DYNAMICS OF MICROBIAL COMMUNITIES DURING DECOMPOSITION OF ^{13}C LABELLED CORN UNDER DIFFERENT TILLAGE PRACTICES IN OHIO USA

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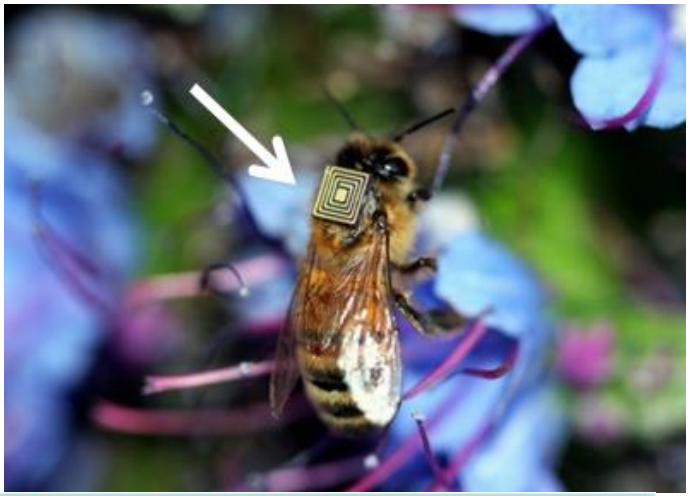
Key Concepts in the research...

Soil microbial communities as central components of soil controlling **carbon decomposition and the partitioning** back to the atmosphere as CO_2 or storing in soils.

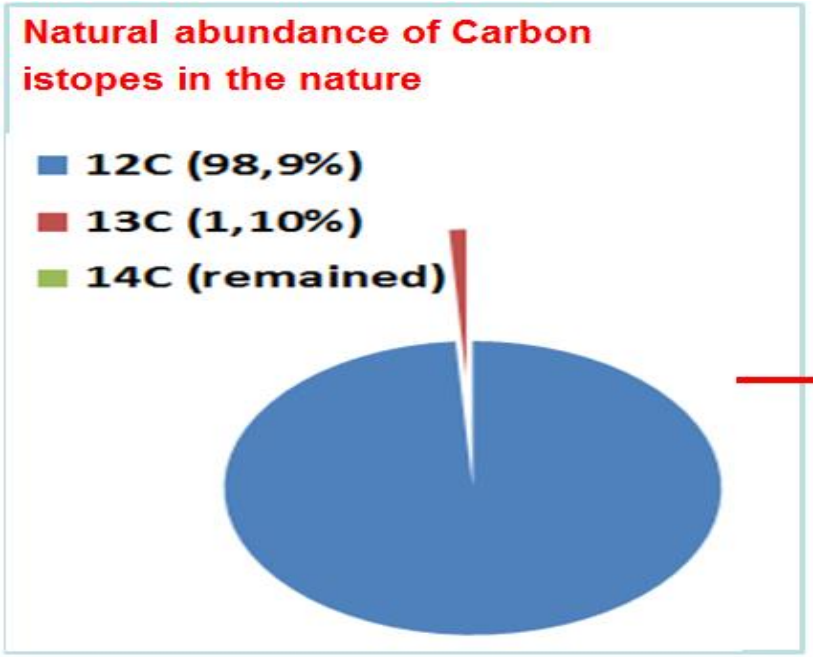
No tillage (NT) ecosystems stabilize carbon by surface decomposition and **binding of organic carbon to mineral soil layers**. On the other hand, to effectively manage NT practices fundamental information is needed on how these systems sequester carbon.

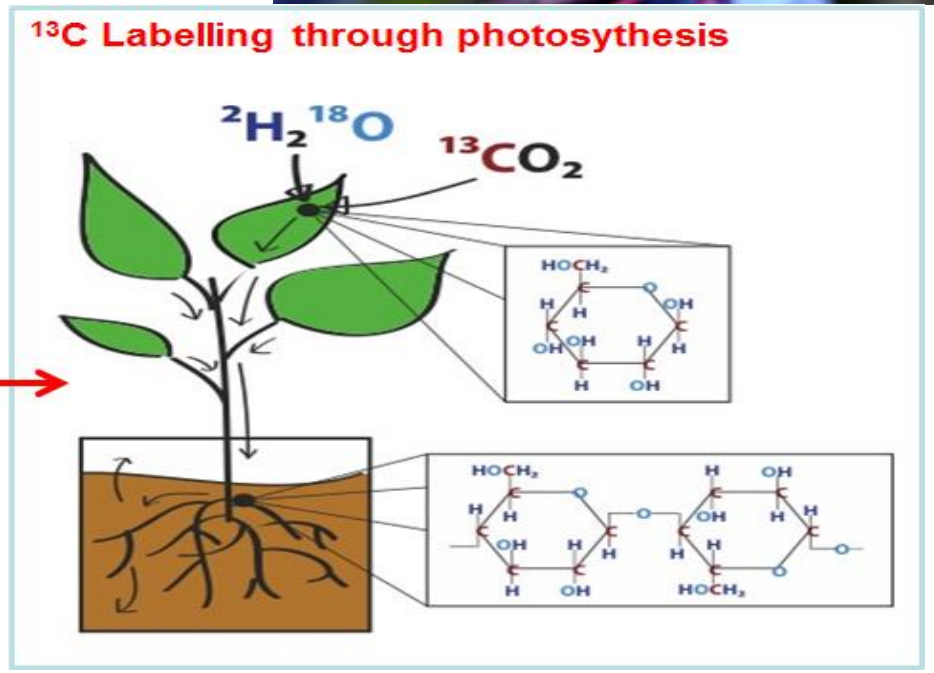
We hypothesize that **nutrient transport** between surface litter and mineral soil is an important mechanism **generated by bacteria and fungal hyphae** and can be **monitored by isotopic carbon pathway (^{13}C)** in the presence of different **microbial barriers (1µ and 5µ meshes)** that may allow us to differentaite fungal and bacterial decomposition processes in NT ecosystem.

WHAT IS ^{13}C LABELLING?



Captured honeybees in Australia, **fitted with tiny sensors** and released back into the wild (as an **extensive environmental monitoring**) to answer questions about **colony behaviours and disorders ,** AUSTRALIA





"...A technique used to track the passage of an isotope, or an atom with a variation, through a reaction, metabolic pathway, or cell. The reactant is 'labeled' by replacing specific atoms by their isotope...." , **Wikipedia**

AIMS OF STUDY

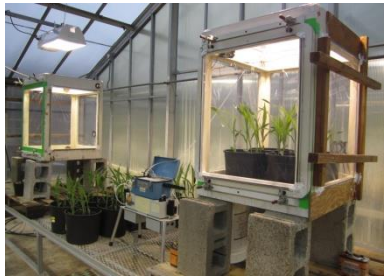
To examine microbial ^{13}C transport from the NT litter layer to the mineral soil layer.

The study is simply based on the comparison of ^{13}C labelled-residue decomposition of under plough tillage (PT) and no-tillage (NT) systems in OARDC*, Wooster, Ohio, USA, where one of the world's oldest experimental NT plot (since 1962) is available.

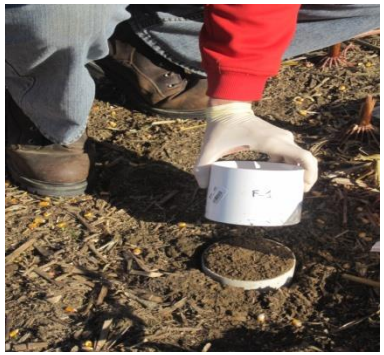
*** Ohio Agricultural Research and Development Center**

MATERIAL and METHODS

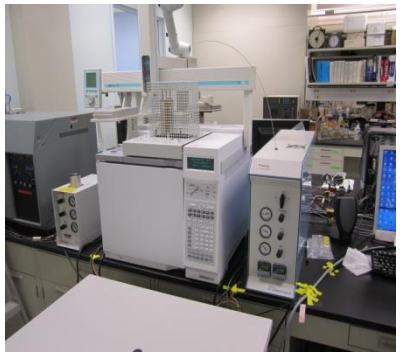
1) Isotopic labelling, preparation of ^{13}C labelled corn residue material for field and laboratory experiments)



2) Field-incubation setup, a PVC mesocosm design fitted with exclusion barriers to understand the degree and temporal dynamics of microbial ^{13}C transport from litter to mineral soil



3) Seasonal monitoring of ^{13}C transport for Autumun (November), Spring (May) and Summer (mid July) through different microbial groups in soil by using ^{13}C PLFA technology*

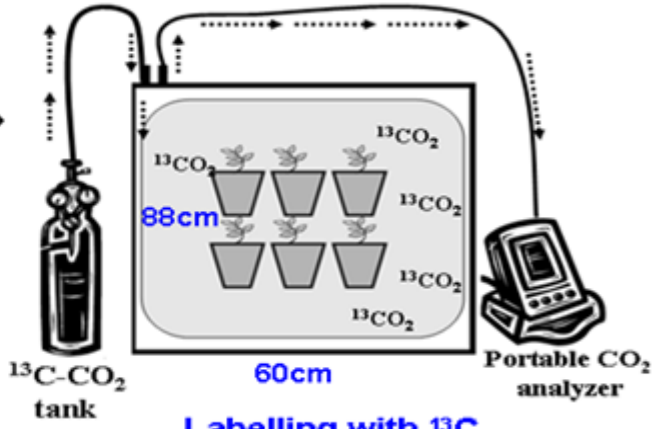


***Measurement of ^{13}C-phospholipid fatty acid profile belongs to different microbial groups in soil.**

^{13}C CORN LABELLING GREENHOUSE EXPERIMENT

Planting
6 seeds
(thin to 4
when reaching
10cm)

Start for labelling
in early of
germination



Labelling with ^{13}C
during photosynthesis
(weekly exposures to $^{13}CO_2$
once a week for couple
hours)

- 40 pots (23x25cm, 12lt)

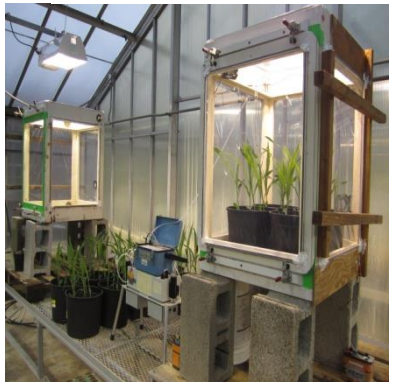
- Peat:perlit media (Fafard 3B mix, 2kg per pot)

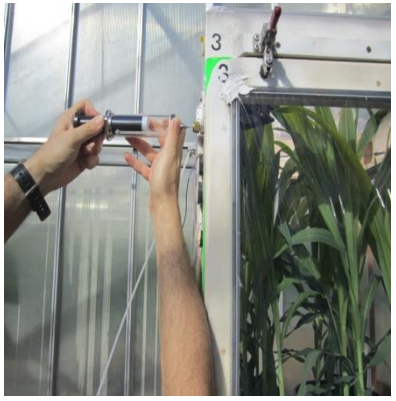
- Fertilization (15-9-12 Osmocote Plus-slow release fertilizer
and 20-10-20 PLS microelements

- Temperature conditions (28/22C daylight/overnight)

- 6 to 8 weeks growth period

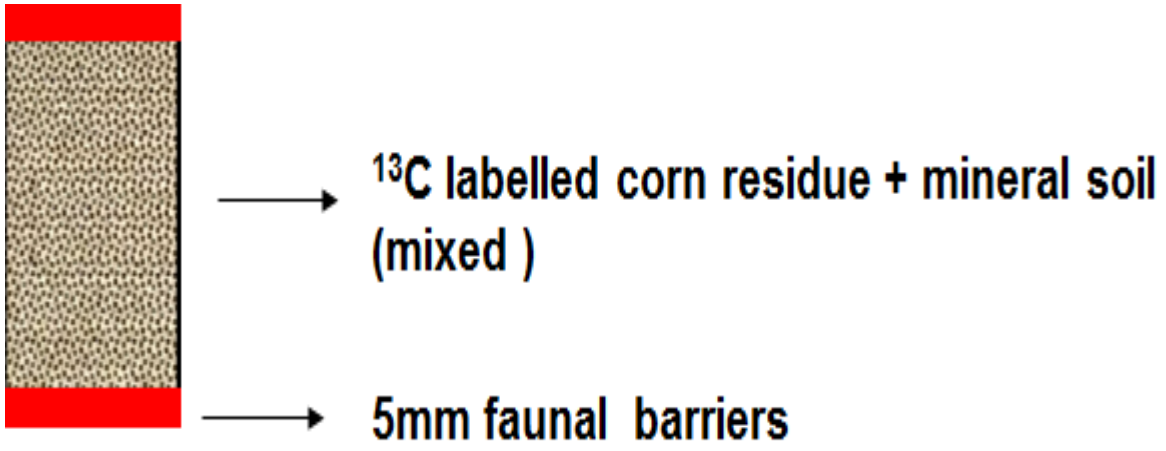
13C labelled corn
with 80-90cm height
and 13-15 g dry biomass
in the end of 6-8 weeks
growth period





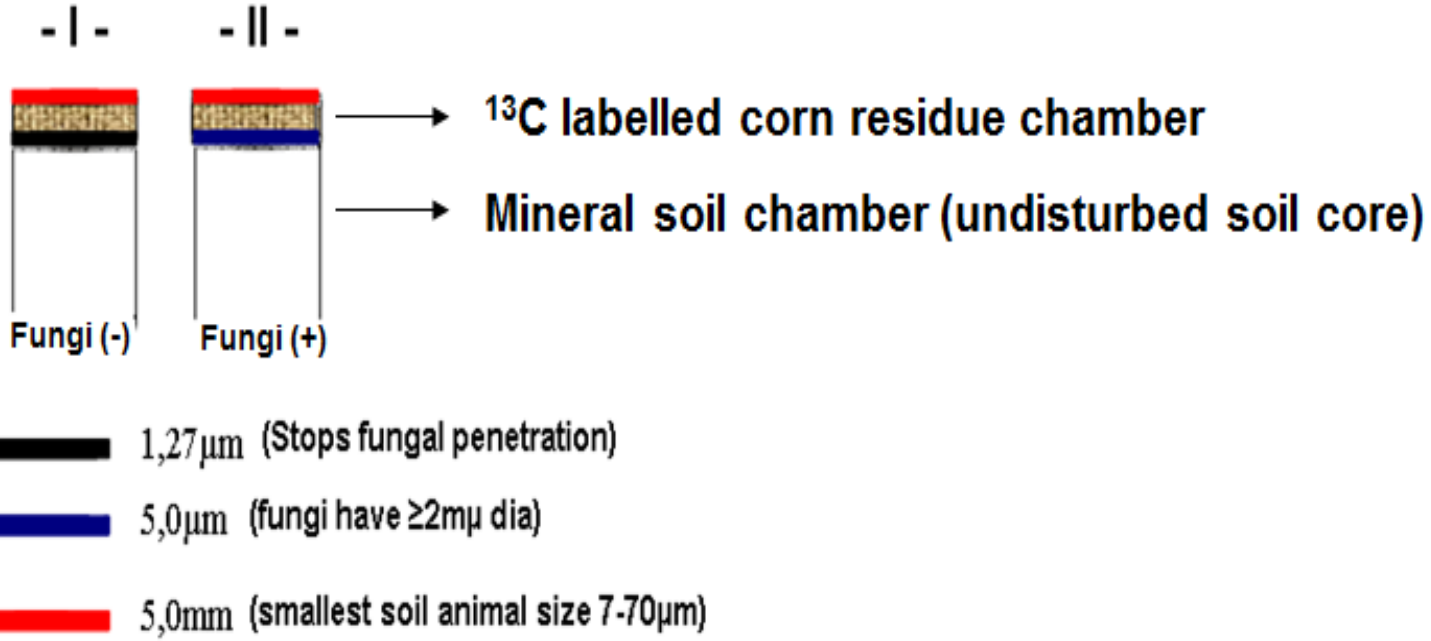
Mesocosm design in Plough Till (PT) plots

(3 inch PVC including mineral soil + ^{13}C labelled corn residue)

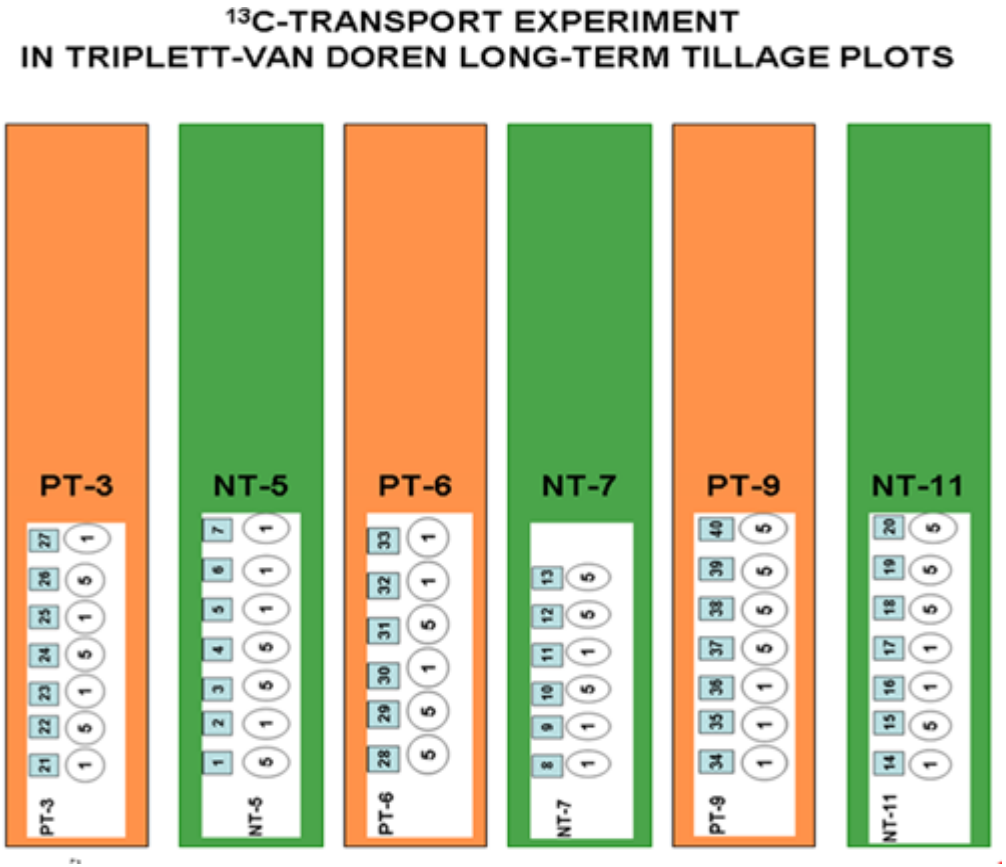


Mesocosm design in No Till (NT) plots

PVC coupling separeted with nylon meshes with different pore size



Field Layout



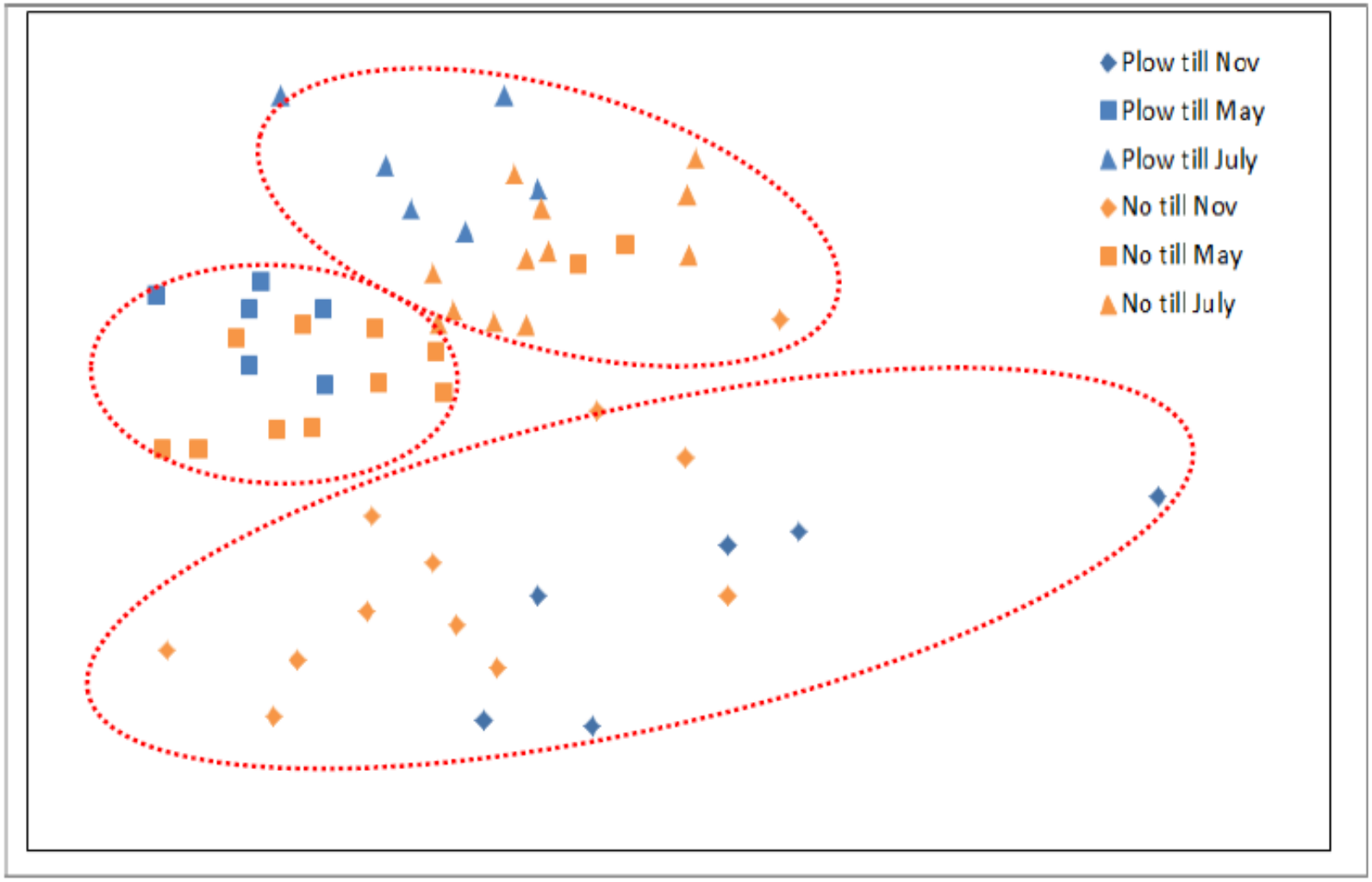
- soil sampling (November, May and July)
- splitting cores to 0-2.5 and 2.5-7.5cm layers
- ^{13}C-PLFA analysis
- SOM fractionation and measurement of ^{13}C enrichment in humic-fulvic acids and humin fractions

Marker fatty acids tracked by 13C applied and related microbial groups in the present study

Gram positive (6FAs)	**15:0 ANTEISO, 16:1 ISO G, 16:0 ISO, 16:0, 17:0 ISO and 17:0 ANTEISO**
Gram negative (4FAs)	**16:1 w7c, 17:0 CYCLO, 16:1 2OH and 18:1 w9t Alcohol**
Non-specific Bacteria (1 FA)	**18:0**
Saprotrophic Fungi (2FAs)	**18:1 w9c and 18:1 w9t**
Arbuscular mycorrhiza (1FA)	**16:1 w5c**

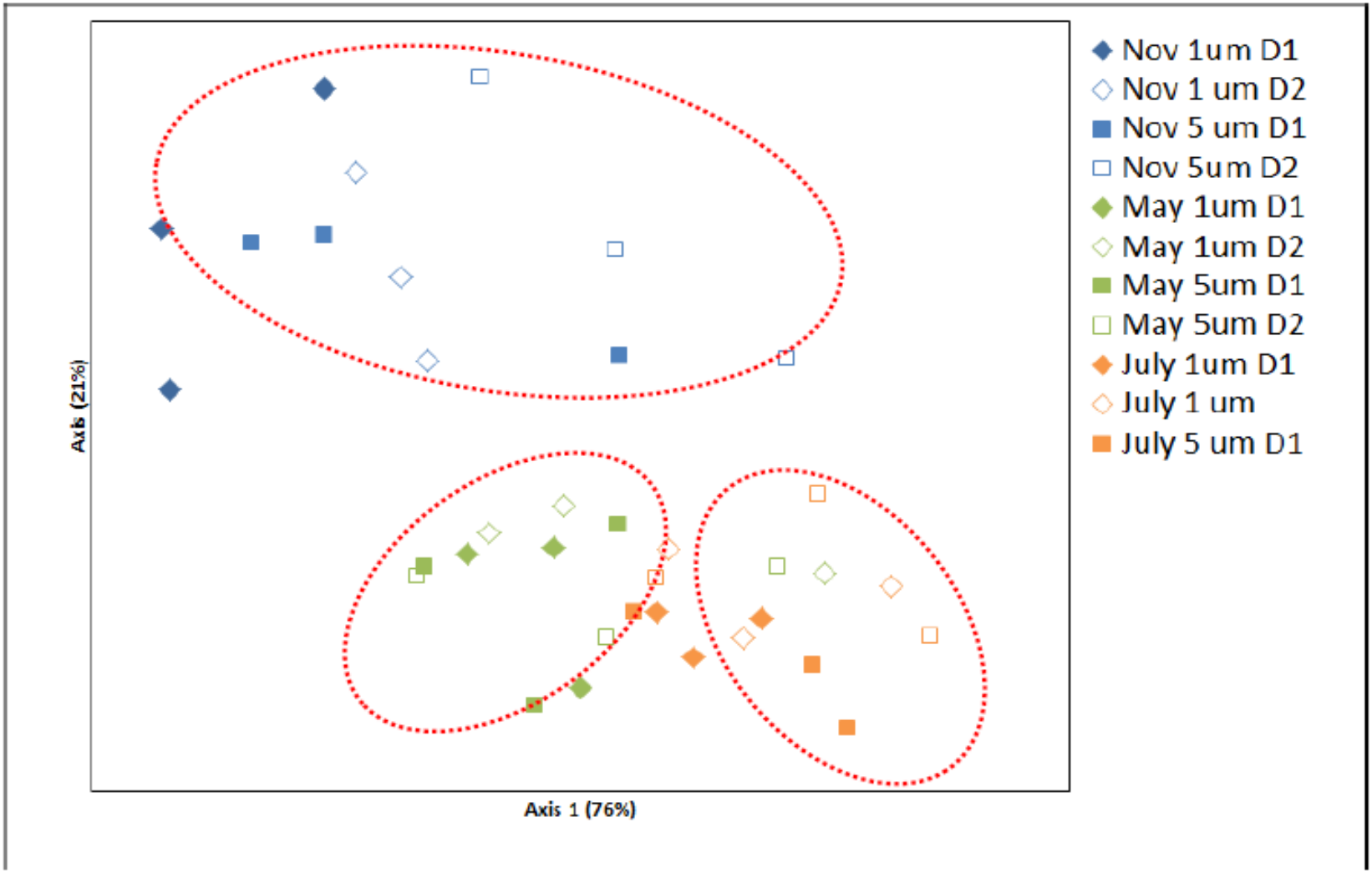
obial groups	Marker FAs	References
Gram+ bacteria	i15:0; a15:0; i16:0; i17:0; a17:0 (16:1ω9c, 16:1ω7c, 16:1ω5c, 18:1ω7 <20%*)	O'leary and Wilkinson, 1988*
Gram- bacteria	16:1ω7c; 18:1ω7c (>20%*)	Zelles, 1999
	17:0cy; 19:0cy; 16:1 OH	Guckert et al. 1985
Actinobacteria	16:0 10ME; 17:0 10ME; 18:0 10ME	Kroppenstedt, 1992
Methanogens	Type I: 16:1ω8 Type II: 18:1ω8	Bowman et al. 1993 Borjesson et al. 1998
Sulphate red. Bac.	17:0cy, 16:0 10ME	Zelles, 1999
Fungi	18:2ω6,9c; 18:1ω9c	Federle, 1986
AM fungi	16:1ω5	Olsson et al., 1999
Protozoa	20:4ω6,9,12,15c	Chen et al., 2001
matodes	20:4ω6,9,12,15c	Ruess, 2005

Results in general
(NMDS analysis by tillage)



Seasonality seems more effective on microbial carbon transfer and no statistically significant difference between different tillage methods

Results in general
(NMDS analysis only no tillage)



Microbial carbon transport was significantly affected from seasonality under different fungal barriers and soil depths ($p < 0.001$) but not from barriers itself


FULBRIGHT
My team...
THANK YOU

Thank you...

谢 谢...

धन्यवाद

Muchas Gracias...

Teşekkürler...

Early December
(icy)

Late December
(frozen)

Mid February
(oversaturated)