COMPOST IMPACTS ON URBAN SOIL CARBON, SOIL HEALTH, AND CLIMATE

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UCMERCED

STOPWASTE
at home • at work • at school

Why study compost and urban soils?

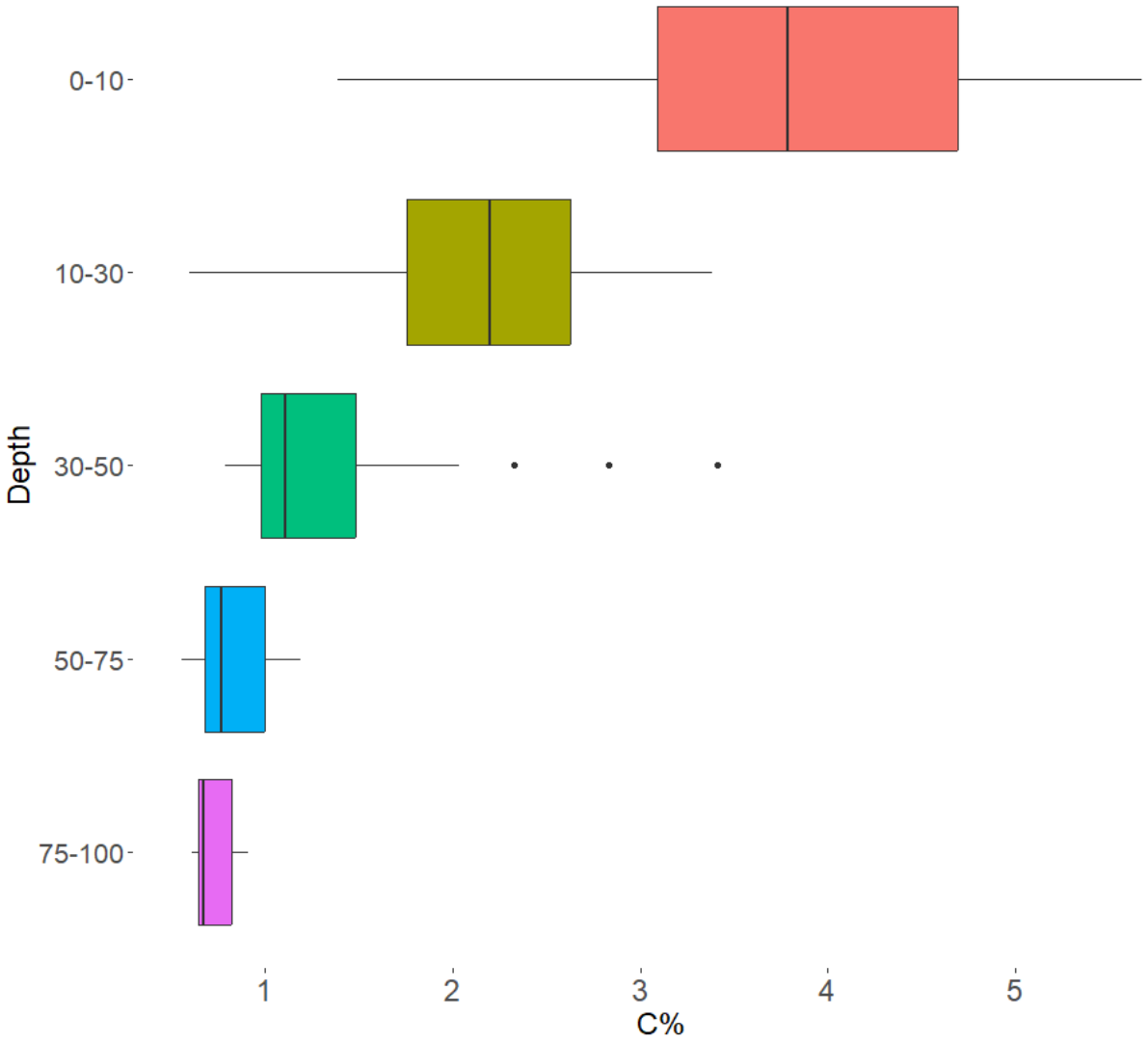
- **SB 1383** requires organics diversion and compost procurement by cities
- UC Merced, StopWaste, and cities of Dublin and Pleasanton interested in urban soil carbon and compost
- Urban areas and understudied and underutilized for compost and soil carbon research
- The impacts of compost on the soil and ecosystem health could impact many human lives due to urban population sizes

What are we measuring?

Shorter Term	Short Term	Long Term
Incubation	**Dublin**	**Pleasanton**
• Plant available N+P • Soil C/N • Short term GHGs	• GHGs • Soil C/N • Plant available N • Plant greenness • Soil water • MBC	• Soil C/N • Density fractionation • Radiocarbon • Bulk density • MBC

DUBLIN

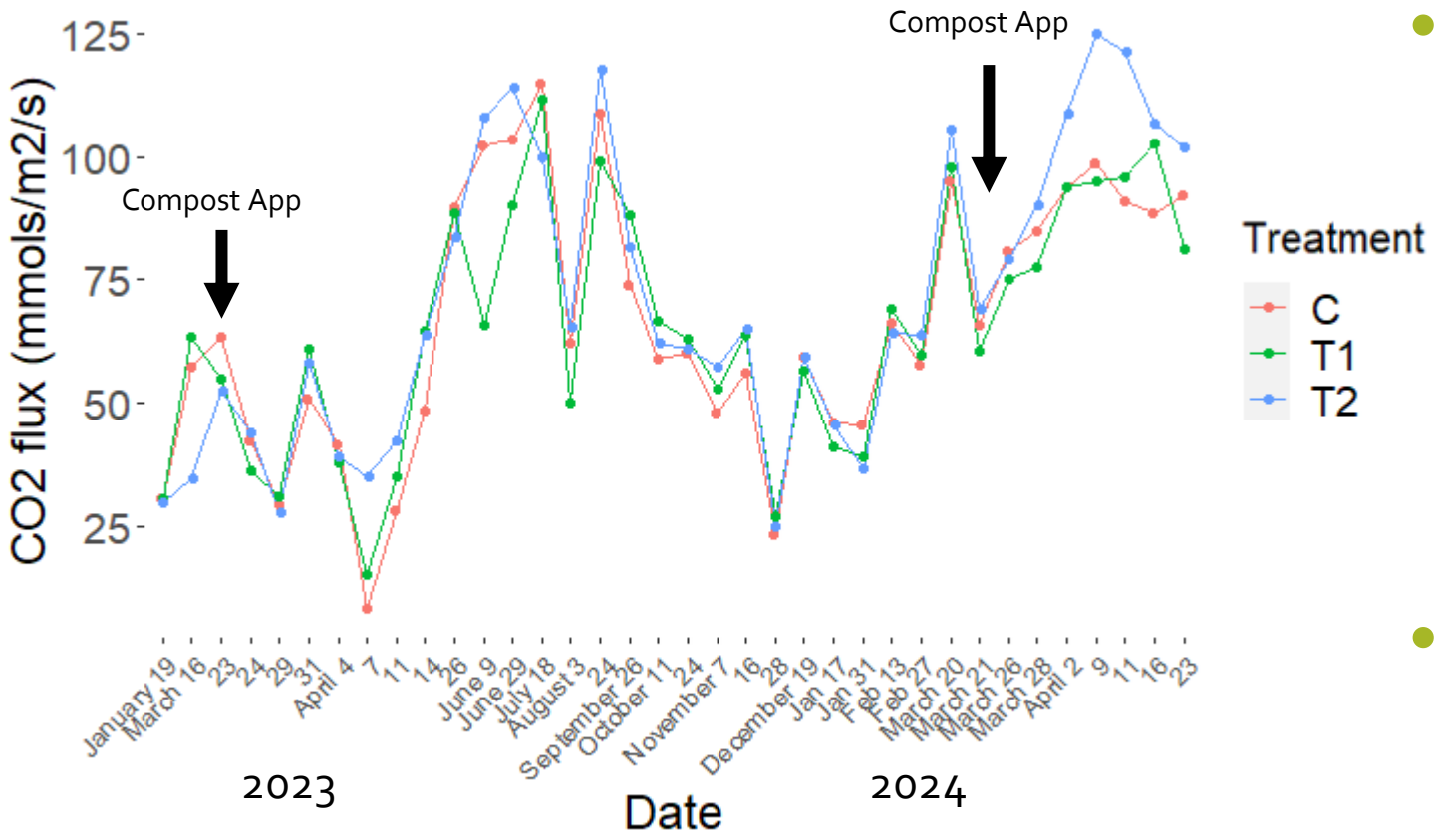
- 1/8in and 1/4in application rates of compost
- Compost applied in March of 2023 and 2024
- Year 1 soil sampling March 2024, Year 2 March 2025
- Twice a month gas monitoring



DUBLIN RESULTS BASELINE

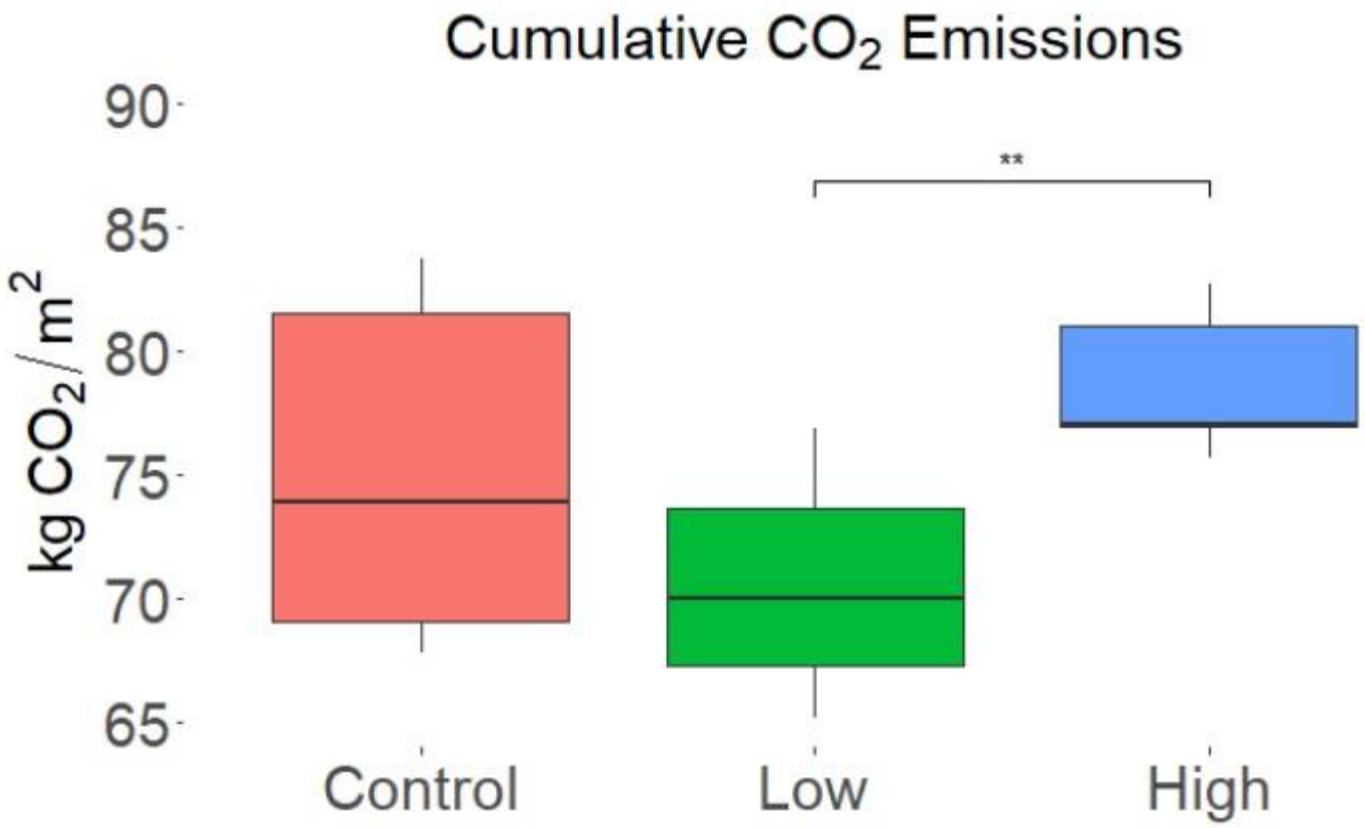
- How much carbon is in urban turfgrass soils?
- High carbon soils as a starting point
- C% falls strongly with depth, but deep C matters!

Dublin Results – CO_2

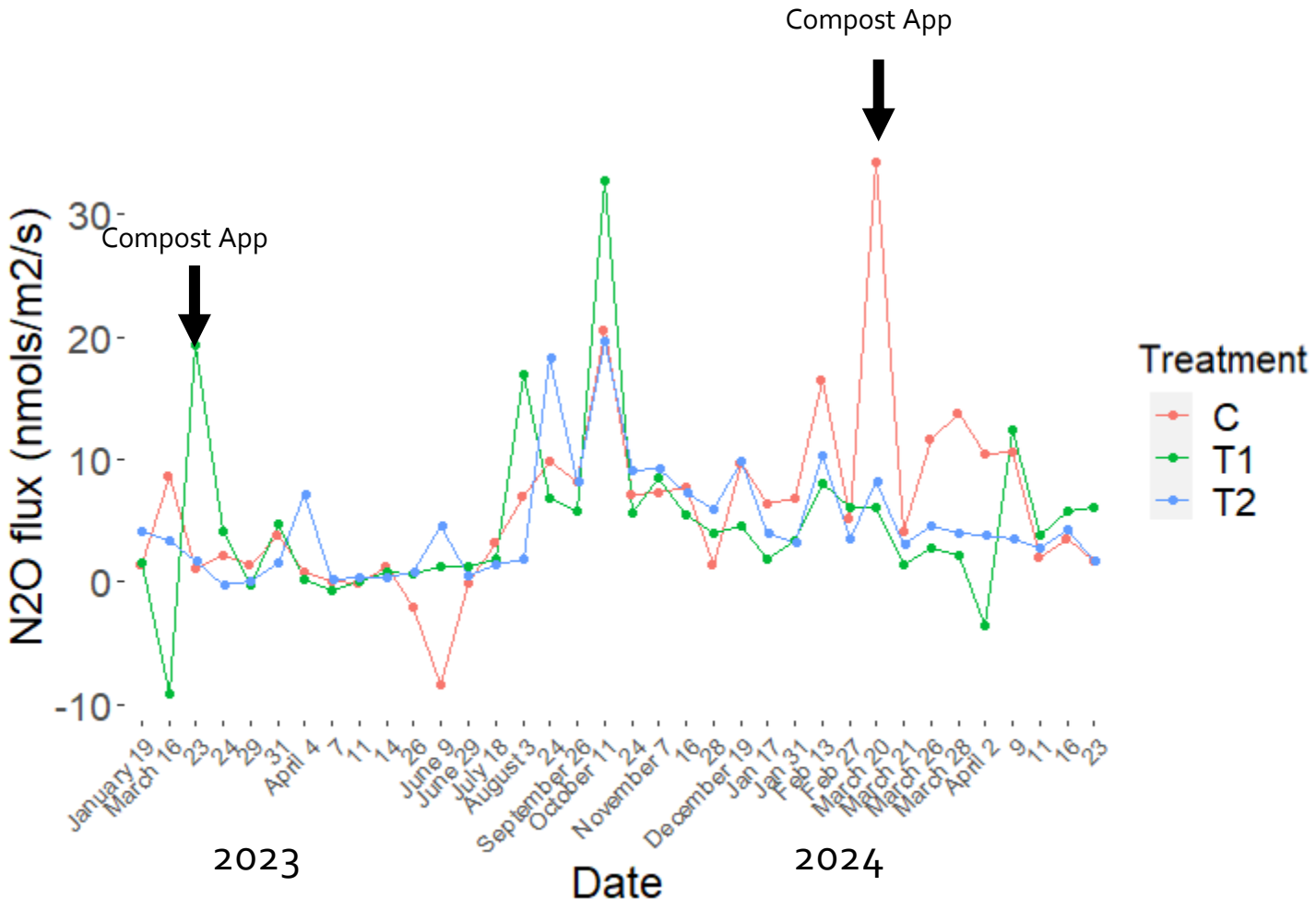


- How does compost impact soil CO_2 flux?
- 1/4in compost application increases CO_2 flux, especially after second application
- Minimal change in CO_2 flux from 1/8in compost application

Cumulative CO_2 Flux



Dublin Results – N2O

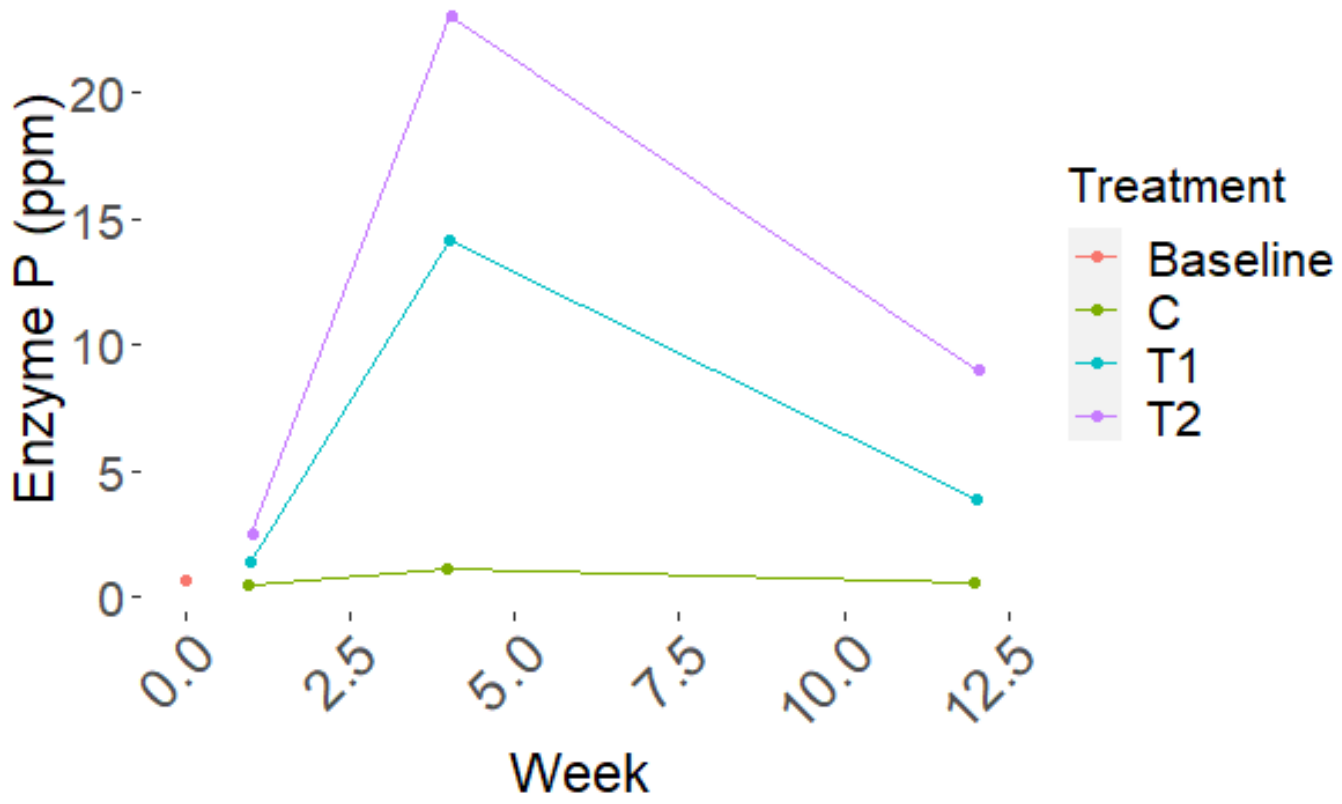


- How does compost impact soil N2O flux?
  - N2O ~300 times as warming vs CO2
- Potentially reduced N2O flux from compost application in year 2
  - Timed with spiked in control due to fertilizer
- Minimal change in N2O flux beforehand

INCUBATION EXPERIMENT

- How does compost and watering type influence plant available nutrients over a year?
- C, T1, T2 and filtered water vs recycled water
- Weeks: 1, 4, 12, 36, 52
  - 3 Replicates for each treatment/water/date

PRELIMINARY INCUBATION RESULTS



- Does compost increase plant available phosphorus?

- Compost increases overall Phosphorus, particularly "active" P

PLEASANTON

Long Term Carbon Dynamics

400+ total soil samples

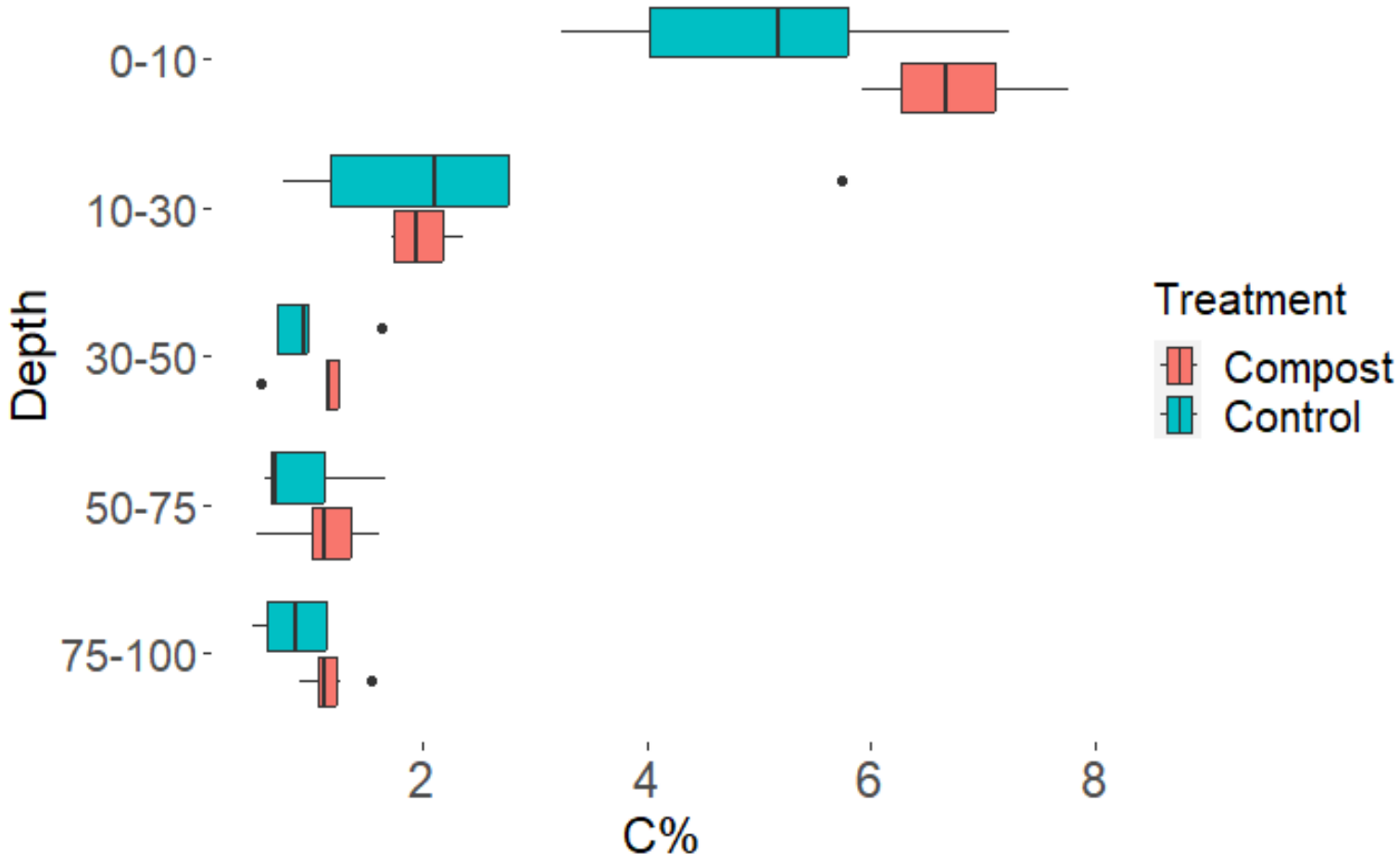
50 DF and 14C samples

- 20 years of compost, 30 years, and never

Why?

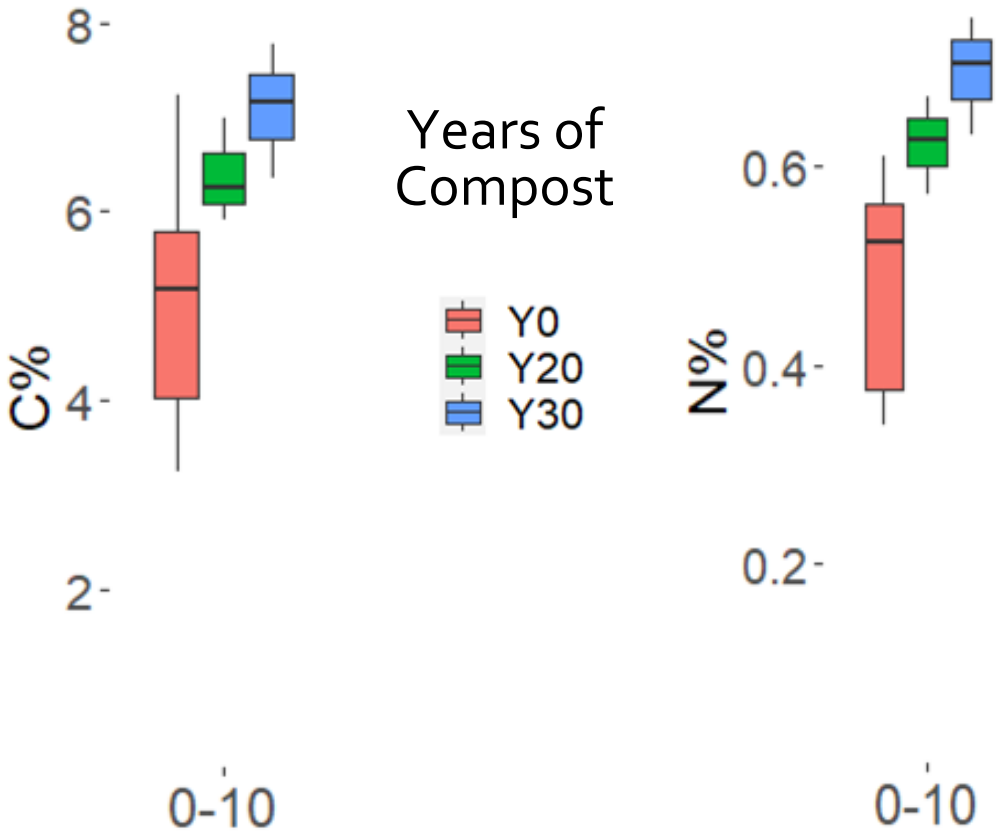
Preliminary Pleasanton Data

- Does long-term compost increase soil C?
- Long term compost application increases topsoil C
- Smaller increases at depth

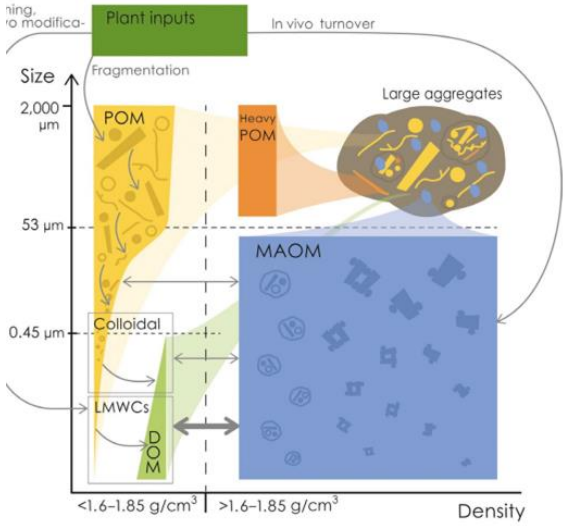


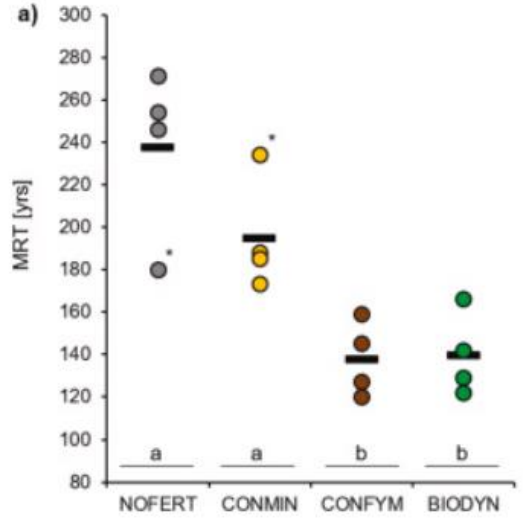
Preliminary Pleasanton Data

- More carbon (and nitrogen) in 30-year compost over 20 year in topsoil



Lavalle et a.2019





Mayer et al.2023

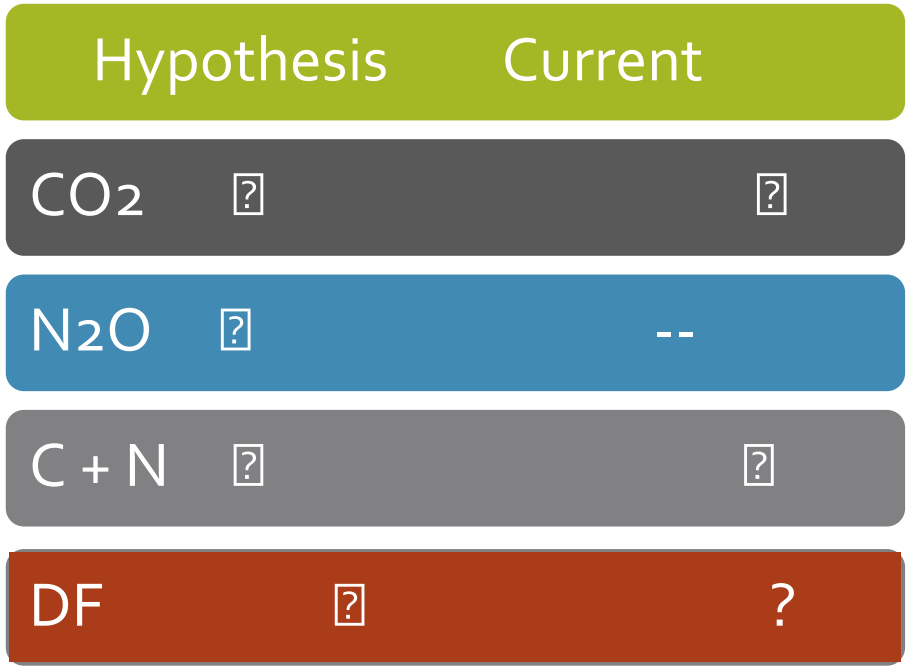
Why use DF? Radiocarbon?

- Density Fractionation can help to understand the persistence of C in soil (**How long will a change last?**)
  - Free light fraction (**FLF**) is "floating" SOM that can be more readily use
  - Heavy fraction (Or **MOAM**) is minerally associated and harder to access

- **14C (radiocarbon) can tell us the relative age of C**
  - Could tell us turnover times of carbon

Conclusions and Future Directions

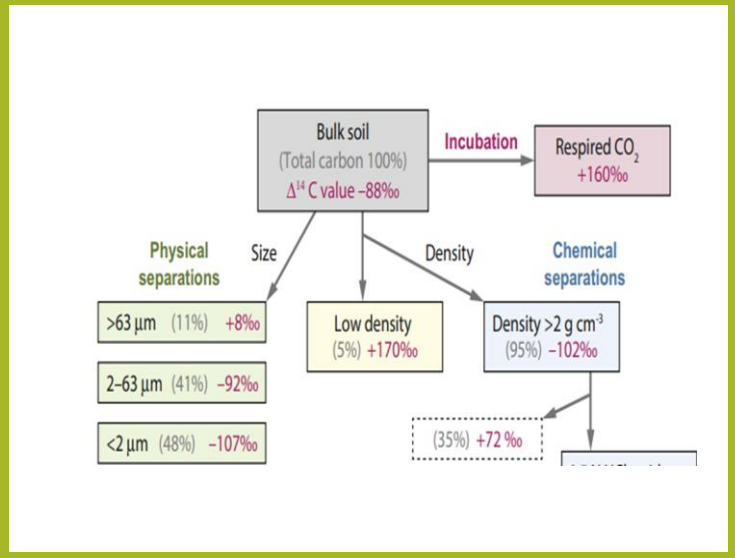
- Turfgrass soils have **high baseline carbon content**
- Higher compost application **increases CO_2 flux**
- Long-term compost application **increases topsoil carbon**

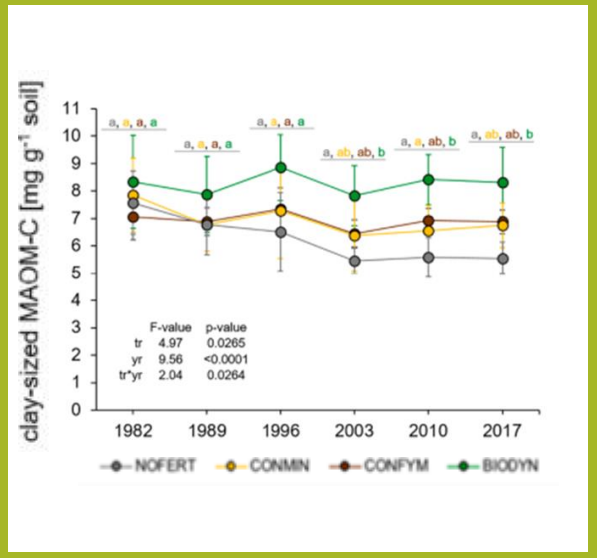


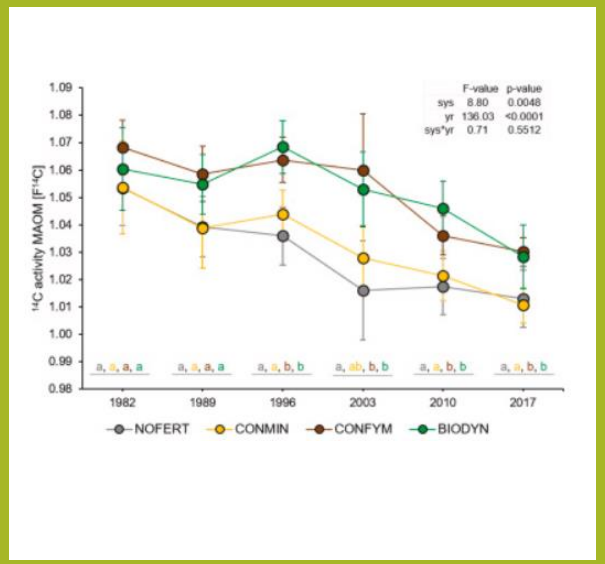
- Process soils for **density fractionation** and **radiocarbon** to assess changes in carbon persistence
  - How does this vary by **depth**?

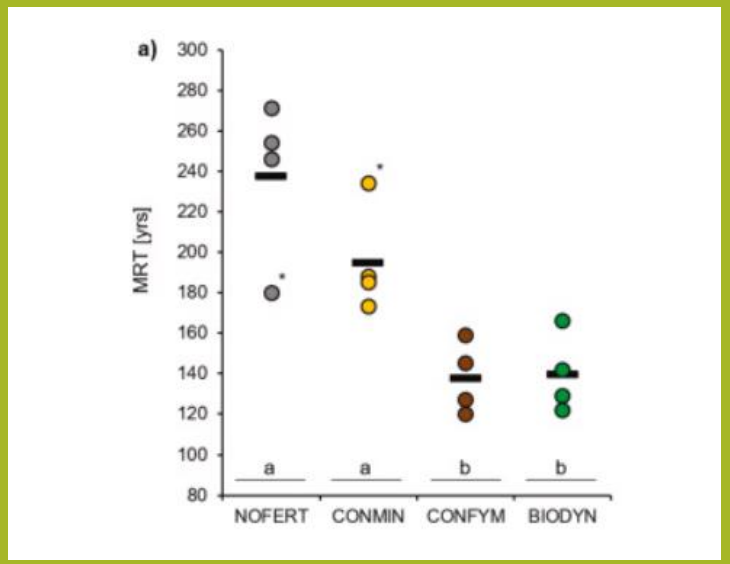
Thanks!

Questions?









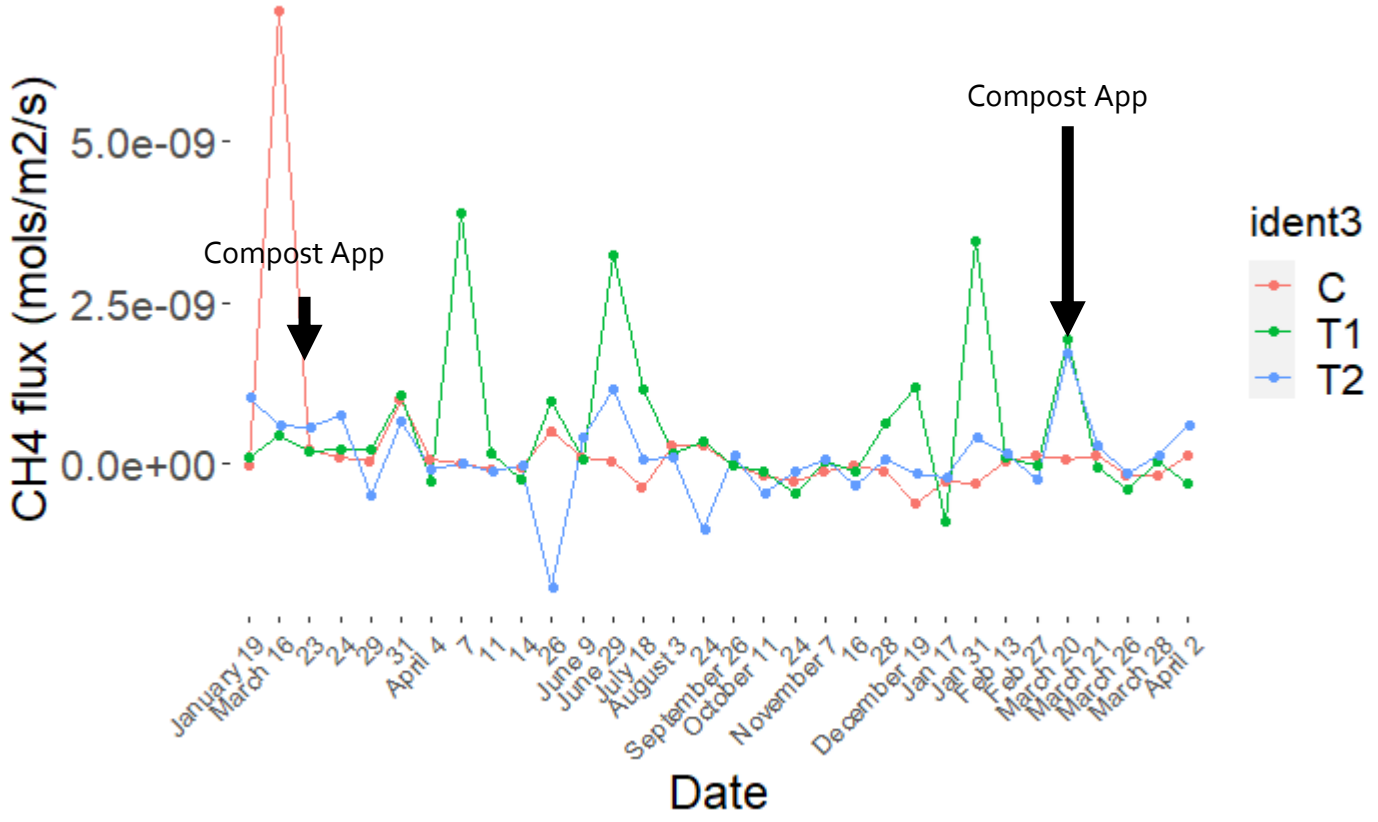
Why 14C?

- **14C (radiocarbon) can tell us the relative age of C**
  - This is especially impacted by "bomb" carbon from nuclear testing

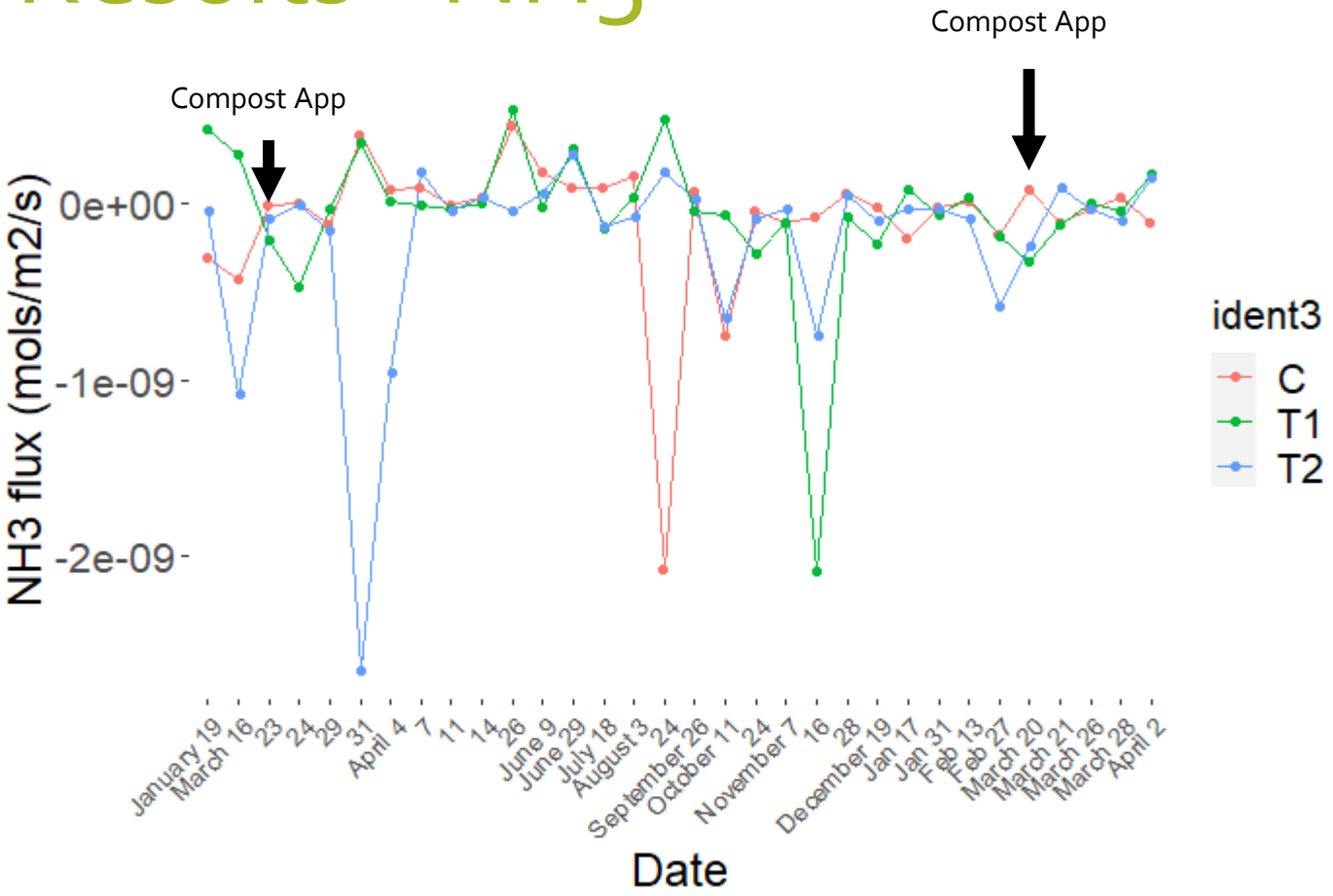
- How might **compost influence turnover time** of carbon pools?
  - Does it differ by pool?
  - By depth?
  - By feedstock?

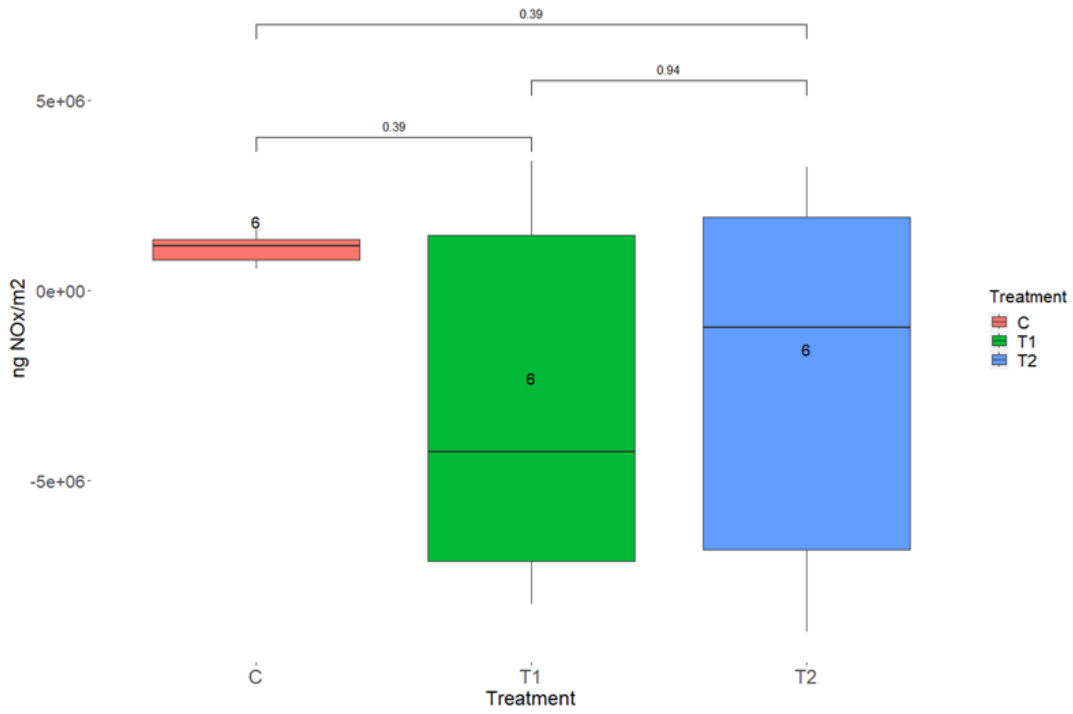
Mayer et al.2023

Dublin Results – CH_4



Dublin Results - NH_3





DUBLIN RESULTS - NOX

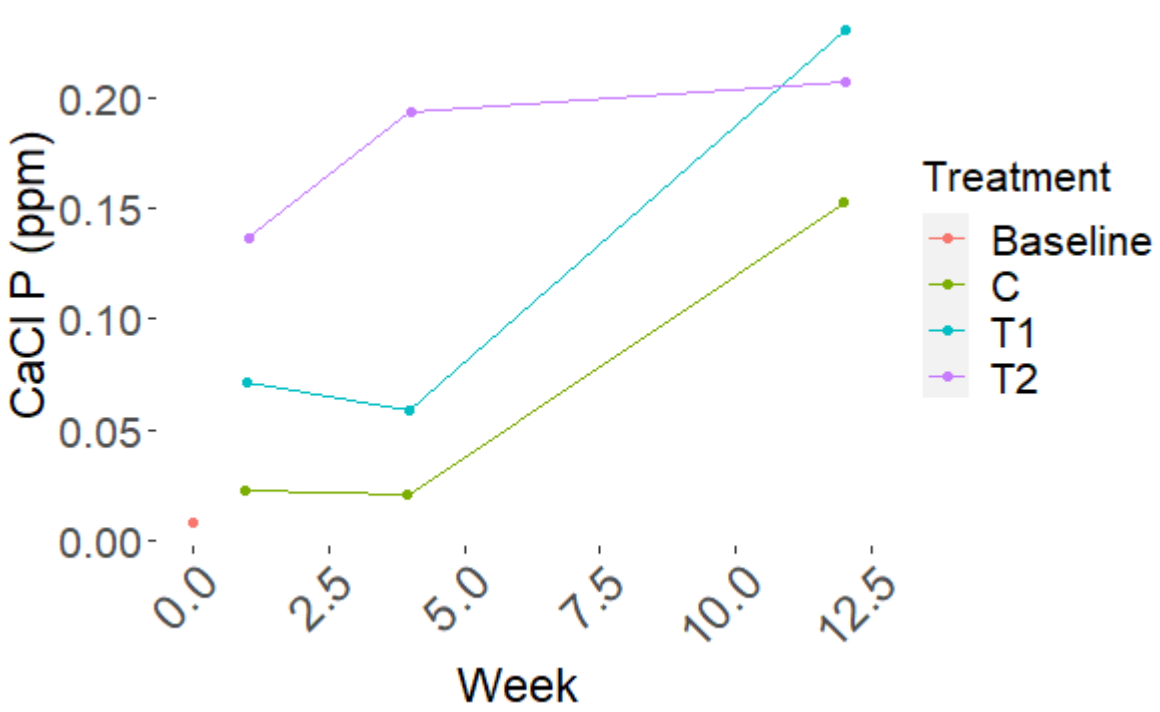
(As of 12/2023)

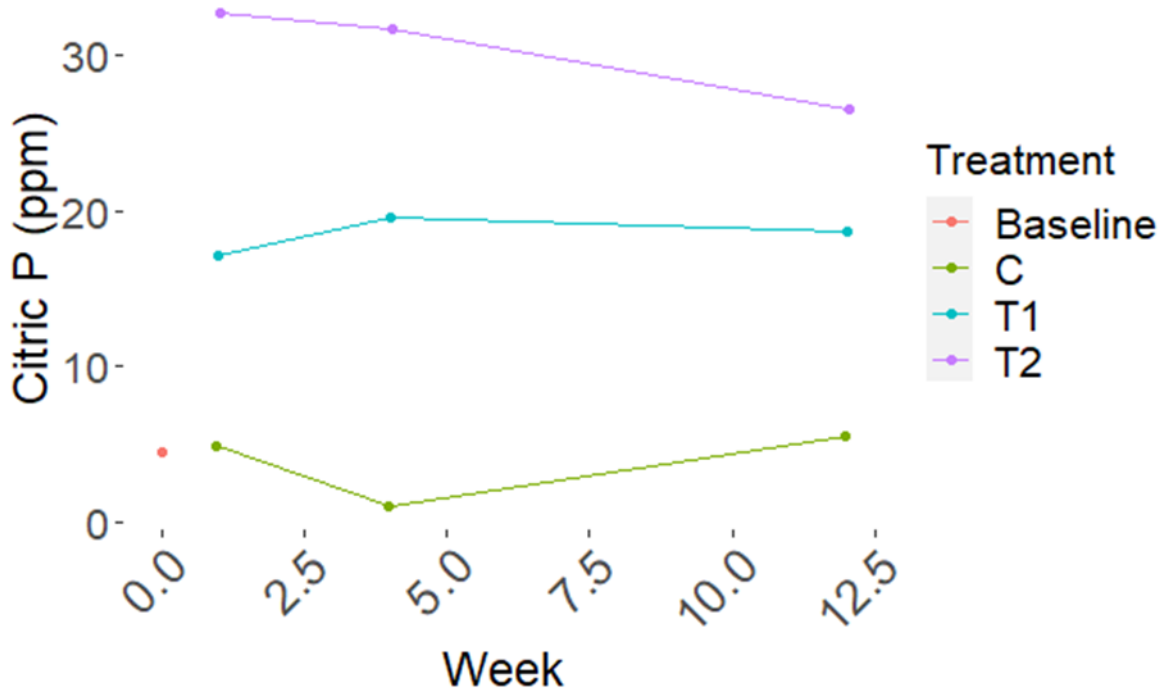
What are the four P pools?

Extractant	Form of P accessed and biotic system emulated by extraction method
0.01 M $CaCl_2$ extractable P	Soluble and weakly adsorbed inorganic P. Emulates P accessed by root interception and diffusion.
10 mM citrate extractable P	Active inorganic P pool sorbed to clay particles or weakly bound in inorganic precipitates. Emulates organic acid release by plants and microorganisms
0.2 enzyme unit extractable P	Organic P readily attacked by acid phosphatase and phytase enzymes. Emulates enzyme release by plants and microorganisms to access labile organic P
1 M HCl extractable	Soluble, active, and moderately stable inorganic P adsorbed to mineral surfaces or present in inorganic (Fe, Al, or Ca) precipitates. Emulates proton extrusion by plants and microorganisms to access adsorbed and precipitated P.

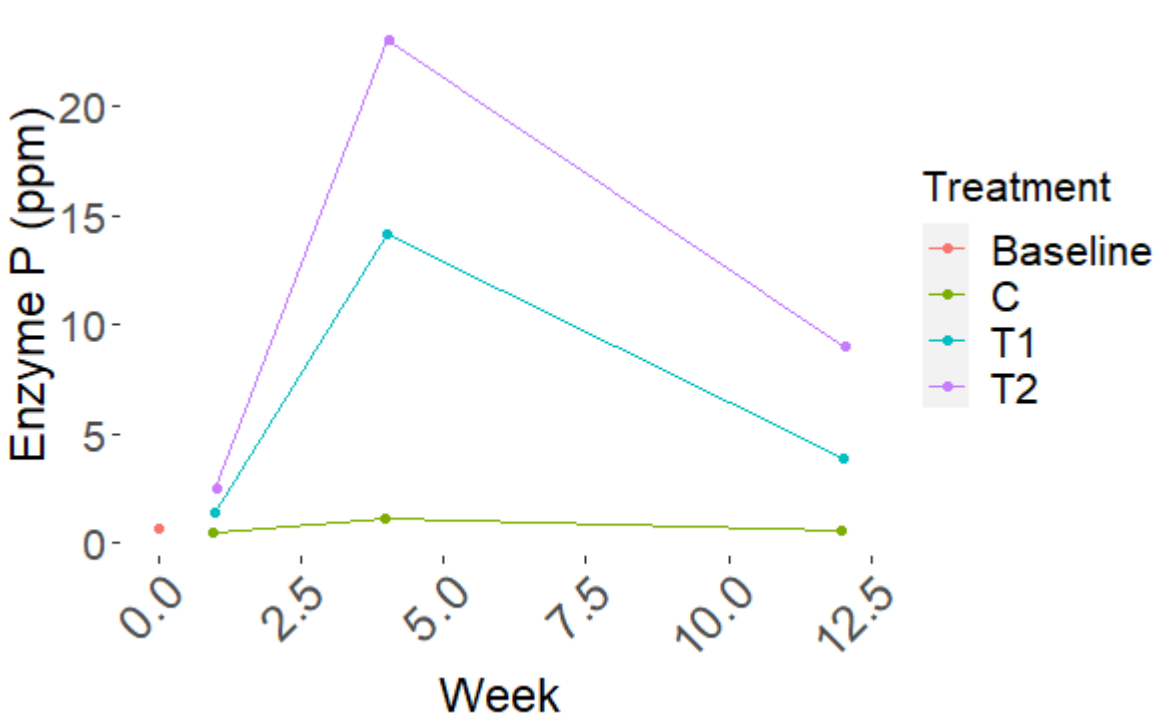
- **CaCl2**: Weakly sorbed P, root interception/diffusion
- **Citrate**: Organic acid release available P
- **Enzyme**: Plant/microbe labile P
- **HCl**: Mineral attached P (difficult to access)

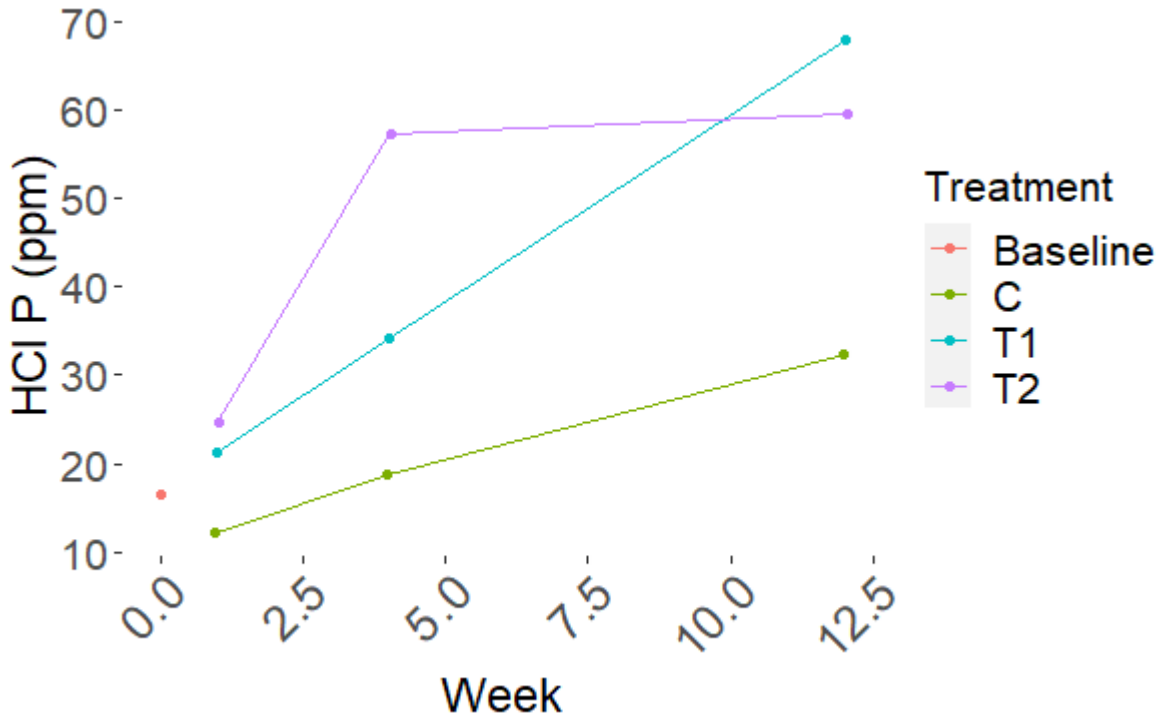
DeLuca et al. 2015





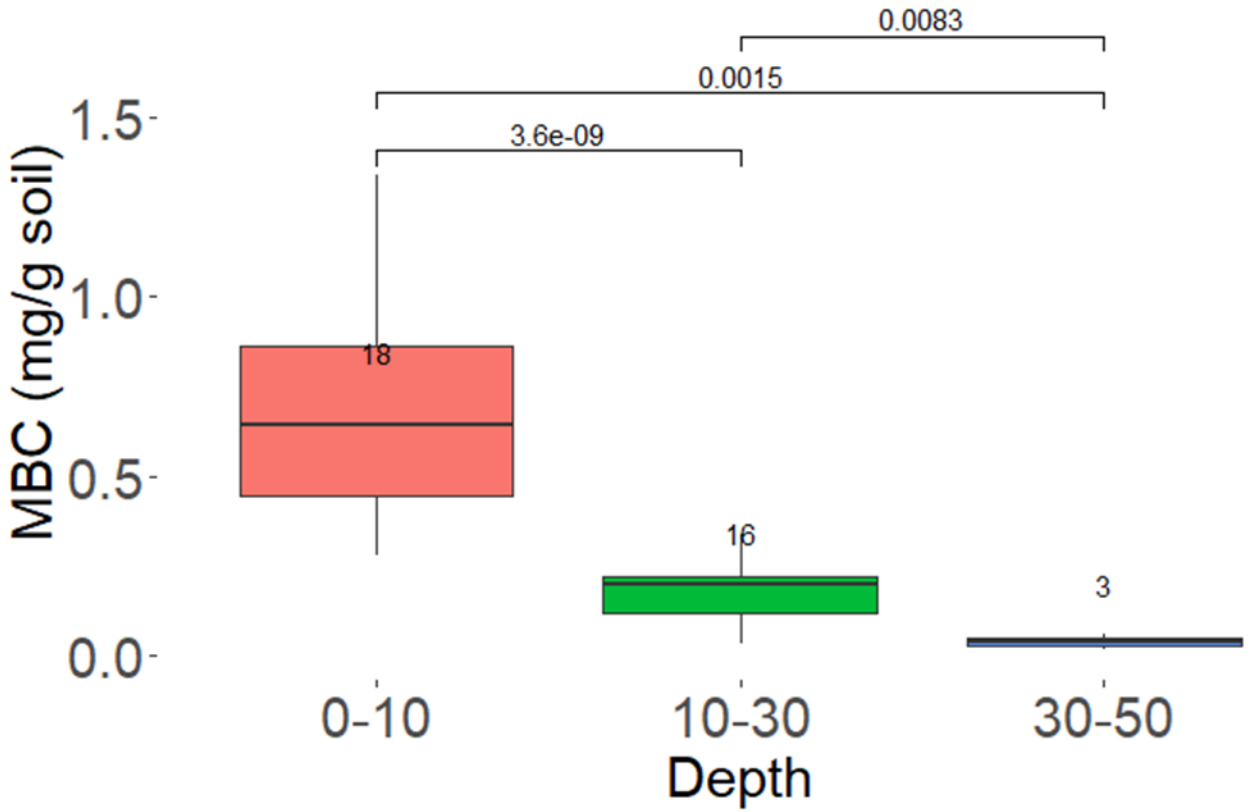
INCUBATION RESULTS - OVERALL





INCUBATION RESULTS - OVERALL

Extra


0.0083
0.0015
3.6e-09
1.5
1.0
0.5
0.0
MBC (mg/g soil)
18
16
3
0-10
10-30
30-50
Depth