SOIL ORGANIC CARBON DYNAMICS IN PENDLETON TILLAGE FERTILITY LONG-TERM EXPERIMENT

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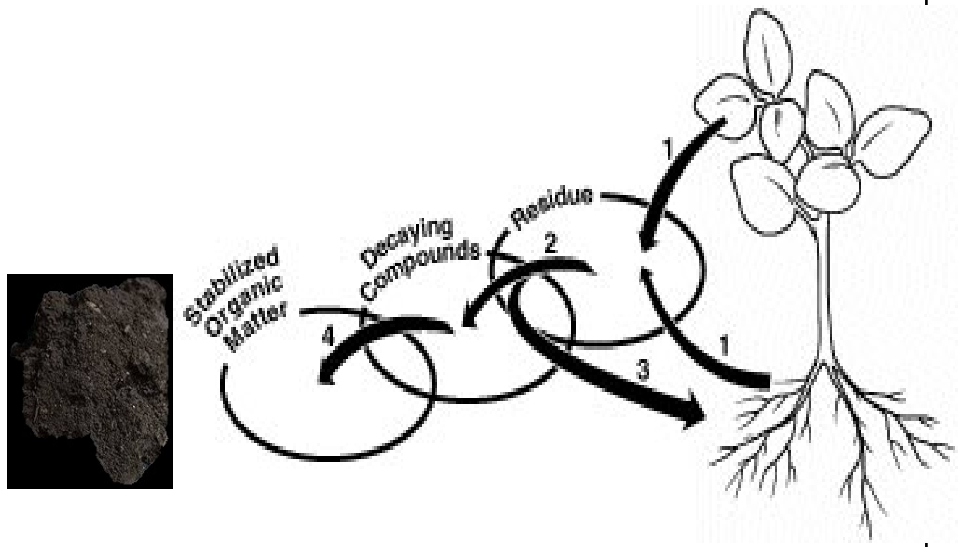
Pendleton long-term experiments

- Long-term experiments (LTEs) serve as a valuable resource for eastern Oregon producers to understand impact of agricultural management practices on soil quality and crop production.
- Studies at Pendleton long-term experiments revealed nearly 50% soil organic carbon (SOC) loss from 0-60 cm soil depth in winter wheat – summer fallow system.
- We aimed to understand how SOC dynamics changes with tillage and N management in tillage-fertility long term experiment.



*Soil organic carbon = Soil organic matter * 0.58*

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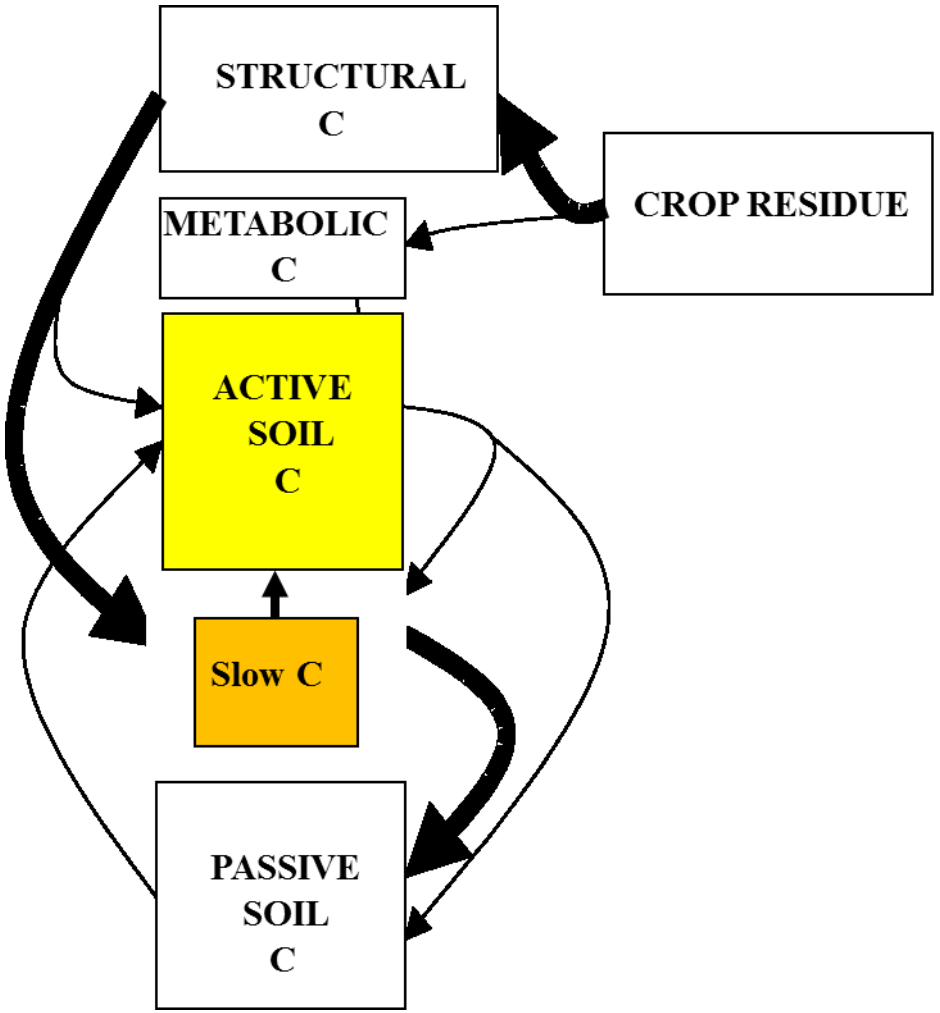
Labile carbon pools



Modified from Norton et al. (2004)

Active, or labile, SOM:

Annual turnover

Mineral C & N

Mineralizable C& N

dissolved organic C & N;

Microbial C & N;

light fraction C & N.

Slow, or protected, SOM:

Decades;

Same as labile, but protected from mineralization within soil structure.

Passive, or stable, SOM:

Centuries to millenia;

Humus;

Mineral-associated C & N.

Research objectives

- Evaluate the effects of tillage and fertilizer N management on soil organic carbon dynamics:
    - 24-hr soil respiration
    - Potentially mineralizable carbon
    - Microbial biomass carbon
    - Metabolic quotient (qCO_2)

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Tillage fertility long-term experiment

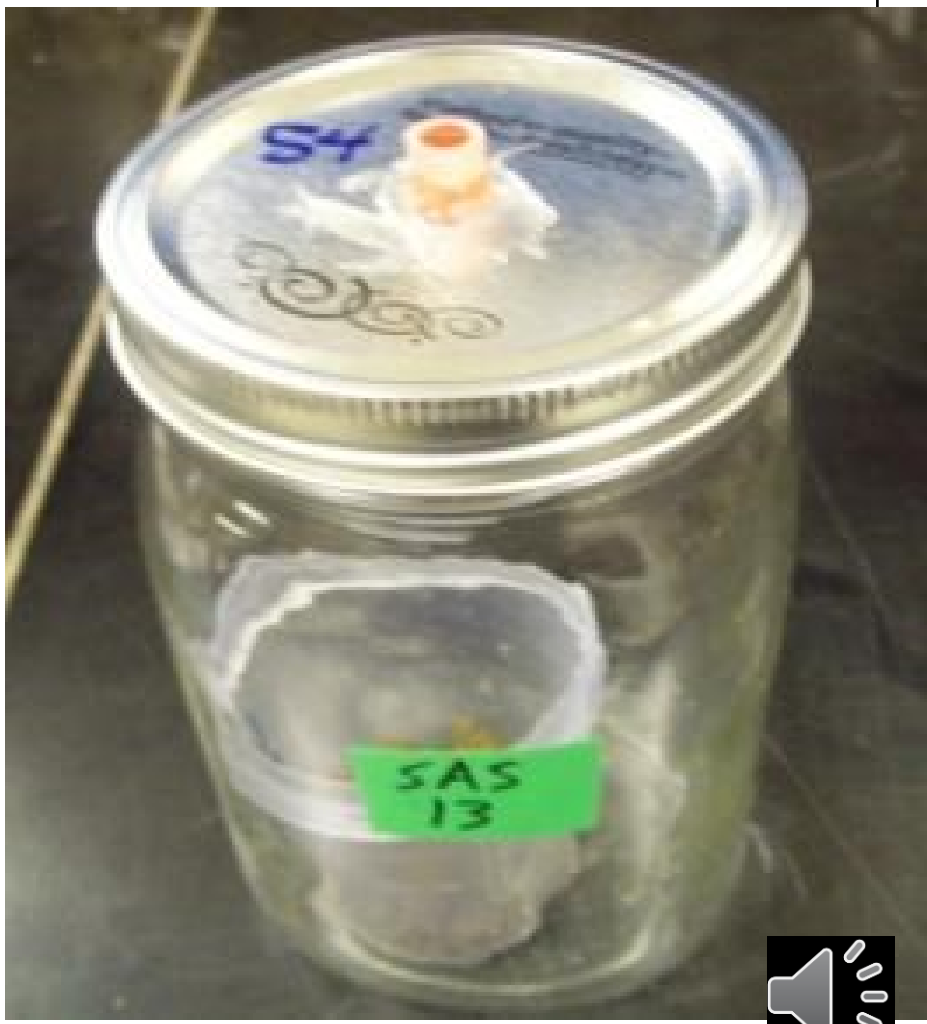
- Experiment was established in 1940.
- Evaluates winter wheat – summer fallow system under three tillage systems and five N rates.

Main plot treatment		**Tillage depth (cm)**
Tillage	**Equipment**	
MP	Moldboard plow	23
DP	Offset disc	10
SW	Subsurface sweep	15

Subplot treatment				
Nitrogen rate	**Nitrogen (kg ha^{-1})**			
	1941-1951	**1952-1961**	**1962-1987**	**1988-2010**
1	0	0	45	0
2	11	34	45	45
3	11	34	90	90
4	11	34	135	135
5	11	34	180	180

Soil sampling and analyses

- We collected soil samples in summer 2014 form plots that received 0 and 90 kg N ha^{-1} under each tillage system.
- Potentially mineralizable C was determined by aerobic incubation method (Zibilnske, 1994).
- Soil microbial biomass C was determined by fumigation incubation method (Horwath and Paul, 1994).
- Microbial metabolic quotient was determined as ratio of soil respiration during a week incubation to soil microbial biomass C (Nie et al., 2013)



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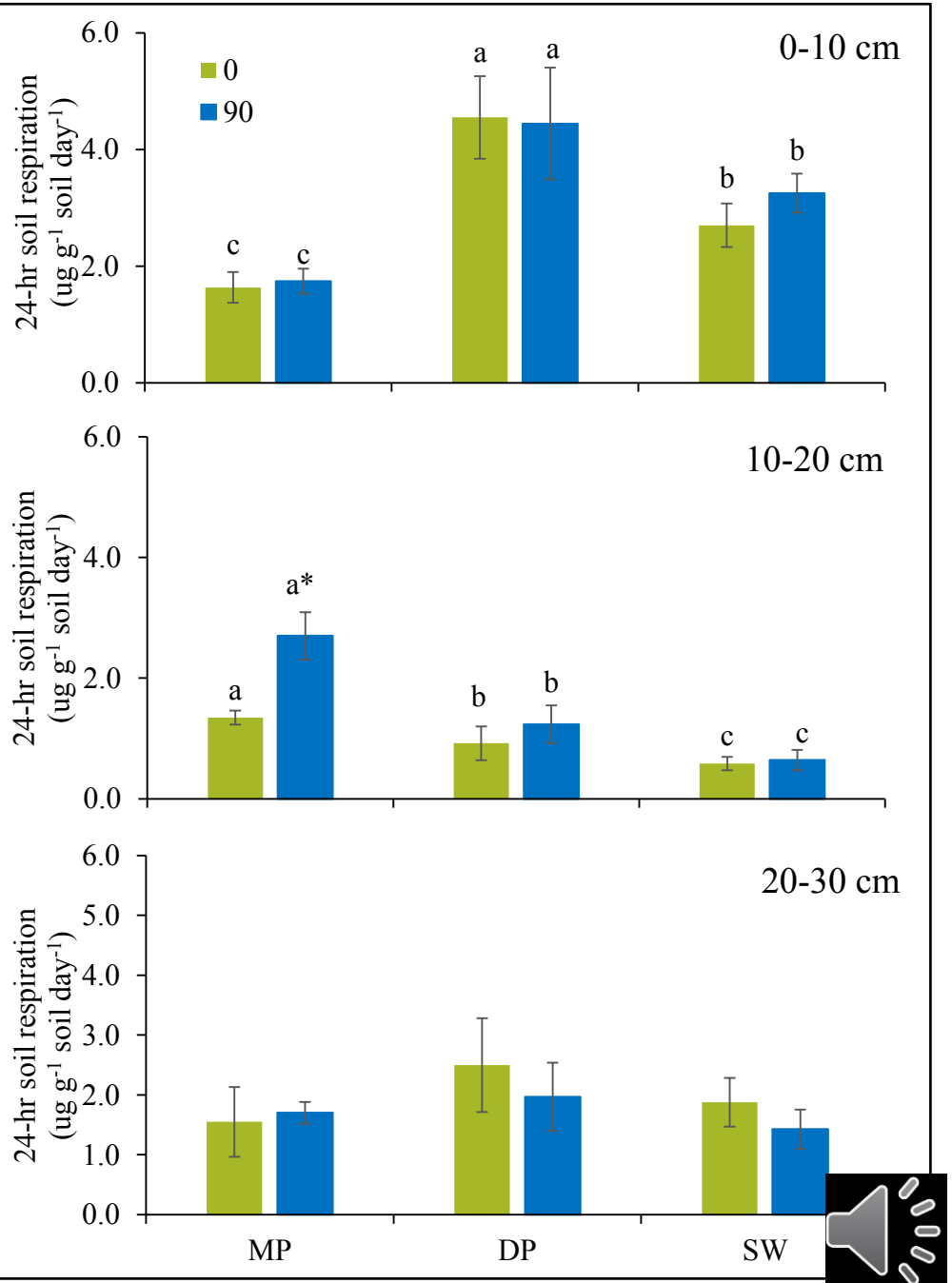
24-hr soil respiration

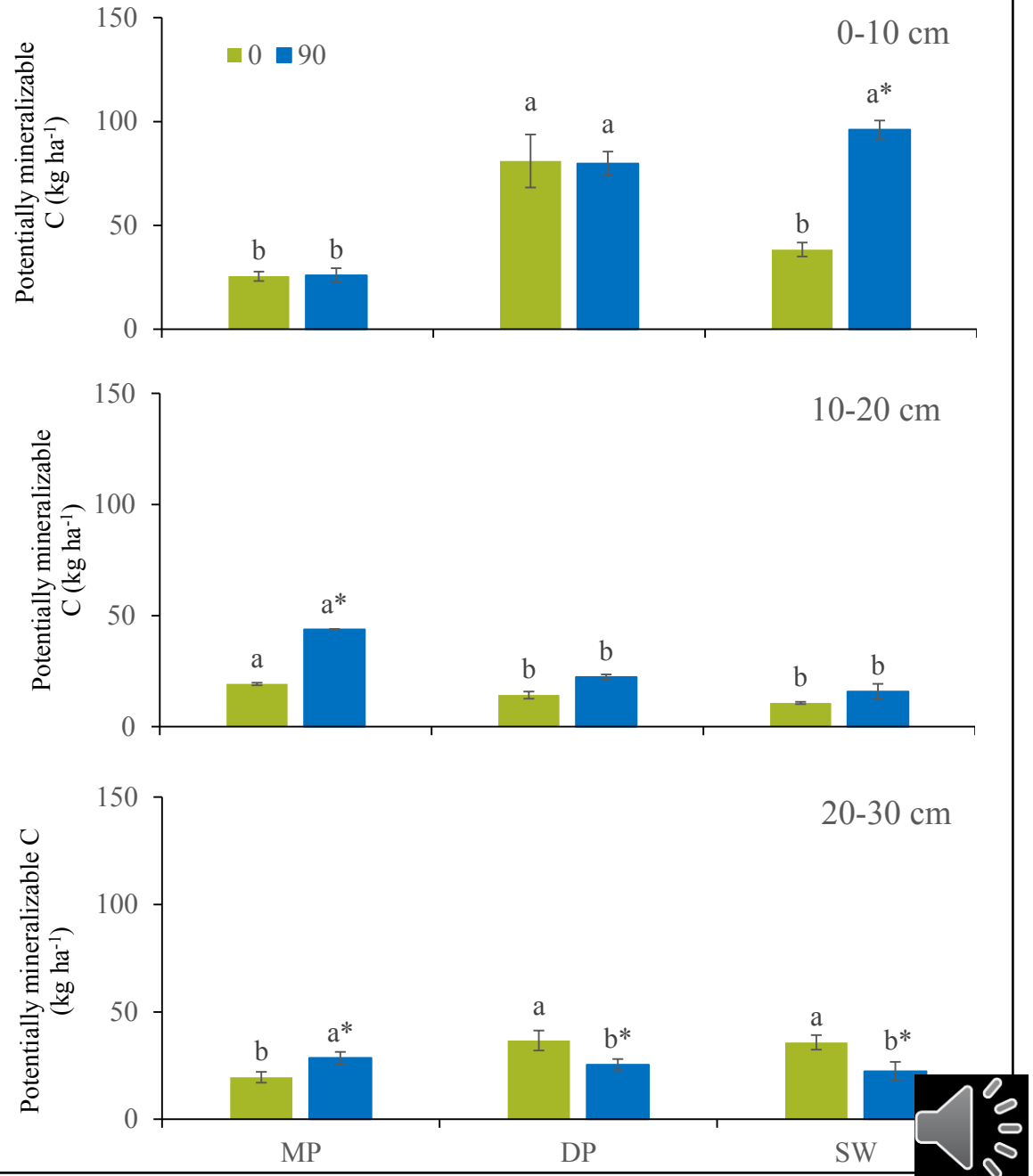
- 24-hr soil respiration was greater under disk tillage than under sweep and plow tillage in 0-10 cm depth.
- It was greater in soils under plow tillage in 10-20 cm depth.
- Effect of N application was observed only at 10-20 cm depth of plow tillage system.

Different lowercase letters indicate tillage effects within N rate and '' indicate N rate effects within a tillage system.*



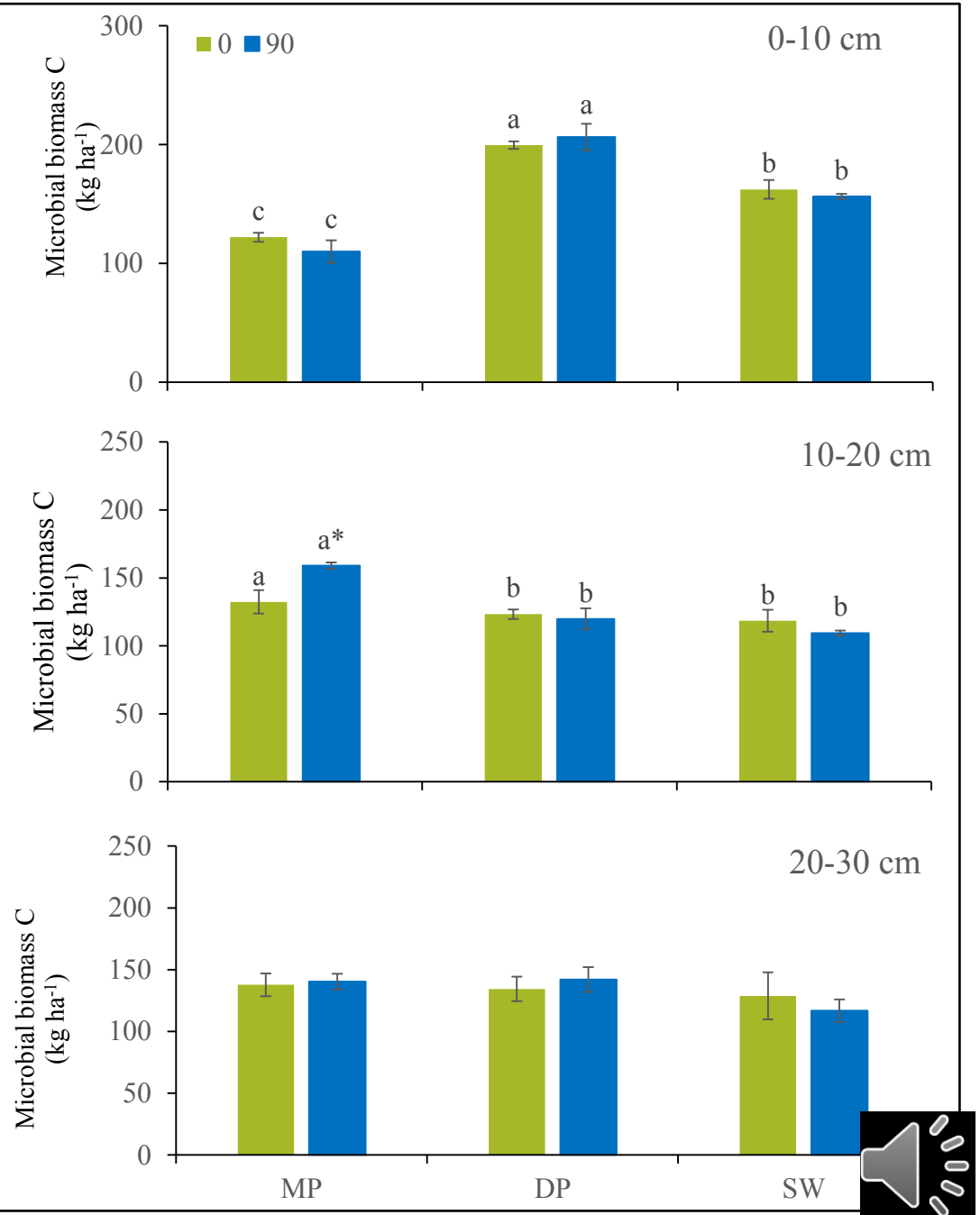
Potentially mineralizable carbon

- Soils under disk tillage had greater PMC content than other systems in 0-10 cm depth.
  - Response of N rate was observed only in Sweep system.
- Soils under Plow tillage had greater PMC content than other systems in 10-20 cm.
  - Response of N was observed in Plow and Disk tillage systems.
- Soil PMC in 20-30 cm depth profile was influenced by both tillage and N application.



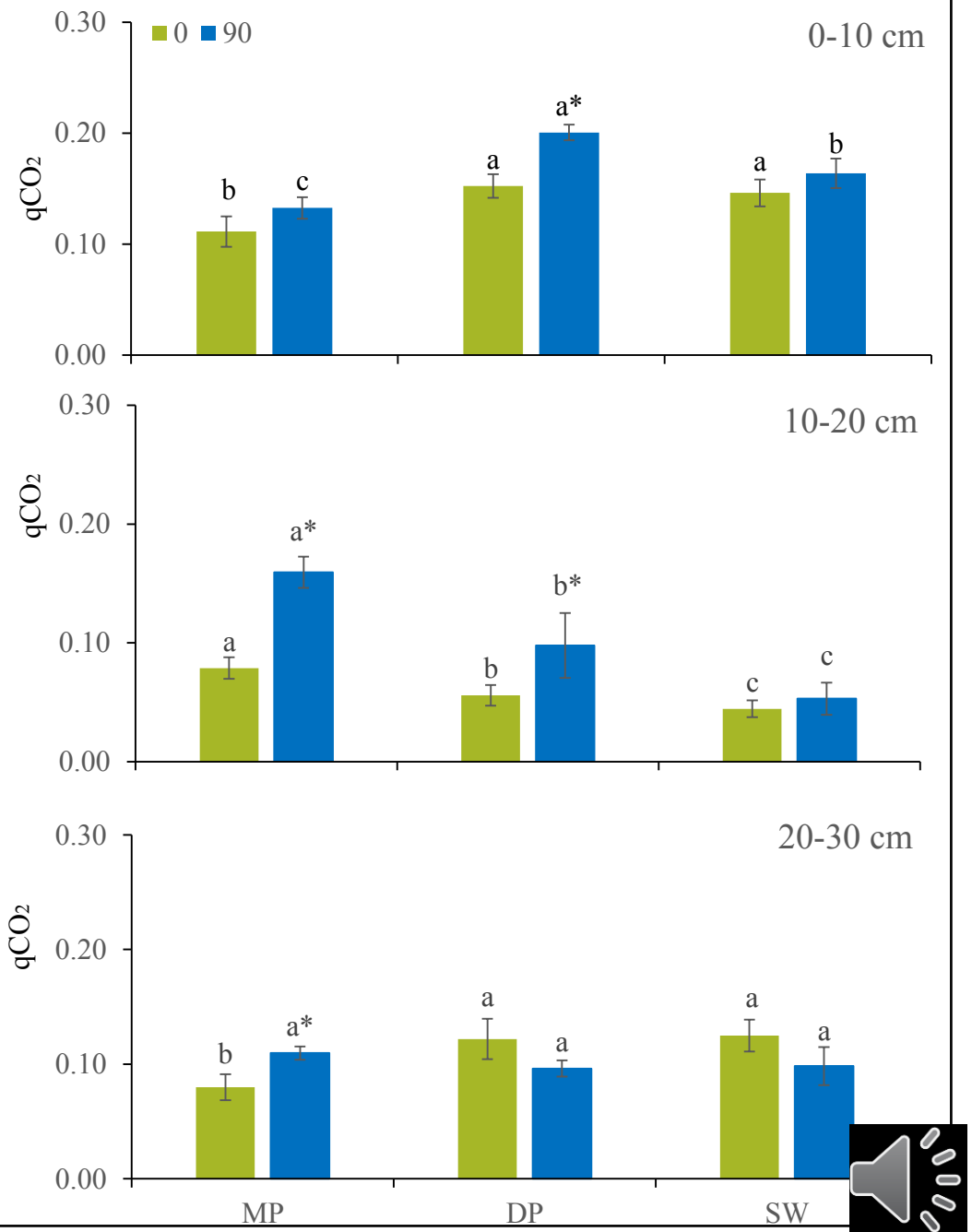
Soil microbial biomass

- Microbial biomass C content was greater under Disk than under sweep and moldboard plow tillage in 0-10 cm depth.
- Plow tillage system had the largest microbial biomass in 10-20 cm depth.
- No effects of tillage and N management in 20-30 cm depth.



Soil metabolic quotient

- Soil respiration per unit microbial biomass
- qCO_2 was influenced by N rate as well as tillage systems in all soil depths.
- qCO_2 was greater under disk tillage than other tillage systems in 0-10 cm.
- In no N addition treatments, disc and Sweep system had greater qCO_2 than under moldboard plow system in 0-10 as well as 20-30 cm depth.

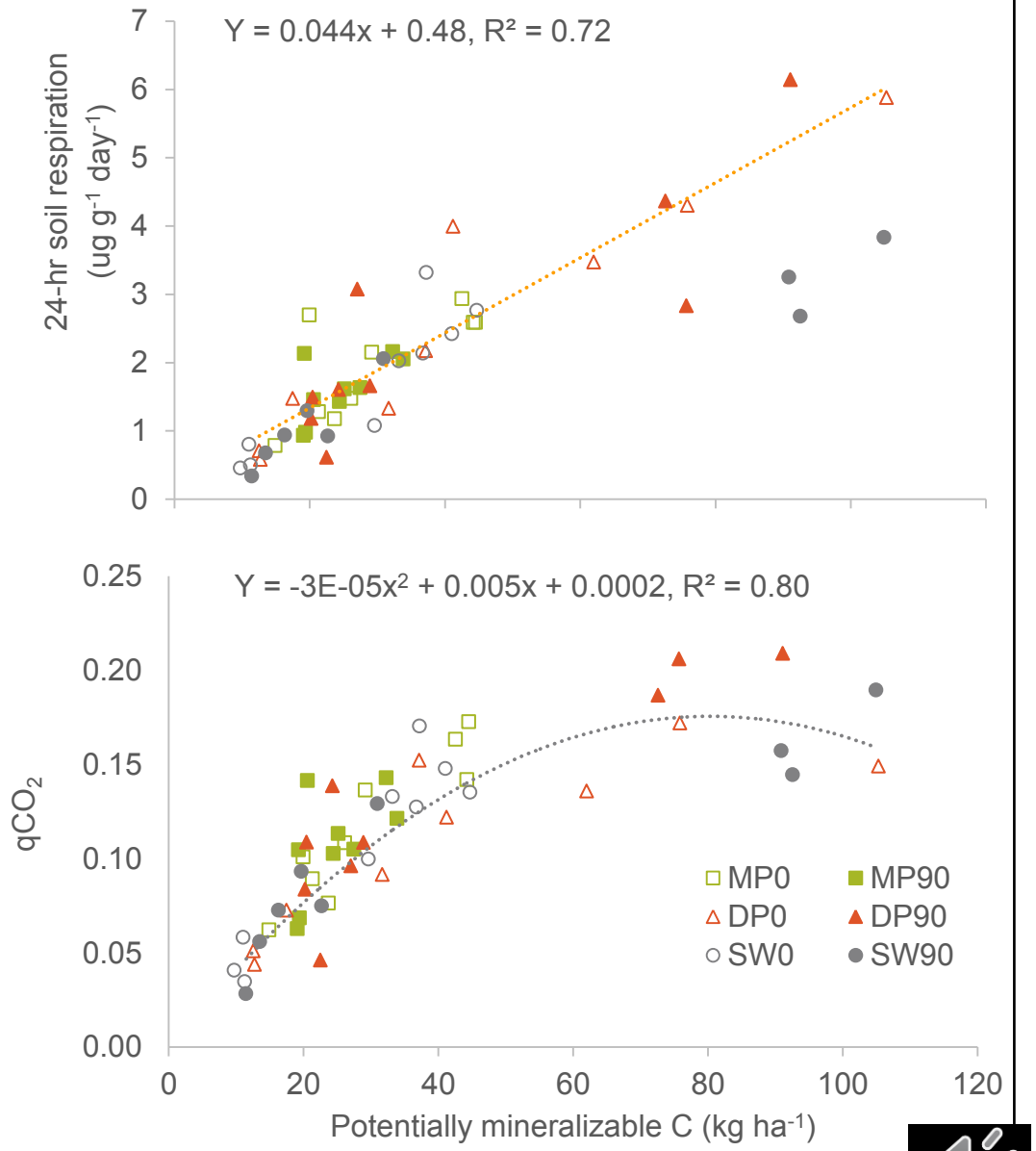


Soil microbial activity

Indicators of soil microbial activity:

A) First 24-hr soil respiration

B) Soil metabolic quotient
increased with increase in the amount of PMC.



Conclusions

- Reduced-tillage approaches such as disk and sweep system can increase soil organic carbon accrual at surface soil through their effects on soil mineralzialbe C and soil microbial biomass.

- Nitrogen addition compliments to the effect of tillage to increase soil organic carbon.

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Thank you

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