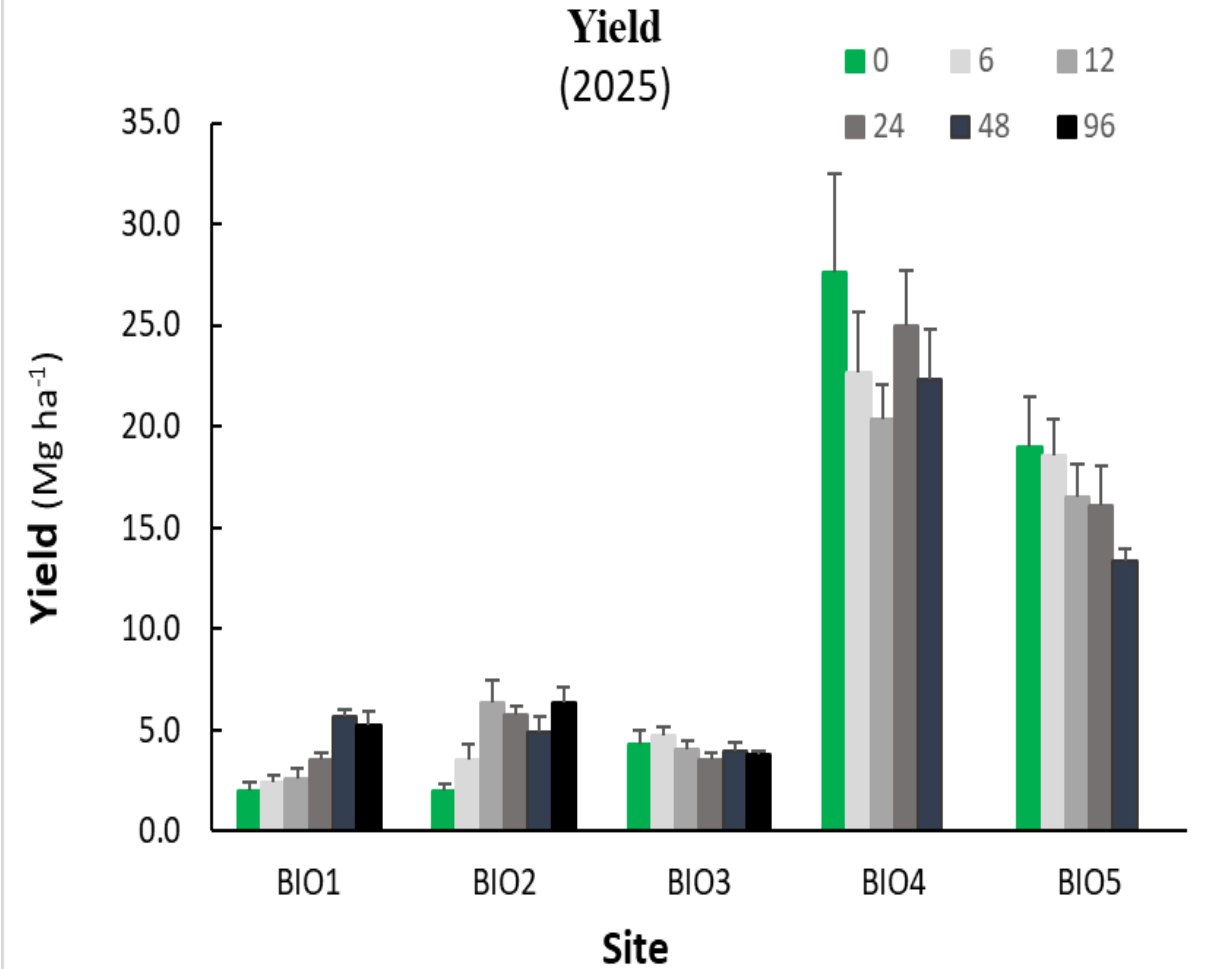
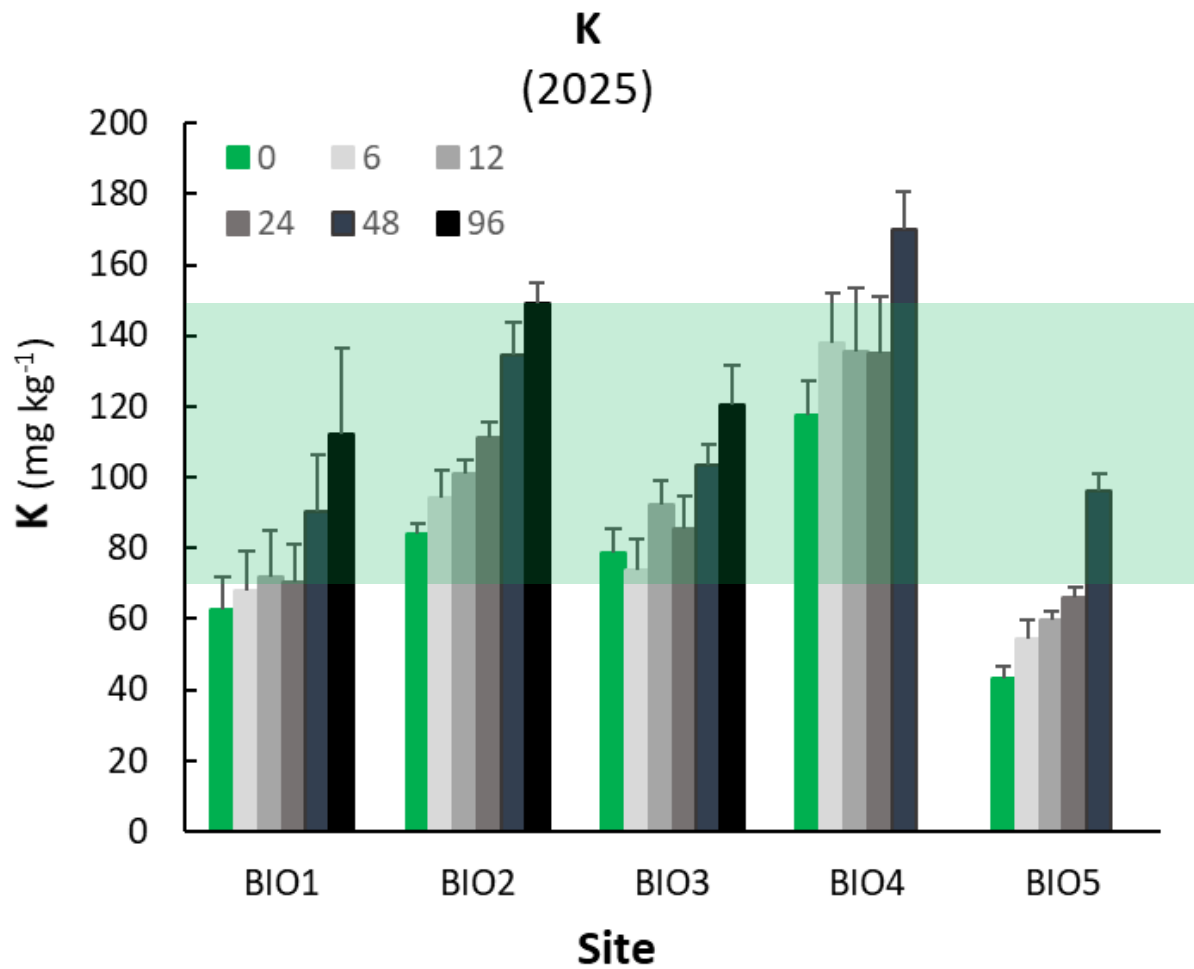
	Dry Basis Unless Stated: Range	Units	Method
Moisture (time of analysis)	15.8	% wet wt.	ASTM D1762-84 (105c)
Bulk Density	14.5	lb/cu ft	
Organic Carbon	86.9	% of total dry mass	Dry Combust-ASTM D 4373
Hydrogen/Carbon (H:C)	0.21 0.7 Max	Molar Ratio	H dry combustion/C(above)
Total Ash	6.1	% of total dry mass	ASTM D-1762-84
Total Nitrogen	0.69	% of total dry mass	Dry Combustion
pH value	7.18	units	TMECC (2001) 4.11, 1:20 dilution
Electrical Conductivity (EC20 w/w)	0.213	dS/m	TMECC (2001) 4.10, 1:20 dilution
Liming (neut. Value as-CaCO3)	8.2	%CaCO3	AOAC 955.01
Carbonates (as-CaCO3)	3.9	%CaCO3	ASTM D 4373
Butane Act.	3.9	g/100g dry	ASTM D 5742-95
Surface Area Correlation	256	m2/g dry	G

All units mg/kg dry unless stated:			Range of	Reporting		Particle Size Distribution			
		Results	Max. Levels	Limit (ppm)	Method		Results	Units	Method
Arsenic	(As)	ND	13 to 100	0.95	J	< 0.5mm	62.0	percent	F
Cadmium	(Cd)	ND	1.4 to 39	0.38	J	0.5-1mm	27.0	percent	F
Chromium	(Cr)	34.4	93 to 1200	0.95	J	1-2mm	8.6	percent	F
Cobalt	(Co)	1.3	34 to 100	0.95	J	2-4mm	2.4	percent	F
Copper	(Cu)	10.5	143 to 6000	0.95	J	4-8mm	0.0	percent	F
Lead	(Pb)	1.6	121 to 300	0.38	J	8-16mm	0.0	percent	F
Molybdenum	(Mo)	ND	5 to 75	0.95	J	16-25mm	0.0	percent	F
Mercury	(Hg)	ND	1 to 17	0.048	EPA 7471	25-50mm	0.0	percent	F
Nickel	(Ni)	18.9	47 to 420	0.95	J	>50mm	0.0	percent	F
Selenium	(Se)	ND	2 to 200	1.90	J	Basic Soil Enhancement Properties			
Zinc	(Zn)	17.4	416 to 7400	1.90	J	Total (Ca)	14678	mg/kg	E
Boron	(B)	24.6	Declaration	9.5	TMECC	Total (Mg)	1176	mg/kg	E
Chlorine	(Cl)	67.5	Declaration	20.0	TMECC	Total (K)	2486	mg/kg	E
Sodium	(Na)	ND	Declaration	951	E	Total (P)	421	mg/kg	E
Iron	(Fe)	2442	Declaration	47.6	E	Ammonia (NH4-N)	5.5	mg/kg	A
Manganese	(Mn)	1107	Declaration	0.95	J	Nitrate (NO3-N)	3.2	mg/kg	A
						Organic (Org-N)	6902	mg/kg	Calc.
						Volatile Matter	15.3	percent dw	D

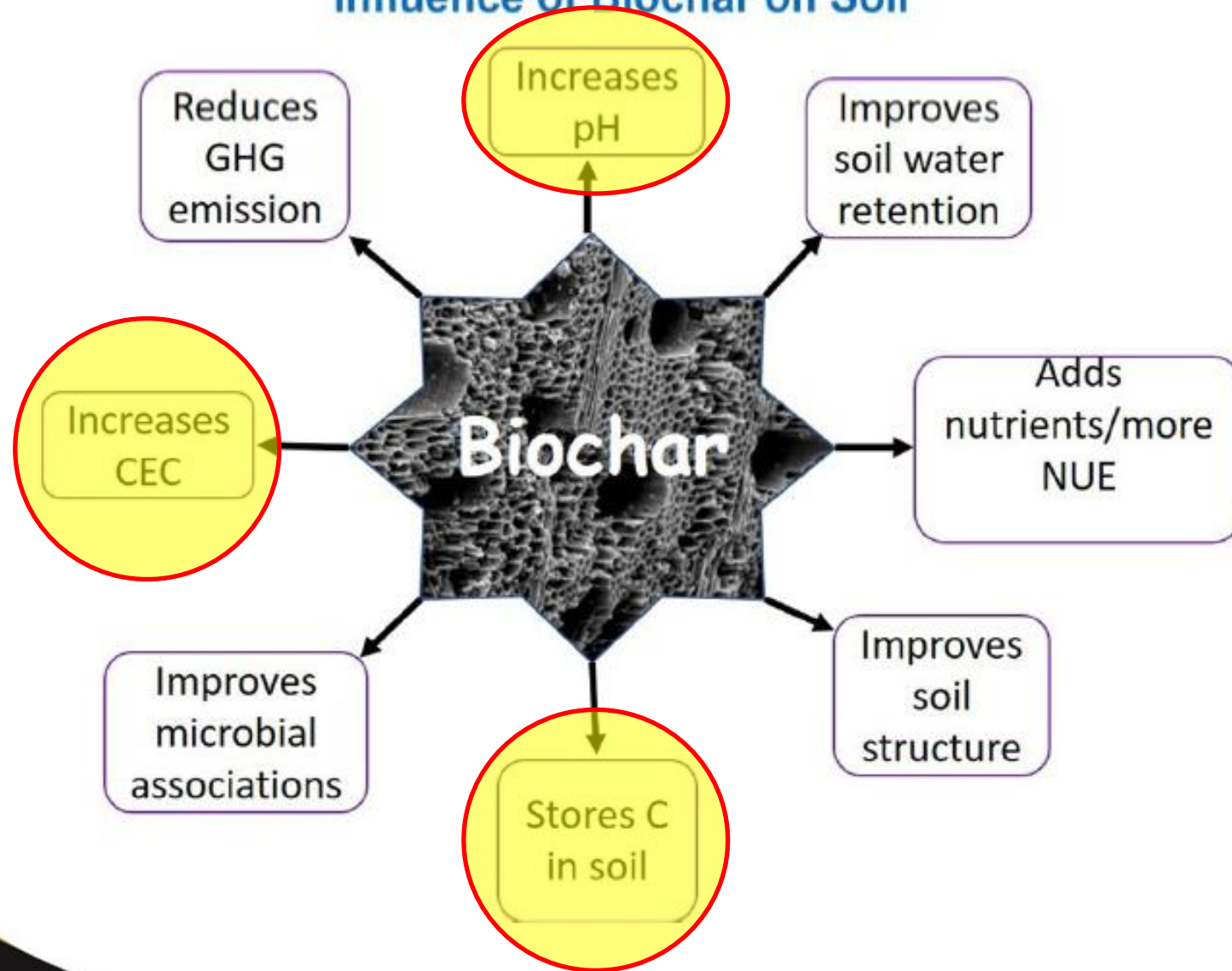
Soil Nutrients



Soil Nutrients



Influence of Biochar on Soil



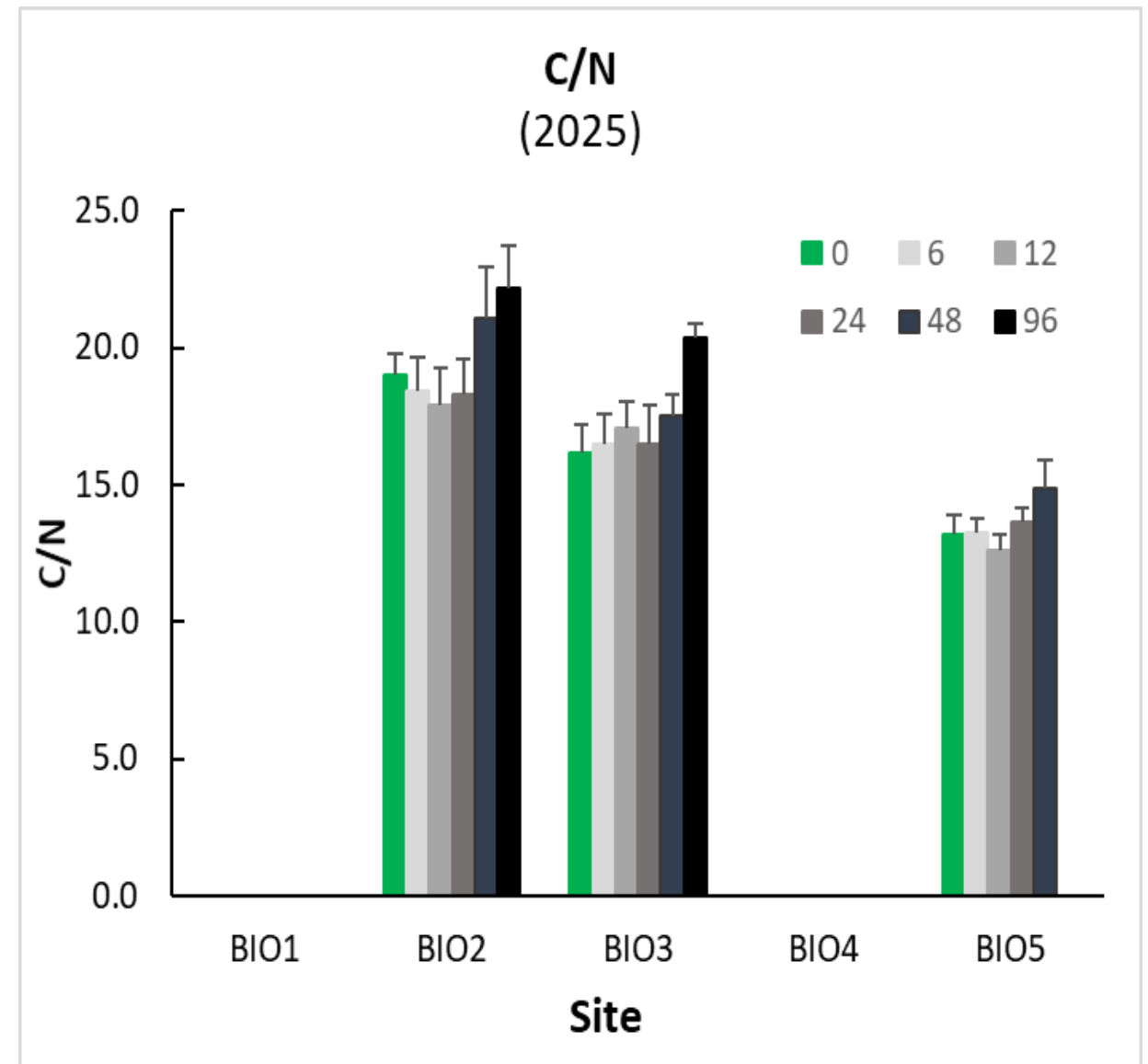
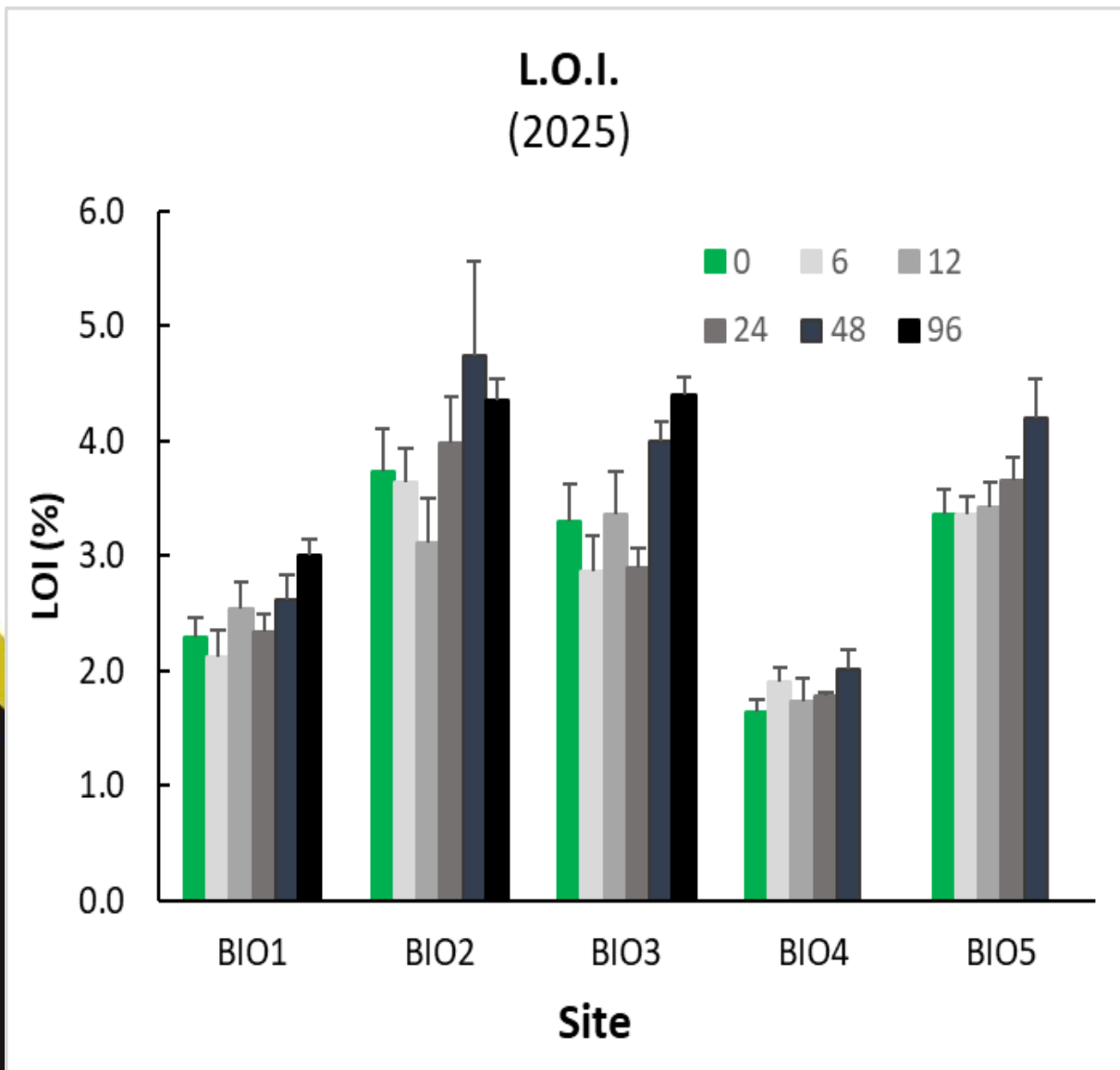
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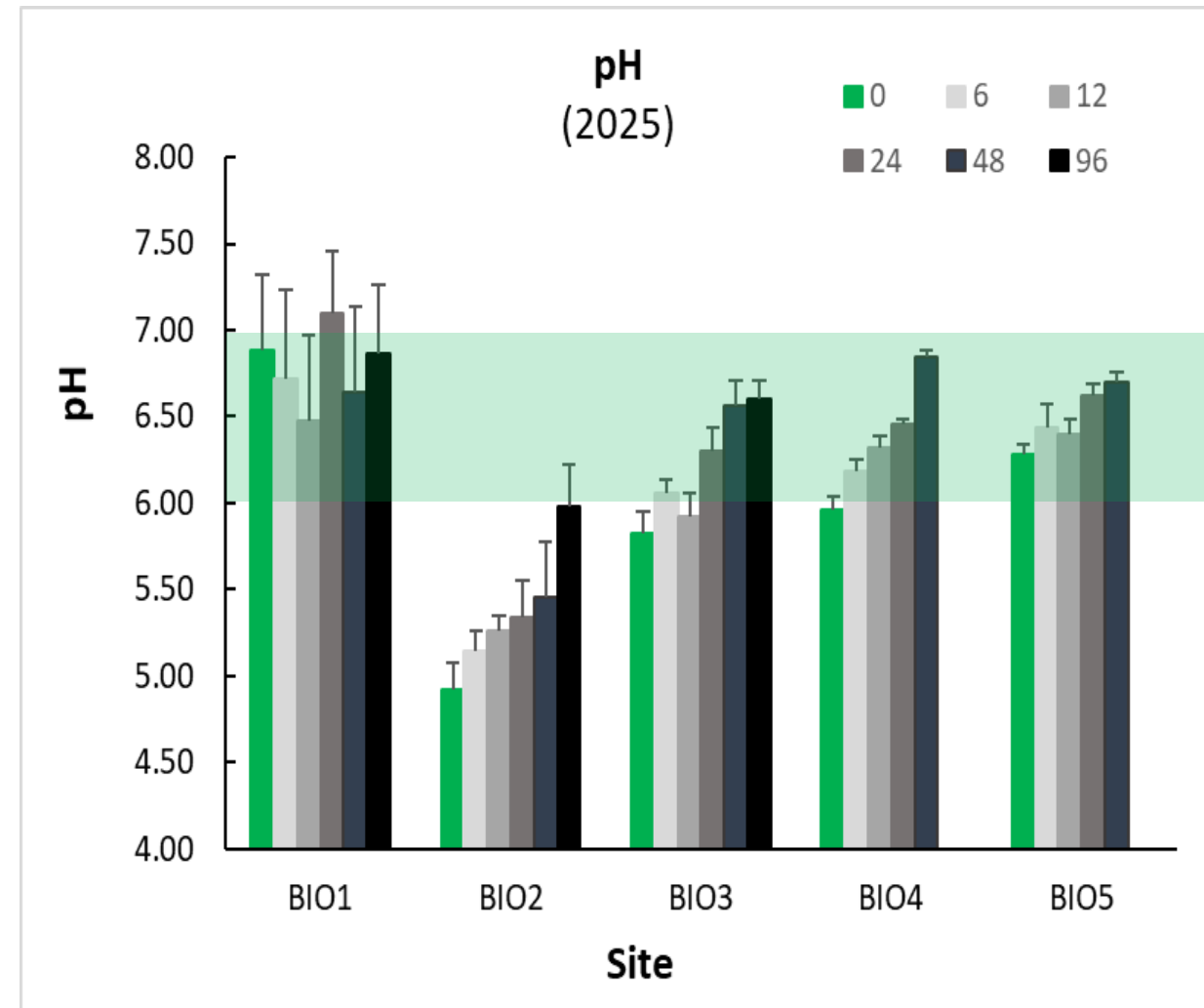
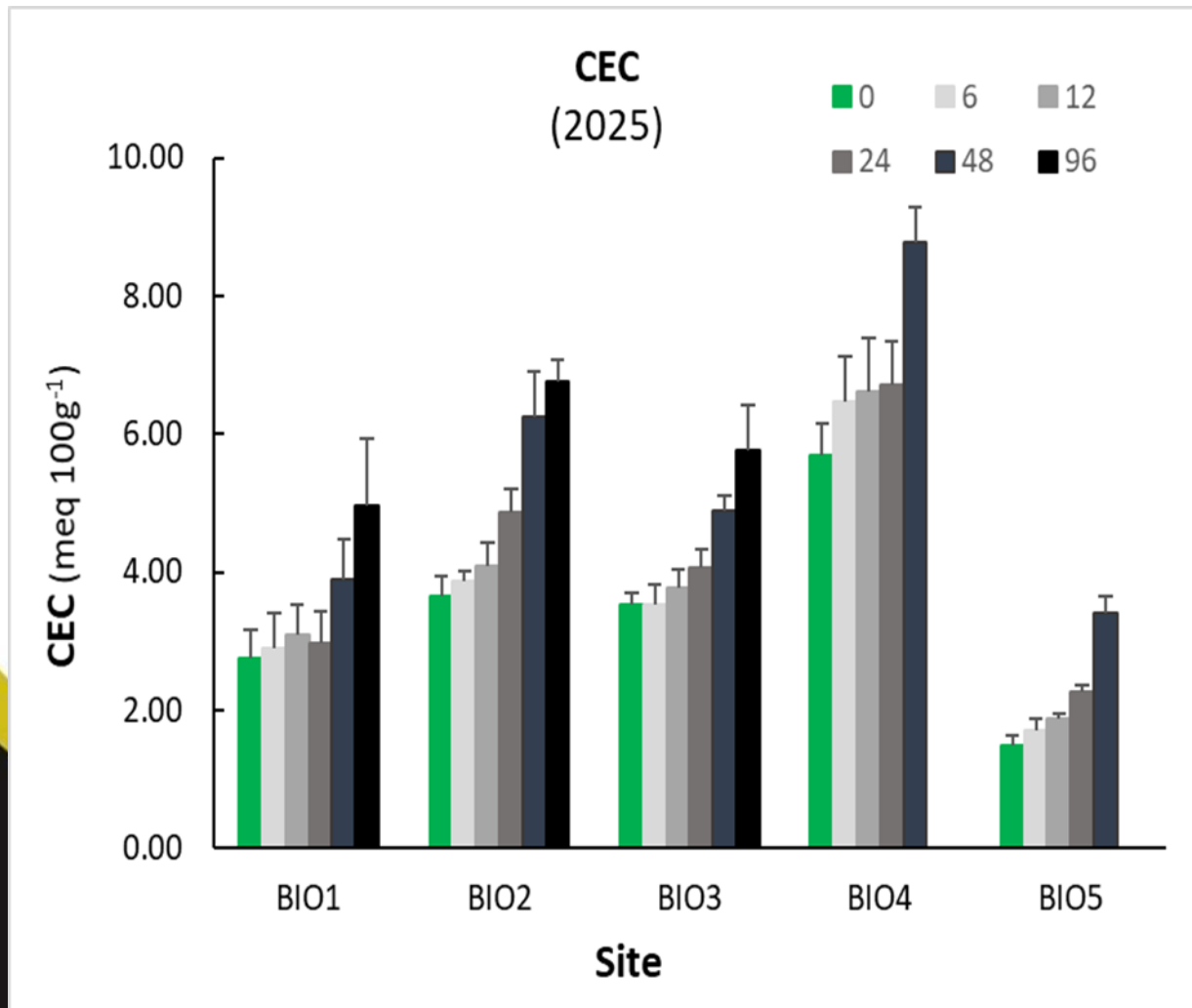
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Soil Properties

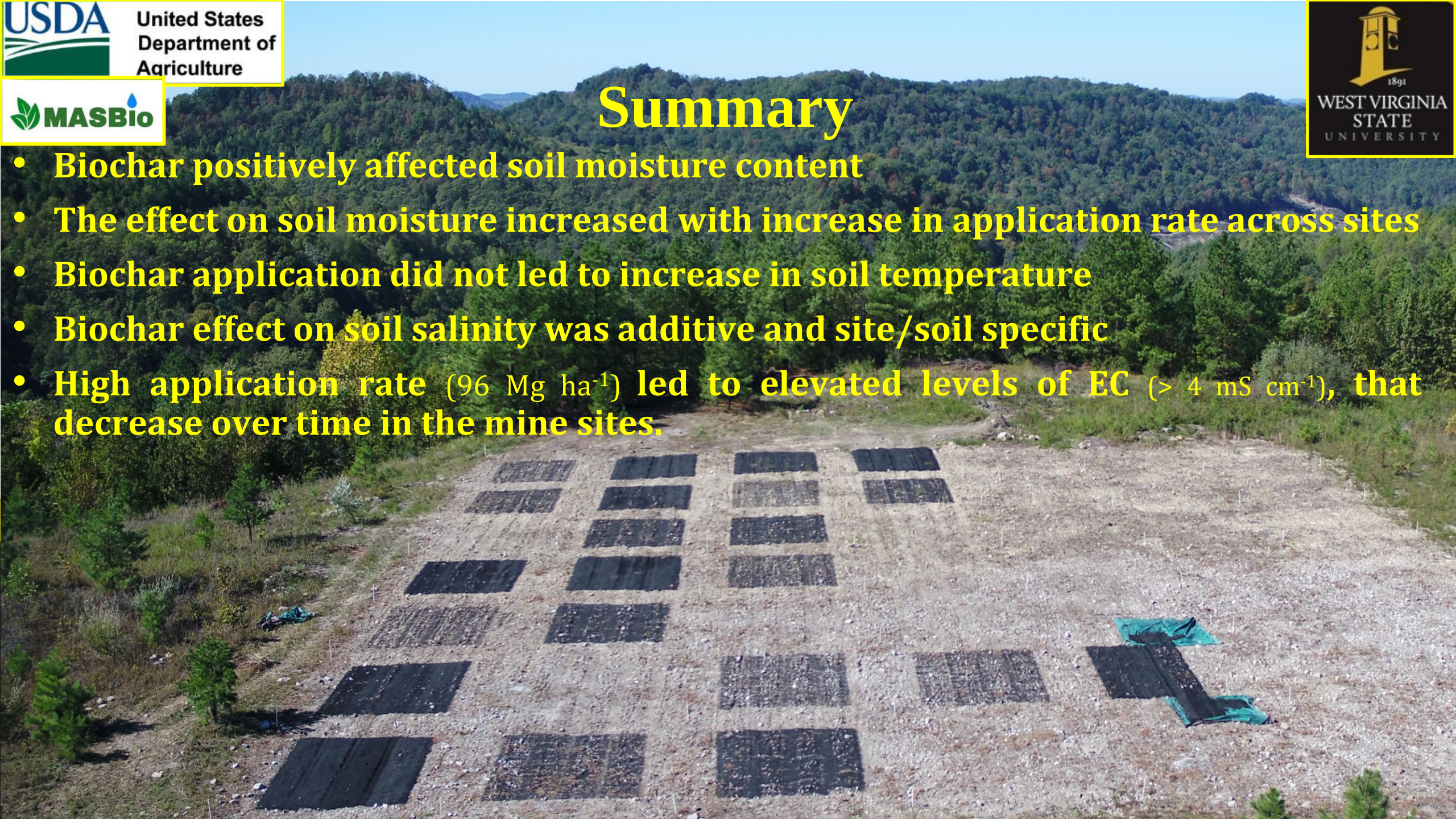


Soil Properties



Summary

- Biochar positively affected soil moisture content
- The effect on soil moisture increased with increase in application rate across sites
- Biochar application did not led to increase in soil temperature
- Biochar effect on soil salinity was additive and site/soil specific
- High application rate (96 Mg ha^{-1}) led to elevated levels of EC ($> 4 \text{ mS cm}^{-1}$), that decrease over time in the mine sites.



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**Robert Cantrell, Chris Hamm, Caleb Greenly, German Banda,
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Penn Virginia LLC, Pritchard Mining, Dakota Consulting

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Integrated Project on Ecosystem Resiliency**