CO_2 evolution after straw incorporation in soil supplemented with nutrients based on C:N:P:S stoichiometry

Nazish Amin, Sharan Panthi, Shayan Kabiri, Sharon O'Rourke
UCD School of Biosystems & Food Engineering, University College Dublin, Ireland

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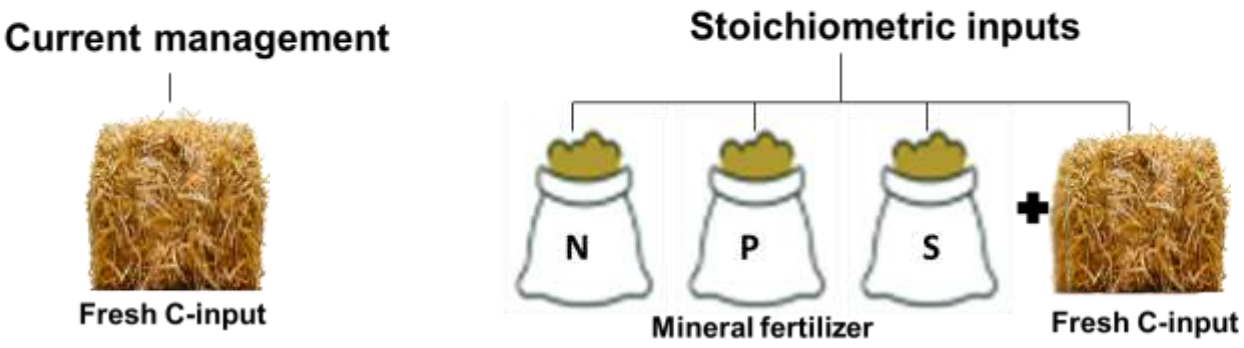
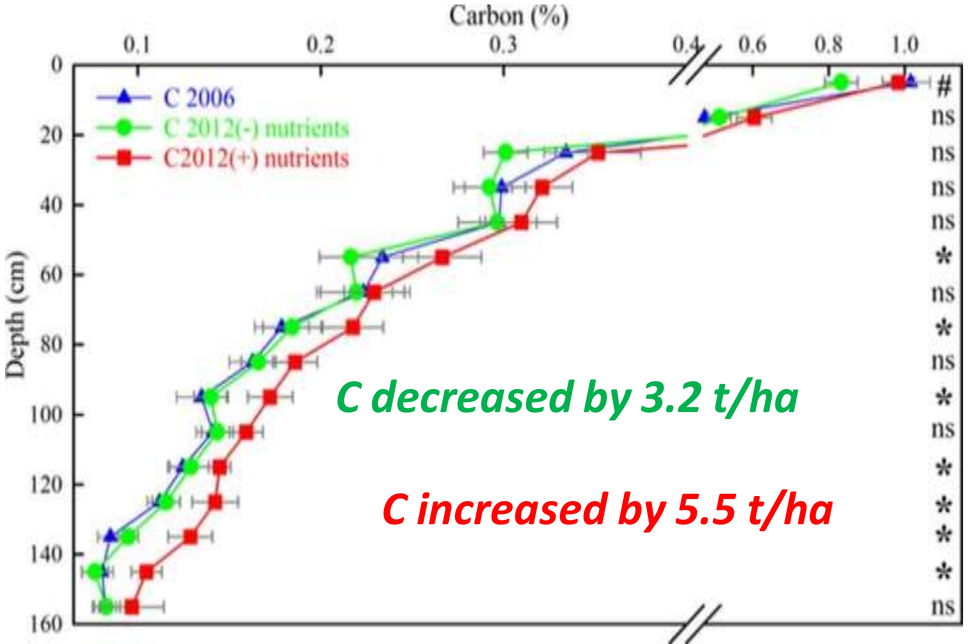
Outstanding Student & PhD candidate Presentation contest

nazish.amin@ucdconnect.ie

Introduction

- Increasing soil C stock is a viable climate change mitigation measure
- Efficiency of fresh organic matter to stabilised soil C is somewhat unknown
- Stabilised SOM = 10,000 C: 833 N: 200 P: 143 S (*Kirkby et al., 2011; Himes, 1989*)





Mean FF-C concentration (%) in 2006 and in the (+) and (−) nutrient treatments in 2012 (Kirkby et al., 2016)

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Aim & Objectives

Aim: To assess soil CO_2 evolution following straw incorporation and soil supplemented with stoichiometric input of N, P and S

Objectives:

- Quantify CO_2 evolution under different scenarios of nutrient supply
- Assess the influence of soil texture and initial SOC on CO_2 production
- Define the time period for microbial decomposition of crop residues in a laboratory mesocosm experiment

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Methods

- CO_2 evolution by closed jar method (Alef, 1995)
- Arable soils (n= 5) with a range in soil texture
- Soil preparation: sieved (<2 mm) & winnowed
- Incubated at 25°C & 70 % field capacity

Treatments:

a) BLANK Jar
b) soil (control),
— *Control treatments*

c) soil + crop residue (CR) – straw
d) soil + CR - straw + 100% supplementary nutrients — *Full nutrient supply*
e) soil + CR - straw + 150% supplementary nutrients — *Surplus nutrient supply*

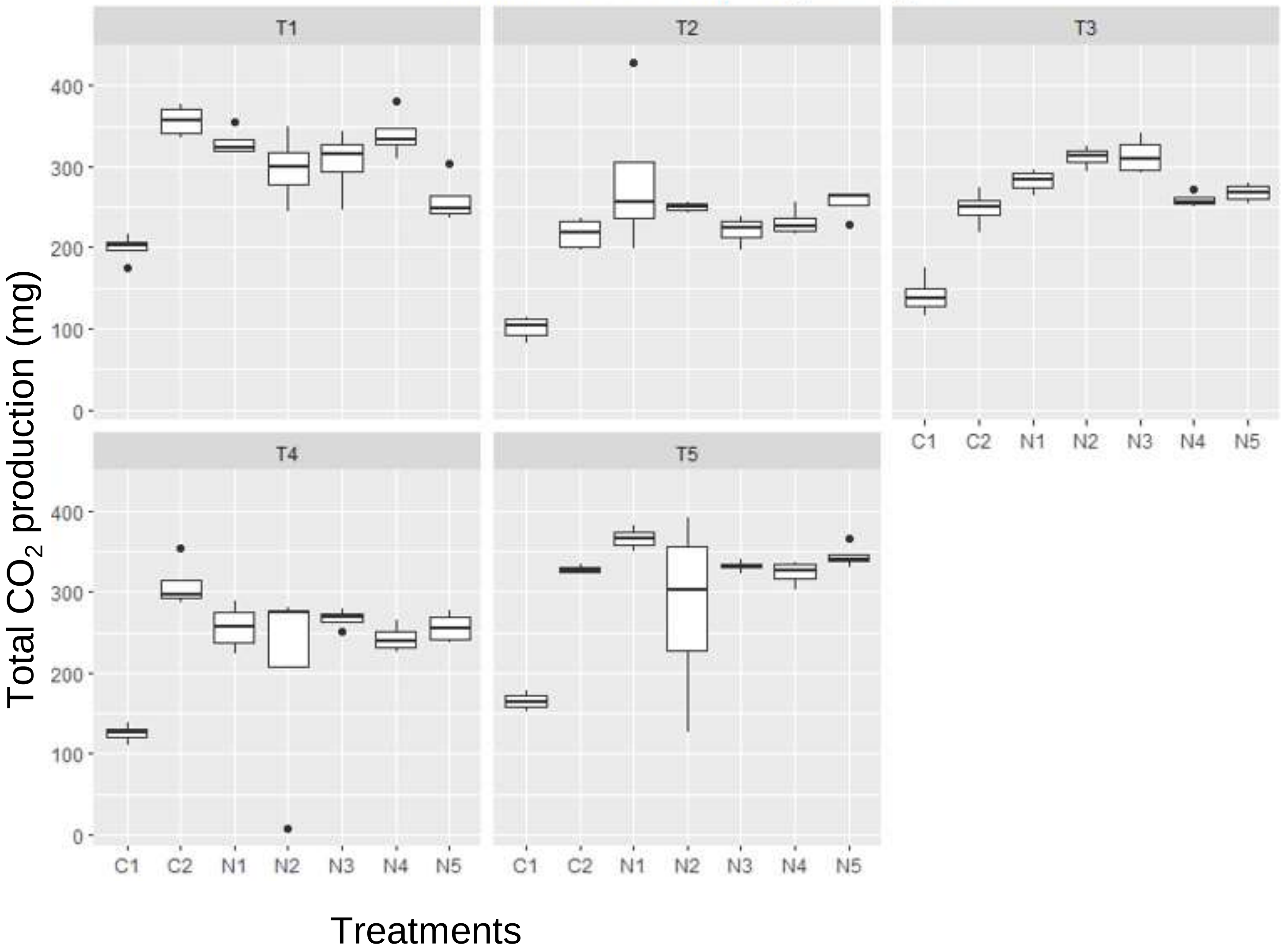
i) soil + CR - straw + N (P, S limiting)
j) soil + CR - straw + N + P (S-limiting)
k) soil + CR - straw + N + S (P-limiting)
— *Nutrient limitation*

C or CO_2 (mg) = [(Bv –Sv) x NE]

Bv = vol acid to titrate blank
Sv = vol acid to titrate sample
N = normality of acid
E = Equivalent weight
Equivalent weight for CO_2-C = 6
Equivalent weight for CO_2 = 22

Results

Total CO_2 production by soil type



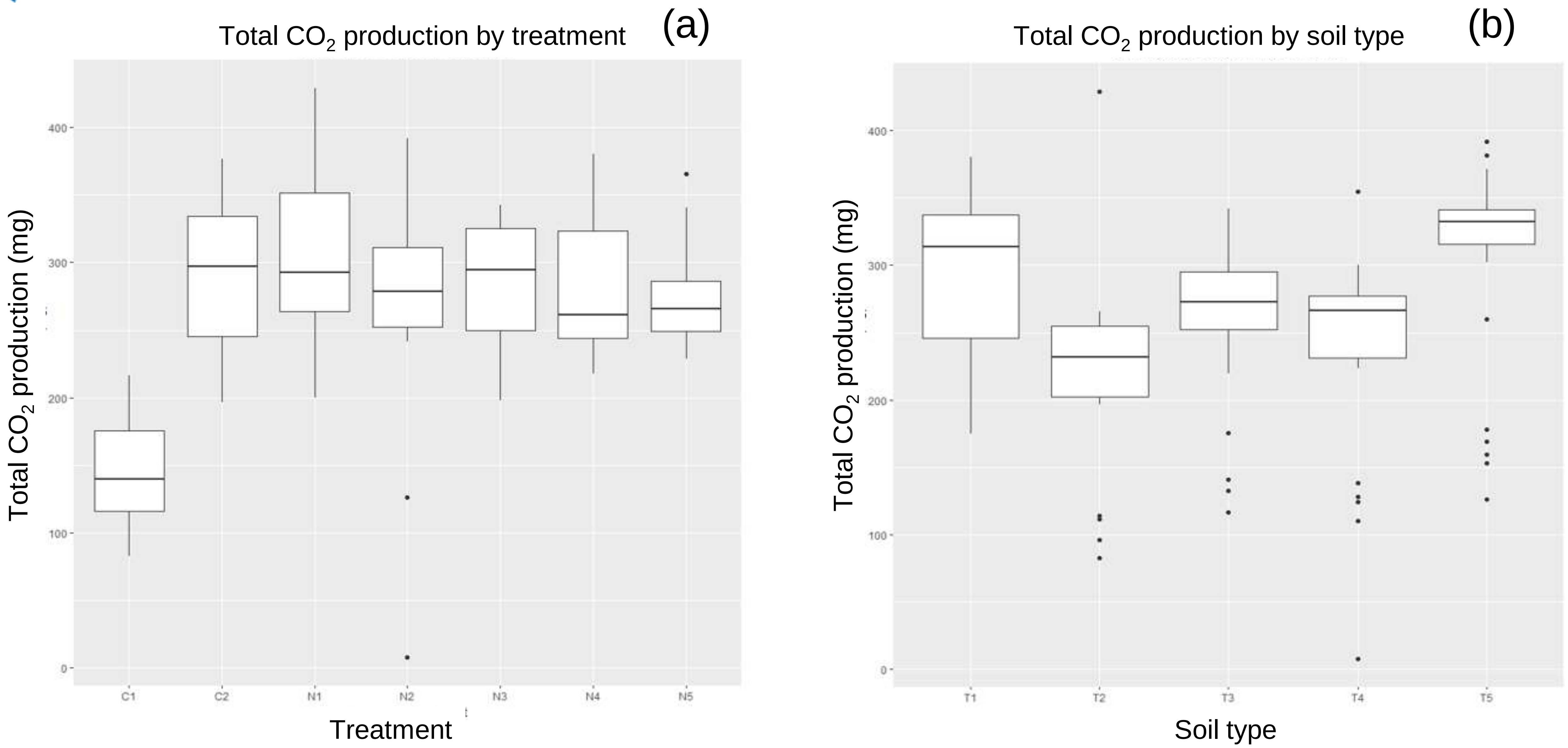
CO_2 production (mg) for five arable soils

Two-way ANOVA showing the treatment effect and soil type effect on total CO_2 production

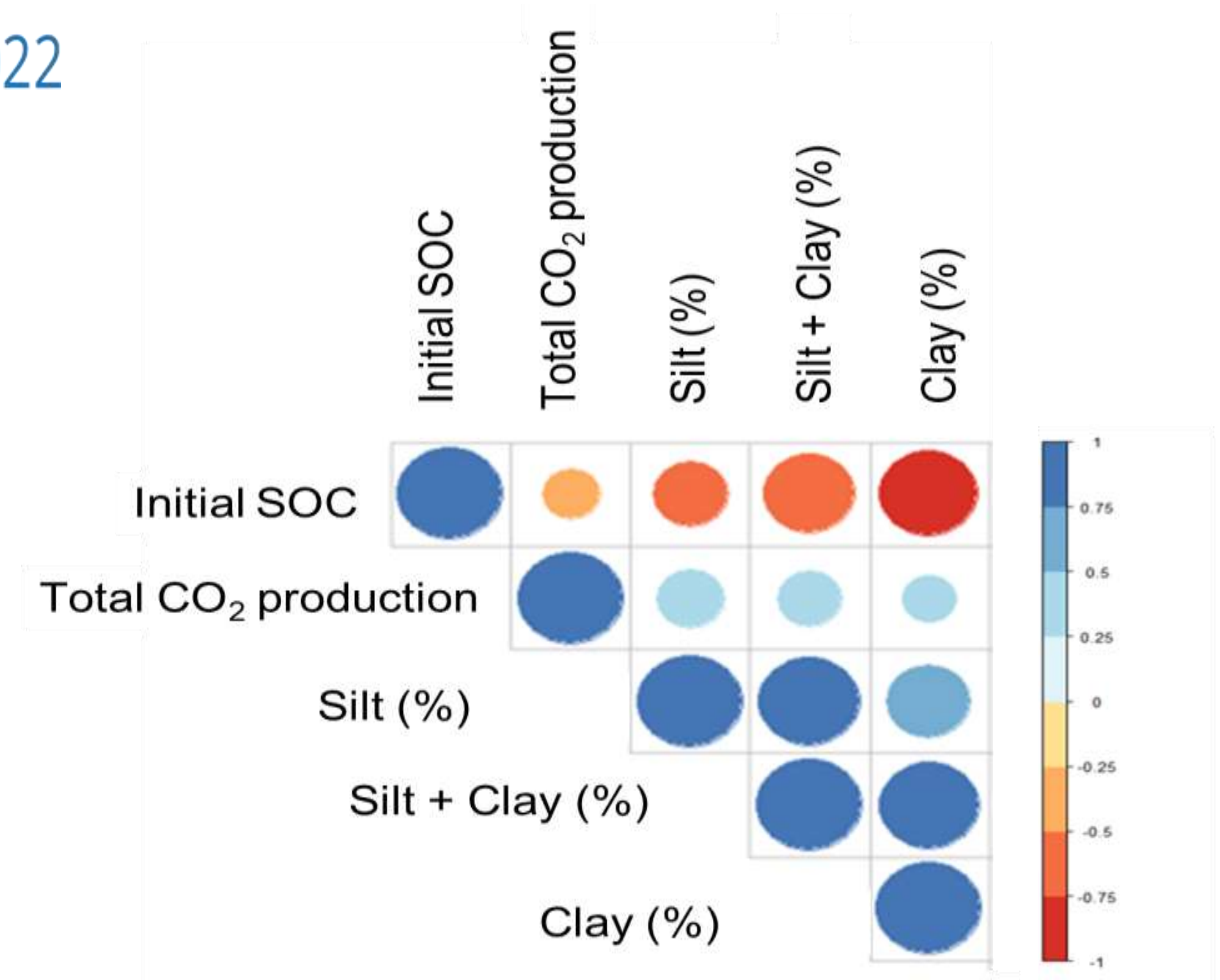
	Sum Sq	Df	F value	Pr (>F)	
Treatment	342985	6	30.059	2.20E-16	***
Soil type	147161	4	19.346	1.73E-12	***
Residuals	245323	129			

Treatments:

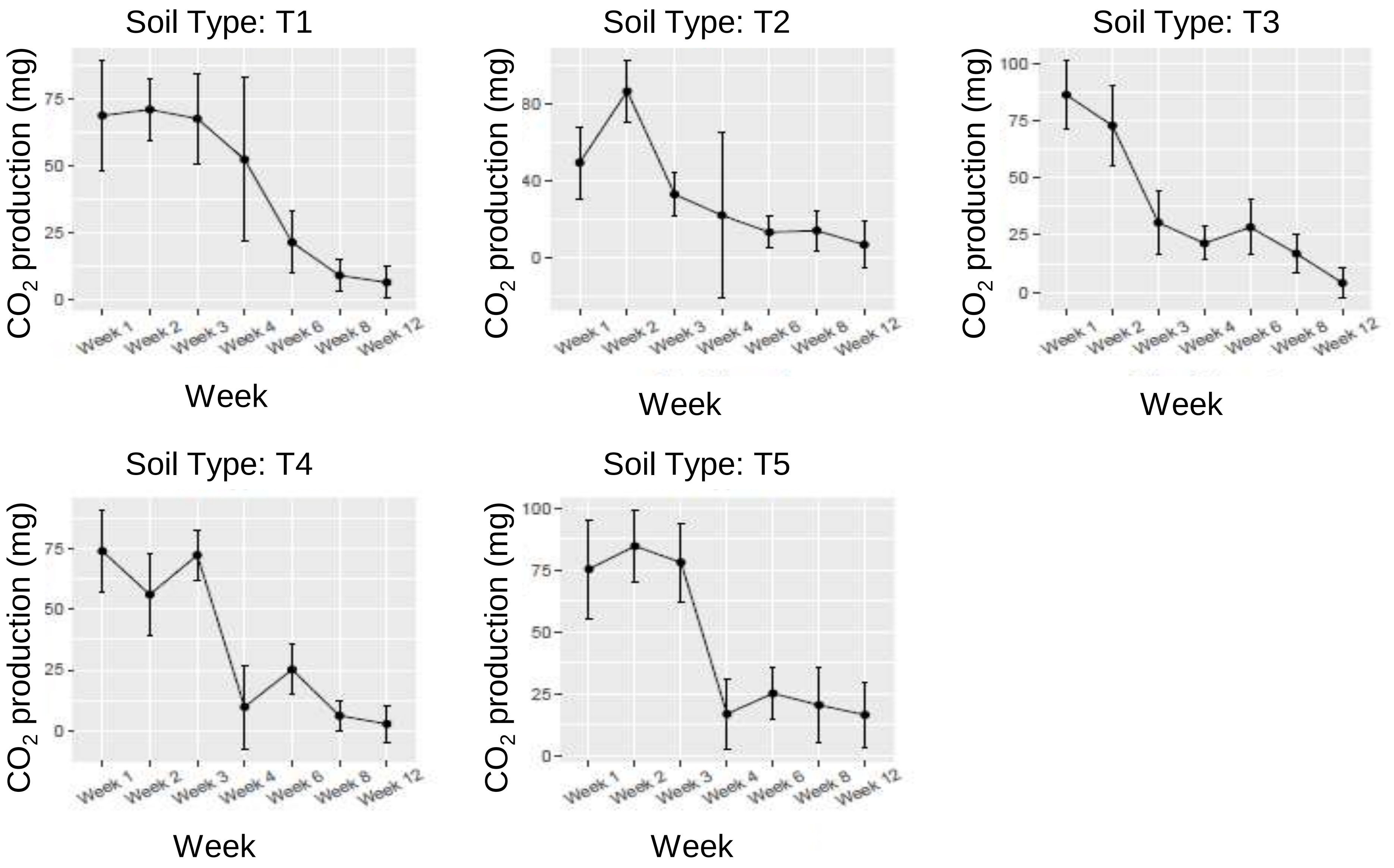
- C1 - Control soil (no straw/nutrients)
- C2 - Control soil (+ straw)
- N1 - Full nutrient supply (+ straw)
- N2 - Surplus nutrient supply (+ straw)
- N3 - Straw + P + S (N – limiting)
- N4 - Straw + N + S (P - limiting)
- N5 - Straw + N + P (S - limiting)



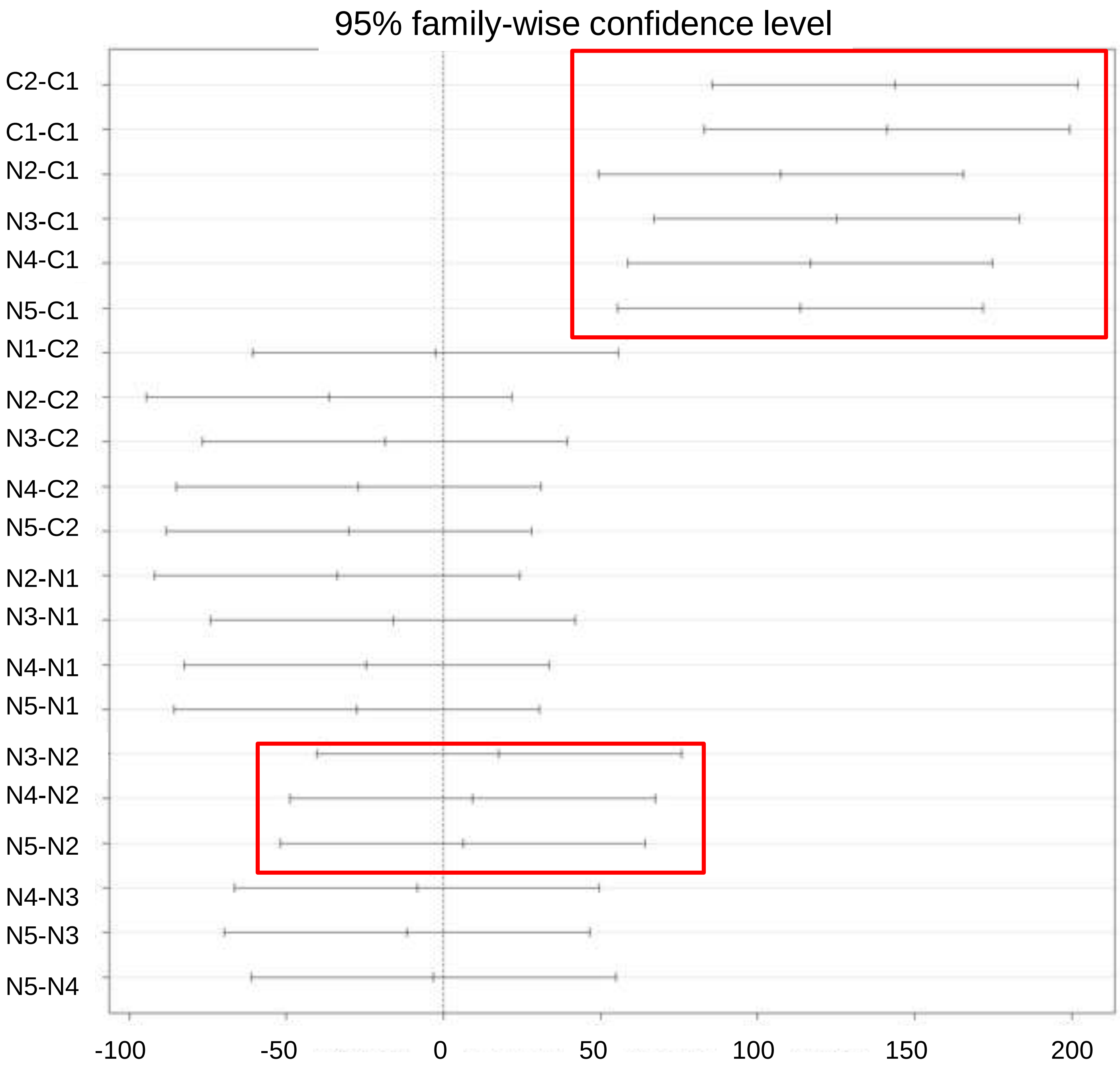
Total CO_2 production by (a) treatment and (b) soil type



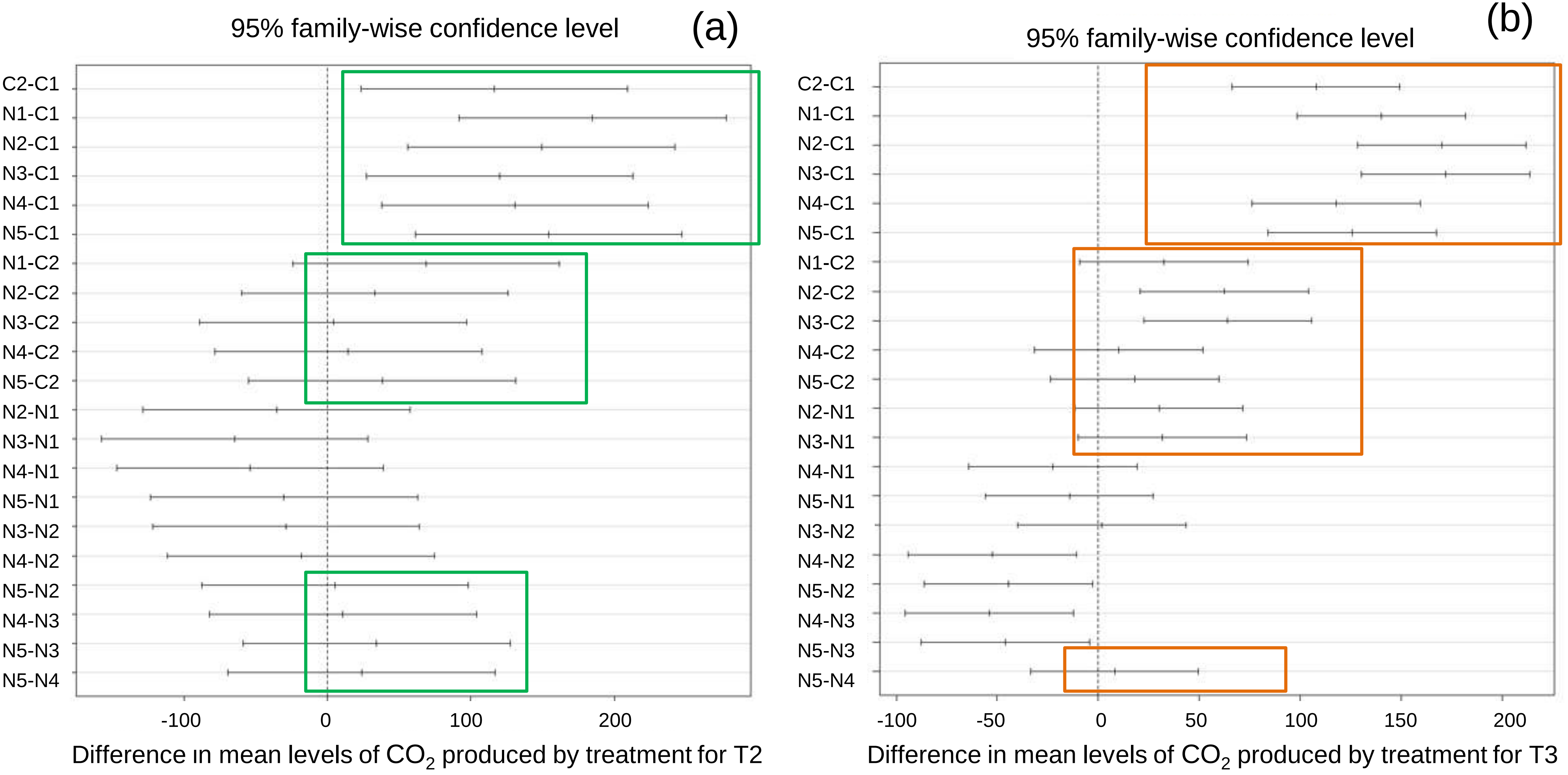
Correlation plot showing the effect of initial SOC on CO_2 production and soil texture



Total CO_2 production across the 12 week experimental period



Difference in mean levels of CO_2 production by treatments for all soil types



Difference in mean levels of CO_2 production by treatments for (a) T2 and (b) T3

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Conclusion

- After a 12-week incubation it was shown that stoichiometric inputs of CNPS had no effect on total CO_2 production

- Supplementation of N, P and S for fresh C-input showed significantly greater CO_2 production in weeks 1 and 2, but not across all soils

- Further work is examining the CNPS stoichiometry for enhanced soil C sequestration across multiple straw incorporation cycles

- A 12-week period was defined for decomposition of the incorporated straw

- Further analysis has been completed on the total C, N, P and S in soil fractions

References

Alef, K. & Nannipieri, P. 1995, Methods in applied soil microbiology and biochemistry, Academic Press, London, San Diego.

Askari, M.S., Cui, J. & Holden, N.M. 2013, 'The visual evaluation of soil structure under arable management', Soil & tillage research, vol. 134, pp. 1-10.

Himes, F.L., 1998. 'Nitrogen, sulfur, and phosphorus and the sequestering of carbon'.In: Lal, R., et al. (Eds.), 'Soil Processes and the Carbon Cycle'. CRC Press, Boca Raton, FL, pp. 315e319.

Kirkby, C.A., Kirkegaard, J.A., Richardson, A.E., Wade, L.J., Blanchard, C. & Batten, G. 2011, 'Stable soil organic matter: A comparison of C:N:P:S ratios in Australian and other world soils', Geoderma, vol. 163, no. 3, pp. 197-208.

Kirkby, C.A., Richardson, A.E., Wade, L.J., Conyers, M. & Kirkegaard, J.A. 2016, 'Inorganic Nutrients Increase Humification Efficiency and C-Sequestration in an Annually Cropped Soil', PloS one, vol. 11, no. 5, pp. e0153698-e0153698.