Applying humalite for enhancing wheat production and soil health

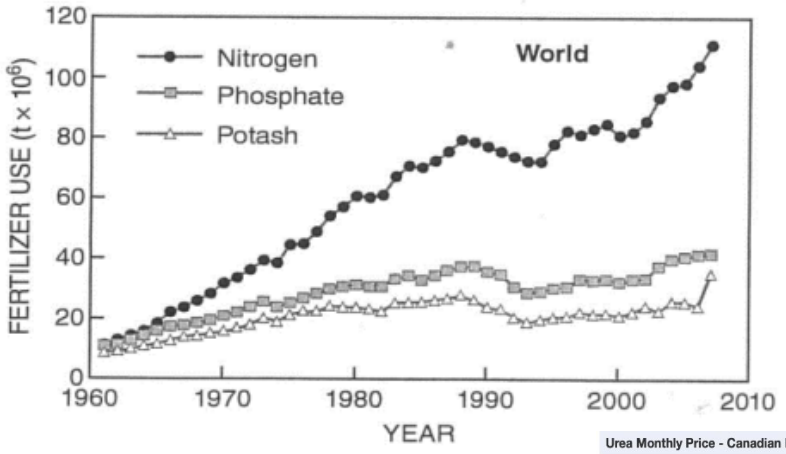
Kwame Ampong, Malinda Thilakarathna, Guillermo H. Ramirez, Yamily Zavala, Randy Spence, Dean Spaner, Sandeep Nain, Khalil Ahmed, Devin Zenchyson-Smith and Linda Gorim

Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, AB, Canada

Background

Current Trends:

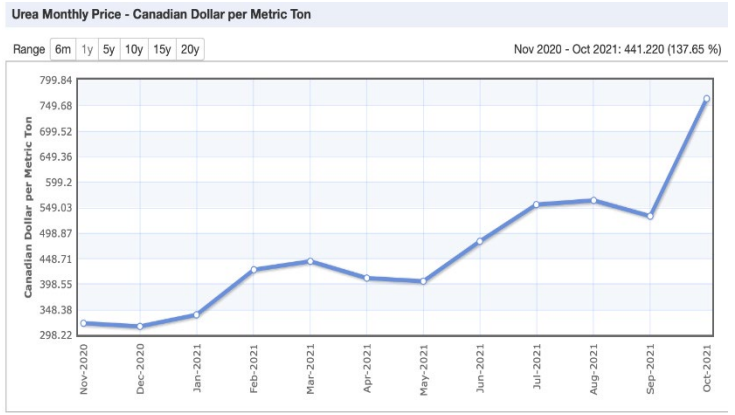
- Increase in food production
- Increase Nitrogen (N) fertilizer use



(FAO, 2008)

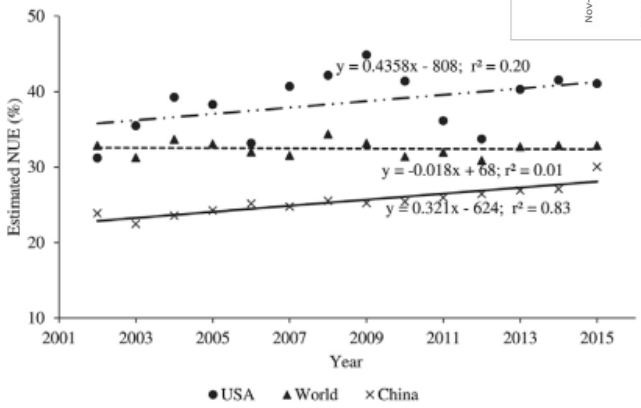
Current Challenges:

- Soil acidification due to inorganic fertilizer use
- Poor soil conditions due to unsustainable crop rotation practices
- Low NUE (Nutrient Use Efficiency) due to:
  - Soil erosion, volatilization, nitrification and leaching of nitrate



Humalite in the Agriculture Space:

- Product has been purchased locally and applied by Alberta farmers
- Unlike pure Humid acids, humalite has limited data to support its role in agriculture



(Omara, 2019)

Background

Various Mechanisms to Improve Nutrient Use Efficiency:

- Agronomic strategies, biological and synthetic N nitrification inhibitors, molecular techniques, use of humic acid (HA)
  - Humic acids are produced from organic and synthetic sources eg. humalite, lignite, peat etc.

Functions of Humic Acid

- Improve soil biological, chemical and physical activities
- Binds nutrients in the soil
- Increase plant nutrient uptake
- Improve soil nutrient availability, fertilizer use efficiency, root and shoot growth, and yield

Background

What is Humalite?

- **Humalite** is naturally oxidized coal-like material
- Found in high deposits in Alberta
- Contains high soluble carbon

Texture	HA	P	K	Mg	Ca	Fe	Zn	Mn	Cu	Mo	Ni
	(%)	g kg^{-1} soil				mg kg^{-1} soil					
Fine	61	0.3	5.9	6.6	55	2120	74	305	21	17	29
Coarse	64	0.3	6.0	7.0	76	2560	73	418	27	17	33

Sample of humalite

Objective of the Study

Objective –
Evaluate application of humalite and urea fertilizer on wheat agronomic parameters and soil health

Materials and Methods

The first experiment was carried out with wheat in May 2021.

Sites:

- St. Albert (University of Alberta) (*black and loamy soil*)
- Gateway Research Organisation (GRO) (*grey and loamy soil*)
- Battle River Research Group (BRRG) (*black and loamy soil*)
- Chinook Applied Research Association (CARA) (Oyen) (*brown soil*)

Urea Rates: (main plot)

- No urea
- Half recommended (based on soil test)
- Full recommended (based on soil test)

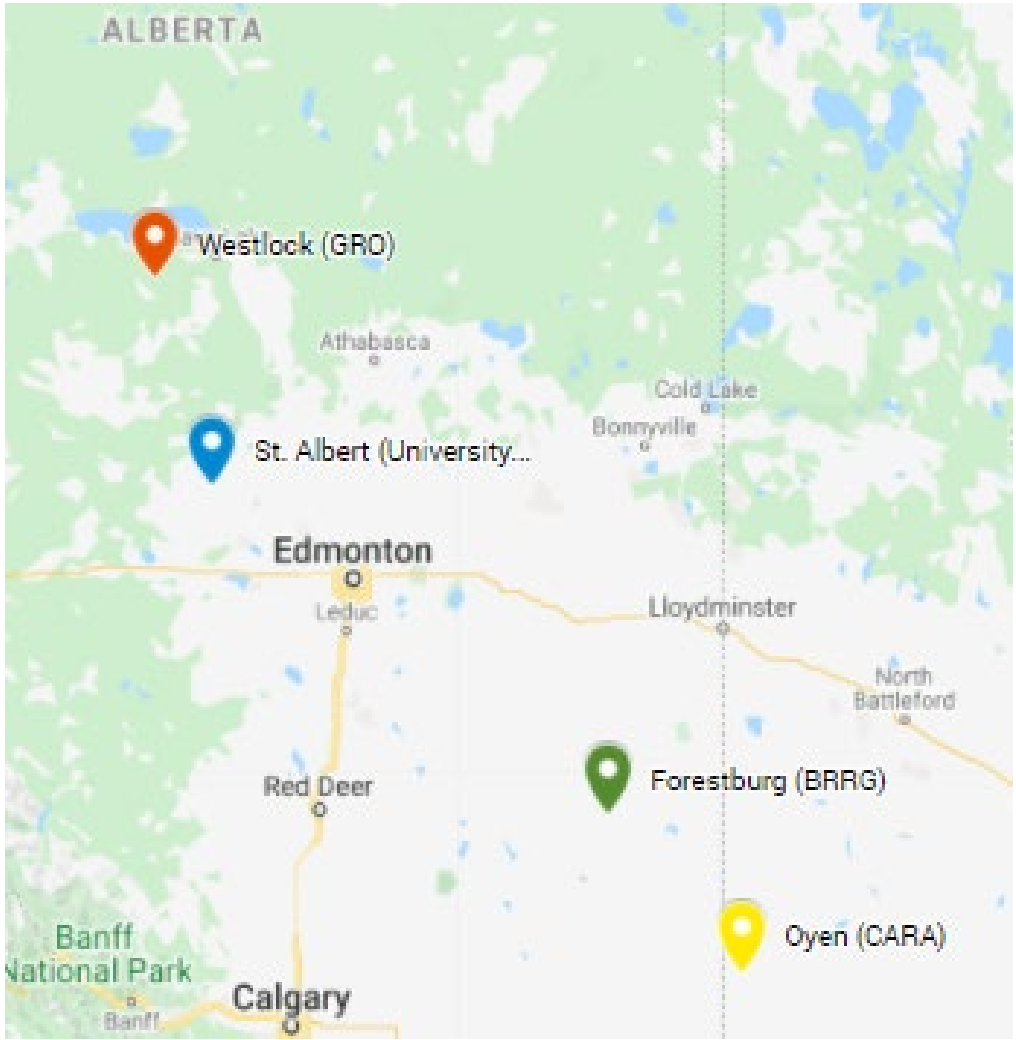
Humalite Rates: (subplot)

- 0, 100, 200, 400 and 800 lbs/ac

Experimental design: split plot in a randomized complete block design with four replicates

Seeding: May, 2021

Harvesting: September, 2021



Effect of Humalite on Wheat Agronomic Parameters

Humalite level (lbs ha^{-1})	Height (cm)	SPAD	Number of grains per head	1000 seed weight (g)	Yield (Kg ha^{-1})	Protein (%)
St. Albert						
0	64.0 ±1.2	45.8 ±0.9	335 ±7^{a}	35.4 ±0.6	2979 ±163	13.6 ±0.7
100	63.8 ±1.0	46.1 ±0.8	334 ±11^{a}	35.3 ±0.5	3167 ±148	14.5 ±0.6
200	65.6 ±0.9	47.0 ±1.0	309 ±7^{b}	34.9 ±0.5	3022 ±168	14.3 ±0.7
400	63.2 ±1.0	46.5 ±0.7	311 ±4^{b}	35.2 ±0.5	3033 ±138	14.3 ±0.7
800	63.9 ±1.5	45.5 ±0.5	311 ±8^{b}	34.2 ±0.5	3002 ±155	14.1 ±0.7
BRRG						
0	61.5 ±1.3	NA	NA	33.5 ±0.7	3429 ±149	16.6±0.2^{ab}
100	62.8 ±1.4	NA	NA	33.1 ±0.5	3409 ±167	16.6±0.2^{ab}
200	61.9 ±1.5	NA	NA	33.5 ±0.4	3508 ±229	16.3 ±0.2^{b}
400	61.9 ±1.0	NA	NA	33.1 ±0.4	3152 ±170	16.9 ±0.2^{a}
800	60.6 ±1.1	NA	NA	33.2 ±0.5	3463 ±194	16.9 ±0.1^{a}
GRO						
0	59.3 ±0.7	48.1 ±0.5	216 ±10	37.8 ±0.3	2535 ±131	17.9 ±0.2
100	59.5 ±0.8	47.8 ±0.5	219 ±8	37.8 ±0.5	2635 ±85	17.9 ±0.2
200	58.9 ±0.9	46.9 ±0.3	223 ±11	37.5 ±0.5	2490 ±124	17.9 ±0.2
400	58.5 ±0.9	47.6 ±0.5	212 ±12	37.8 ±0.3	2501 ±95	17.9 ±0.1
800	58.3 ±1.1	47.5 ±0.4	206 ±12	37.0 ±0.5	2549 ±109	17.8 ±0.2
CARA						
0	58.2 ±1.1	53.9 ±0.9	NA	23.2 ±0.8	1609 ±150	16.5 ±0.8
100	56.9 ±1.2	53.2 ±1.1	NA	22.7 ±0.5	1603 ±126	17.0 ±0.7
200	60.0 ±1.7	53.4 ±1.0	NA	24.4 ±0.5	1970 ±193	16.1 ±0.8
400	57.6 ±1.5	54.7 ±0.8	NA	23.0 ±1.0	1537 ±157	16.9 ±0.7
800	56.9 ±1.2	54.1 ±0.9	NA	24.4 ±0.9	1814 ±123	16.2 ±0.7

Note: Values within each section in the same column with the same letter are not different at $p < 0.05$.

Results:

- At St. Albert and GRO sites humalite application at 100 lbs/ha saw the highest yields of wheat
- At BRRG and CARA sites, application of humalite at 200 lbs/ha saw the highest yields of wheat
- Application of humalite at 100 lbs/ha saw the highest protein percentage

Summary:

- Humalite application at lower rates (100-200 lbs/ha) results in higher wheat yields and increased protein content
- Alone, humalite application under all soil conditions resulted in significant increases in wheat yield further proving humalite's efficacy

Interaction Effect of Urea and Humalite on Wheat Agronomic Parameters

Urea level	Humalite level (lbs ha^{-1})	Yield (Kg ha^{-1})	Protein (%)	Yield (Kg ha^{-1})	Protein (%)	Yield (Kg ha^{-1})	Protein (%)	Yield (Kg ha^{-1})	Protein (%)
		St. Albert		BRRG		GRO		CARA	
Zero	0	2393 ±85	10.8 ±0.2	3257 ±116de	16.3 ±0.4	2692 ±94^{ab}	17.5 ±0.1	1810 ±318	13.5 ±1.0
Zero	100	2737 ±212	12.7 ±0.9	3432 ±31^{cde}	16.0 ±0.5	2679 ±88^{abc}	17.3 ±0.3	1889 ±358	14.4 ±1.3
Zero	200	2755 ±250	13.2 ±1.8	3165 ±108de	15.5 ±0.3	2418 ±66^{defg}	17.3 ±0.3	1817 ±95	13.8 ±0.5
Zero	400	2636 ±182	11.9 ±1.0	2420 ±127^{f}	16.6 ±0.6	2371 ±72^{fg}	17.5 ±0.2	1587 ±322	15.4 ±1.0
Zero	800	2415 ±190	12.3 ±1.1	2890 ±125^{ef}	16.7 ±0.3	2336 ±137^{fg}	17.1 ±0.3	1571 ±181	14.2 ±1.1
Half	0	3080 ±92	13.7 ±1.2	3312 ±157^{cde}	16.8 ±0.4	2174 ±132^{g}	18.0 ±0.3	1180 ±97	18.1 ±0.8
Half	100	3277 ±132	14.7 ±0.9	3861 ±316^{abc}	16.8 ±0.1	2458 ±13^{bcdef}	18.1 ±0.2	1338 ±123	17.3 ±0.3
Half	200	2741 ±101	14.1 ±0.7	4397 ±87^{a}	16.4 ±0.3	2626 ±145^{abcde}	18.1 ±0.3	1972 ±246	16.9 ±1.3
Half	400	3266 ±238	14.6 ±0.8	3403 ±68^{cde}	17.1 ±0.5	2654 ±108^{abc}	18.0 ±0.4	1531 ±326	17.1 ±1.5
Half	800	3149 ±111	14.5 ±1.1	3427 ±213^{cde}	17.1 ±0.1	2643 ±135^{abcd}	18.1 ±0.1	2031 ±191	16.8 ±1.1
Full	0	3463 ±94	15.5 ±0.5	3719 ±403^{bcd}	16.9 ±0.1	2737 ±283^{a}	18.4 ±0.2	1886 ±219	18.0 ±0.4
Full	100	3486 ±226	16.1 ±0.6	2939 ±116^{ef}	16.9 ±0.3	2767 ±229^{a}	18.3 ±0.1	1588 ±100	18.8 ±0.6
Full	200	3660 ±23	15.7 ±0.5	2876 ±125^{ef}	17.0 ±0.1	2409 ±328^{efg}	18.2 ±0.1	2120 ±597	18.2 ±1.2
Full	400	3253 ±41	16.3 ±0.9	3633 ±145^{bcd}	17.0 ±0.3	2445 ±234^{cdef}	18.2 ±0.1	1476 ±231	18.6 ±0.3
Full	800	3445 ±170	15.6 ±0.8	4073 ±344^{ab}	16.8 ±0.1	2636 ±300^{abcde}	18.2 ±0.1	1833 ±227	17.8 ±0.9
Mean		**3050**	**14.1**	**3387**	**16.7**	**2536**	**17.9**	**1709**	**16.6**

Note: Values within the same column with the same letter are not different at $p < 0.05$.

Results:

- When full recommended urea was applied with 200 lbs/ha of humalite, wheat yields saw that highest significant increase from full urea application and 0 lbs/ha of humalite at the St. Albert and CARA sites
- When full recommended urea was applied with 400 lbs/ha of humalite, wheat protein content saw the highest significant increase from full urea application and 0 lbs/ha of humalite at the St. Albert and CARA sites
- When half recommended urea was applied with 200 lbs/ha of humalite, wheat yields at the BRRG site say the highest significant increase
- When half recommended urea was applied with 400 and 800 lbs/ha of humalite, wheat protein content at the BRRG site saw the highest significant increase

Interaction Effect of Urea and Humalite on Wheat Agronomic Parameters

Summary:

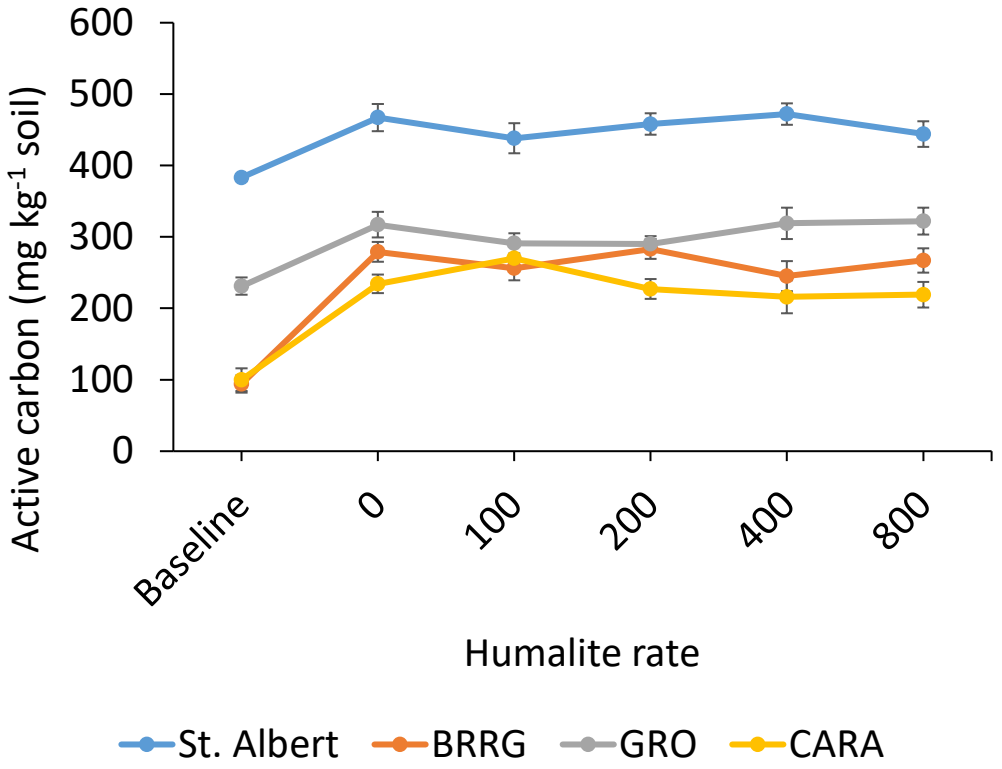
- In prolonged saturated soils humalite application at 200 lbs/ha and half recommended urea levels showed significant increases in wheat yields, effectively showing humalite's role in improving soil physical, chemical and biological properties

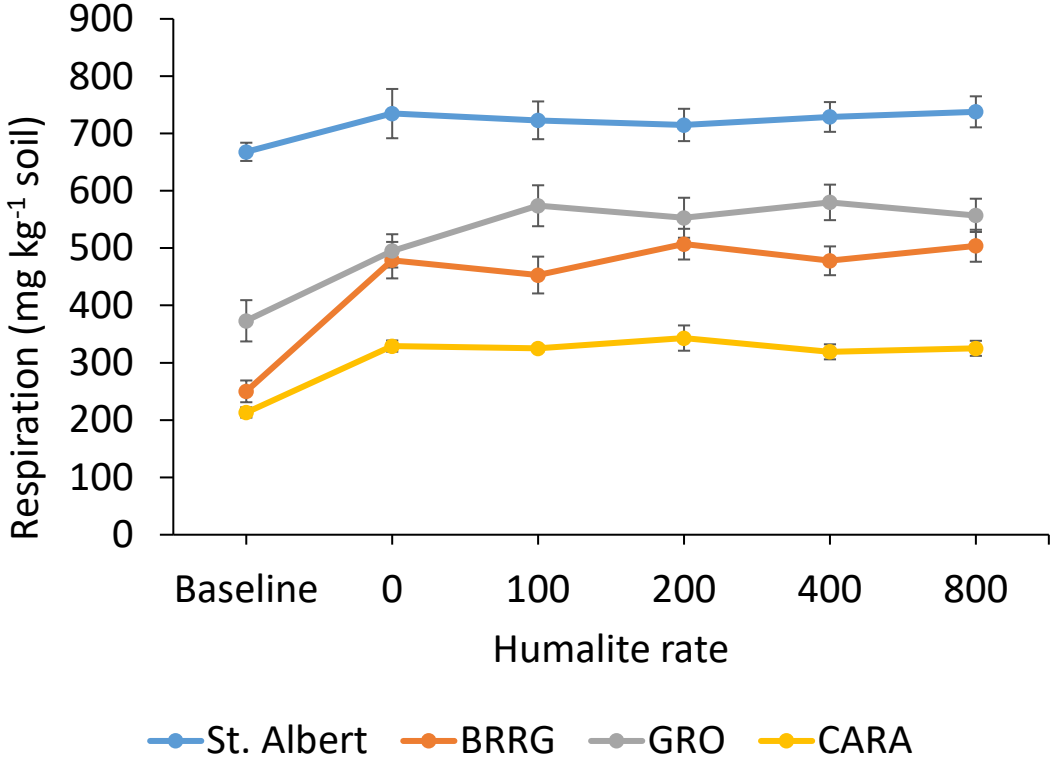
- Even with full urea levels, humalite additions from 100 – 400 lbs/ha saw significant increases in wheat yields and protein content showing humalite's role in increasing soil productivity and nutrient capturing

- Humalite interactions with humalite has proven to significantly increase wheat yield and protein content for all soils
  - An exception is found at the GRO site (grey and loamy soil) where full urea and 0 lbs/ha of humalite showed the highest protein content

- Humalite's incorporation with urea has indicated positive interactions in amplifying wheat agronomic parameters

Effect of humalite on soil active carbon and respiration

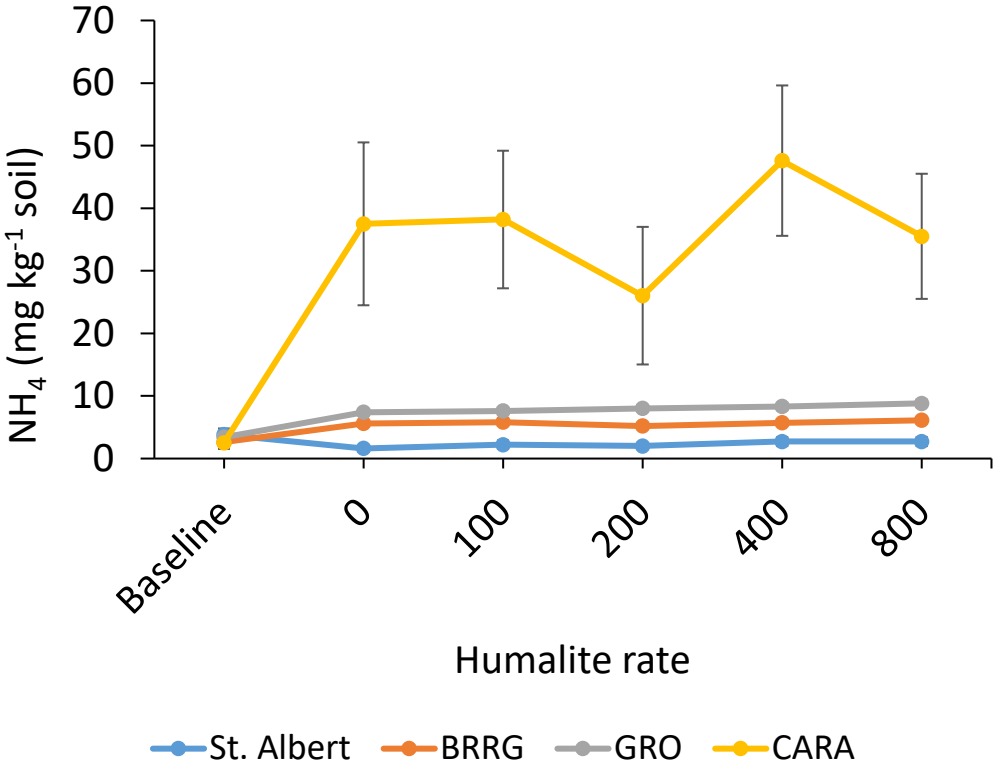


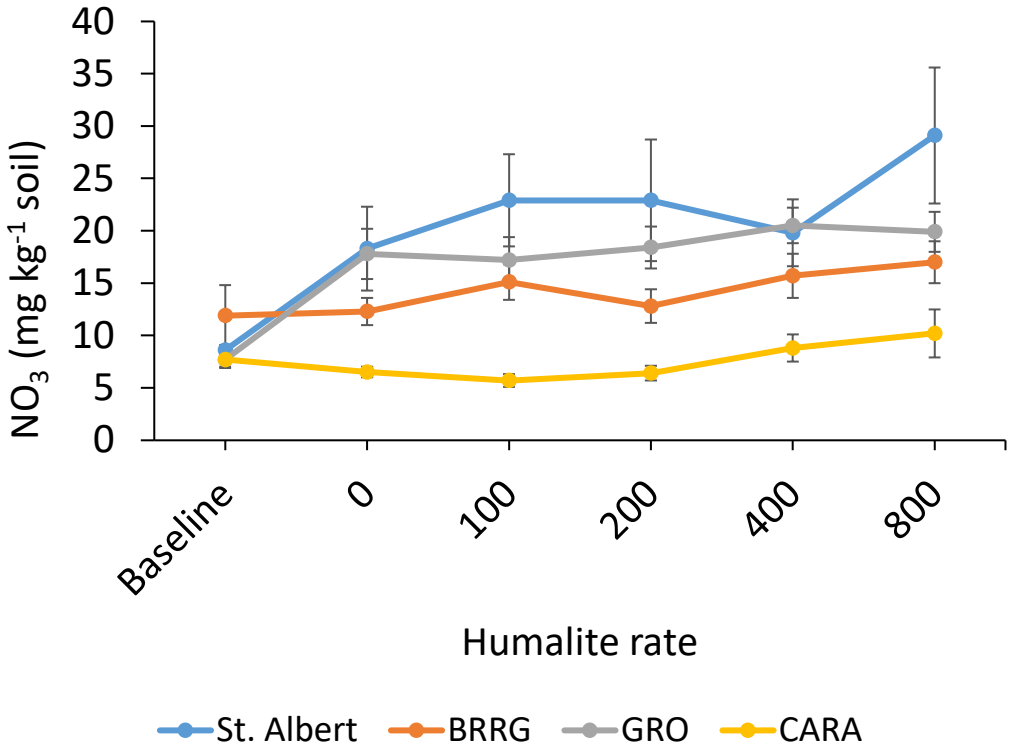


Results:

- Humalite addition at 100 lbs/ha saw the highest rates of active carbon and respiration for lower quality soils (grey and brown)
- Humalite addition at rates from 100 to 400 lbs/ha saw an increase in respiration for lower quality (grey) soils and higher quality (black)

Effect of humalite on soil ammonium and nitrate

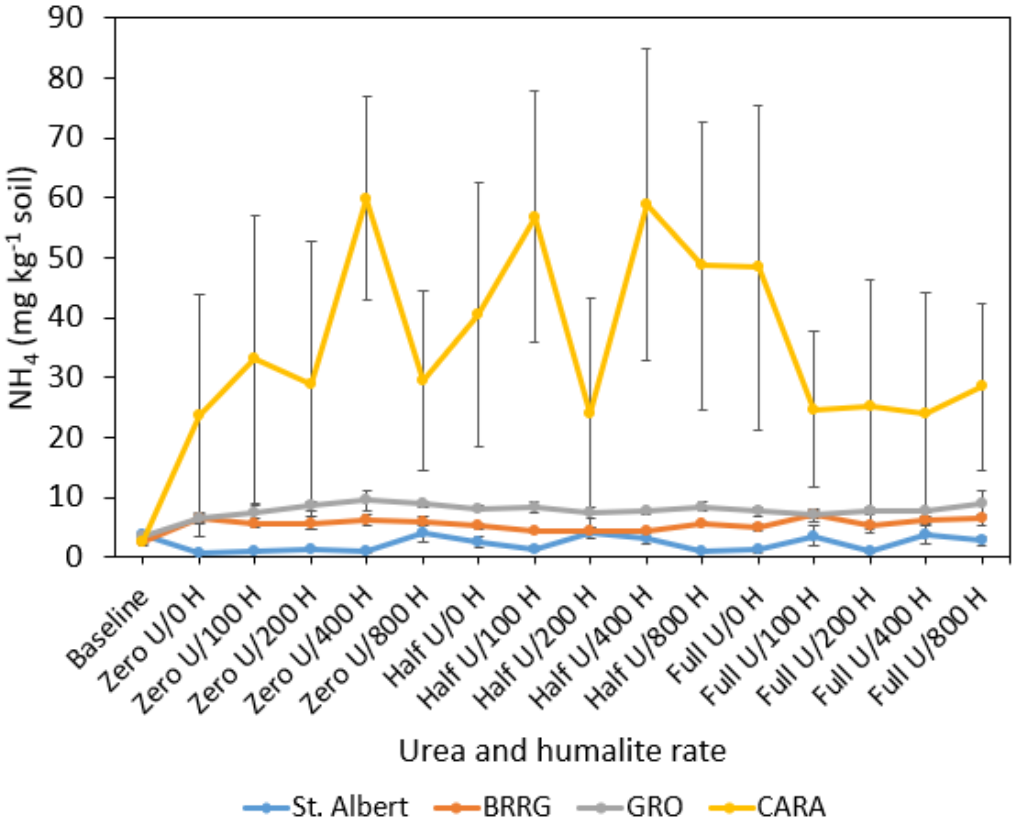


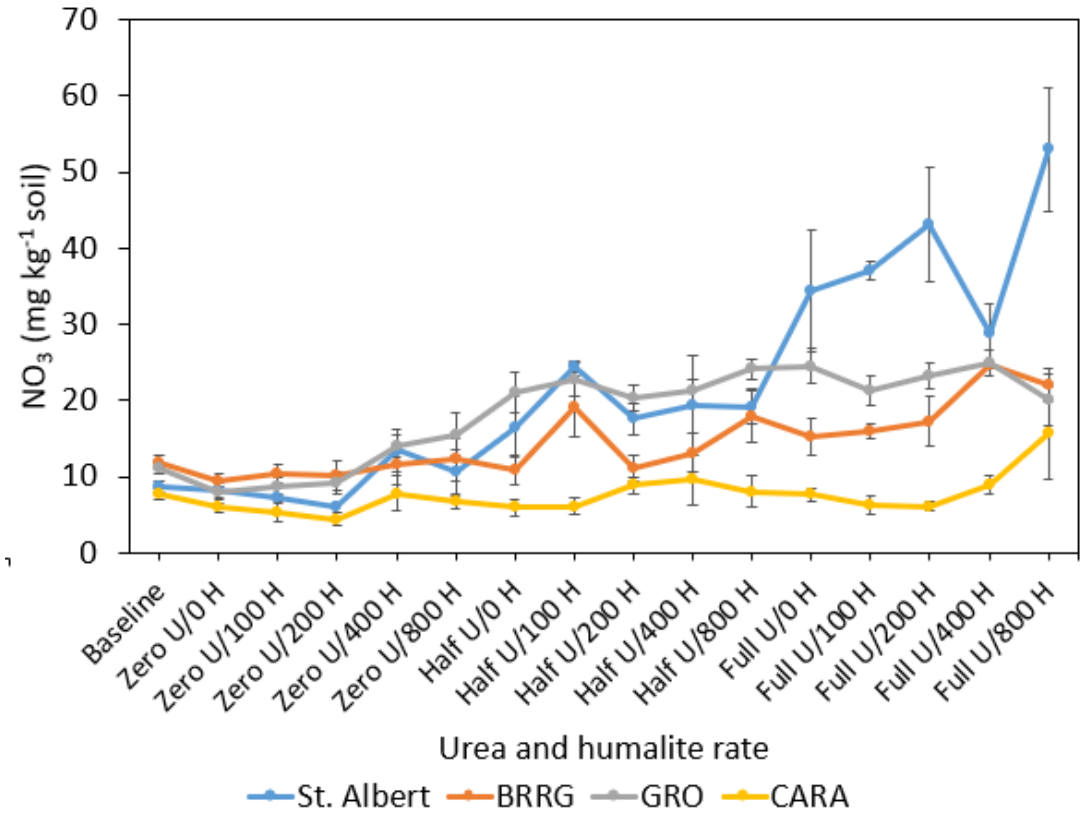


Results:

- Humalite addition increased soil nitrates for all soil types
- Humalite addition increased soil ammonium for brown soils

Interaction effect of urea and humalite on soil ammonium and nitrate





Results:

- Humalite addition with urea increased soil nitrates for all soil types at full urea and 400/800 lbs/ha of urea
- Humalite addition with urea increased soil ammonium for brown soils

References

Nardi, Serenella, Ertani, A., & Francioso, O. (2017). Soil–root cross-talking: The role of humic substances. *Journal of Plant Nutrition and Soil Science*, *180*(1), 5–13.

Nardi, S., Schiavon, M., and Francioso, O. (2021). Chemical structure and biological activity of humic substances define their role as plant growth promoters. *Molecules* 26. doi:10.3390/molecules26082256.

Omara, P., Aula, L., Oyebiyi, F., & Raun, W. R. (2019). World Cereal Nitrogen Use Efficiency Trends: Review and Current Knowledge. *Agrosystems, Geosciences and Environment*, *2*(1), 1–8. https://doi.org/10.2134/age2018.10.0045

Rose, M. T., Patti, A. F., Little, K. R., Brown, A. L., Jackson, W. R., & Cavagnaro, T. R. (2014). A meta-analysis and review of plant-growth response to humic substances: Practical implications for agriculture. In *Advances in Agronomy* (Vol. 124, Issue January 2014).

Sible, C. N., Seebauer, J. R., & Below, F. E. (2021). Plant biostimulants: A categorical review, their implications for row crop production, and relation to soil health indicators. *Agronomy*, *11*(7).