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LIÈGE université

High-C/N straw inputs lead to higher mineral associated organic matter than low-C/N straws

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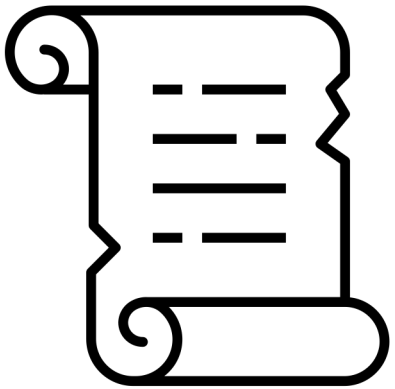
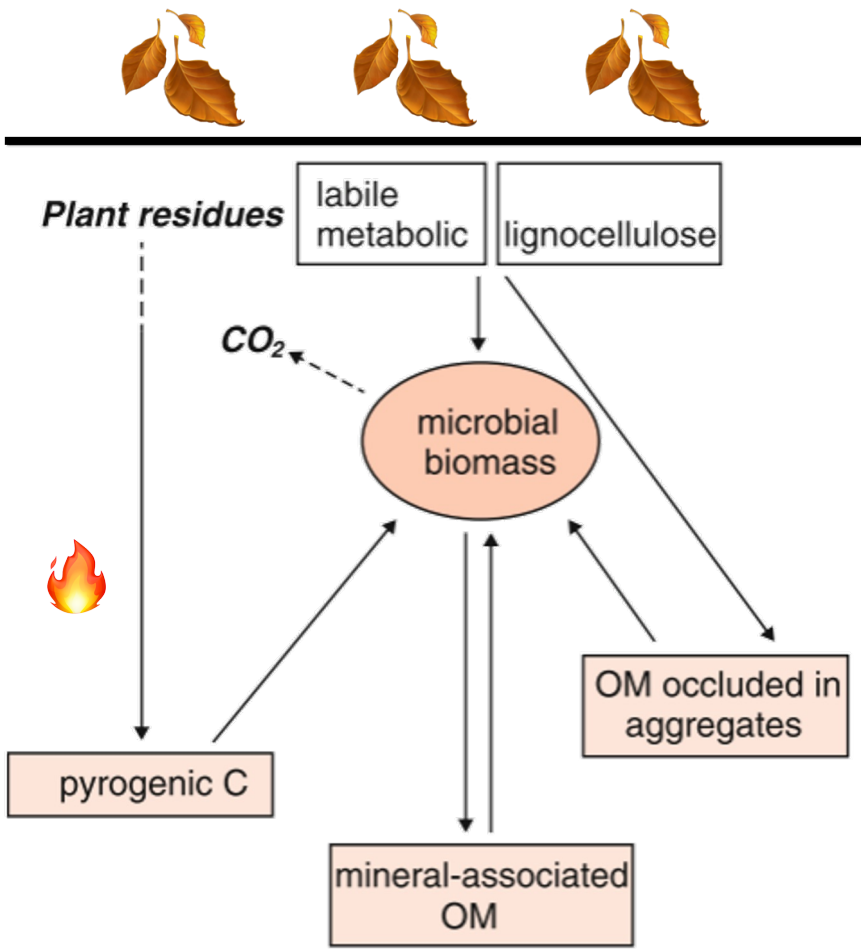
Outline

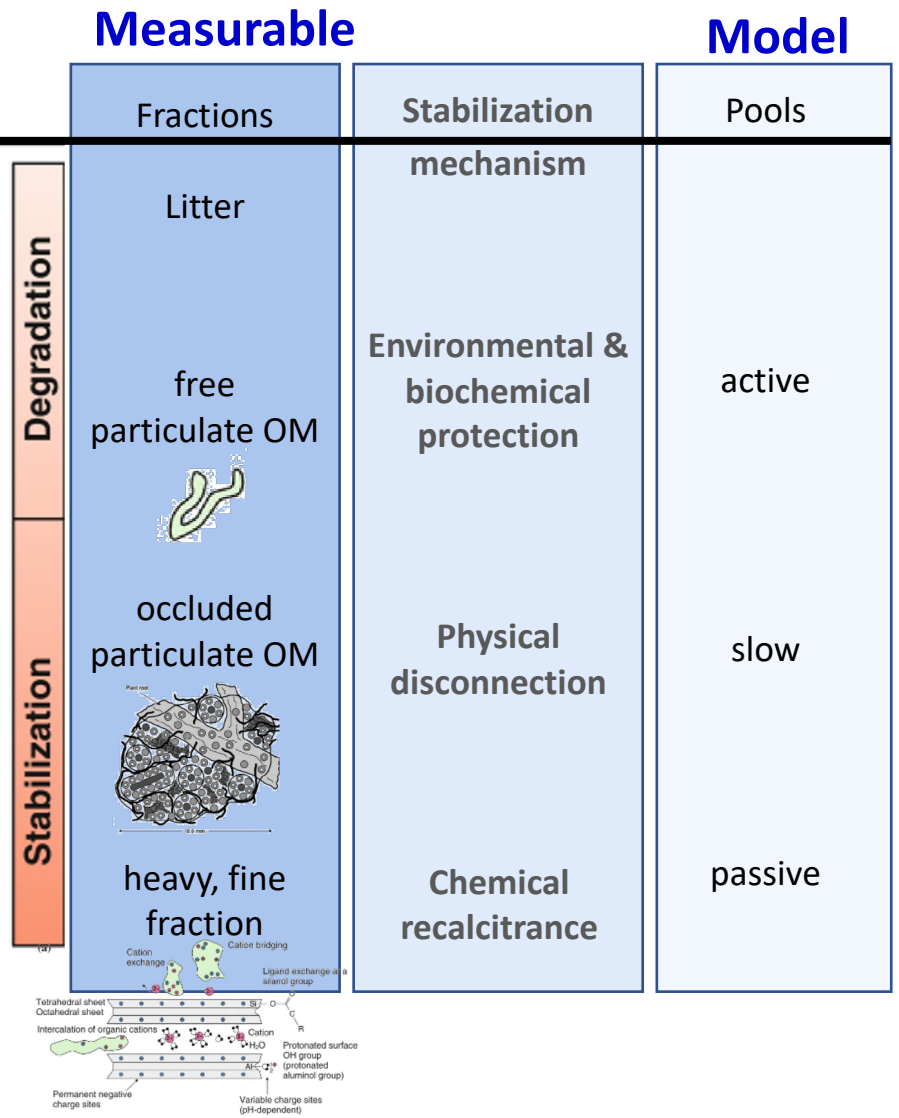


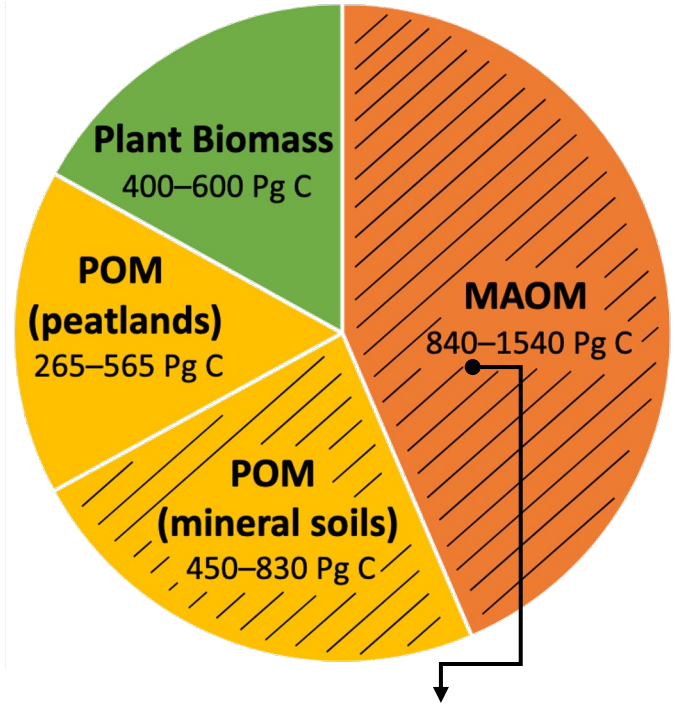
1. Background
2. Material and method
3. Result and discussion
4. Conclusion

Dominance of MAOM in Soil Organic Carbon



(Blume et al., 2016)





- 34-51%
- Slow turnover rates
- Stable OM

(Sokol et al., 2021)

Litter quality

The quality of plant litter is a critical determinant in the stabilization of organic matter through mineral interactions

C: N
Lignin: N

Low

(dp.pconline.com.cn)

High

(xczx.voc.com.cn)

High-quality litter

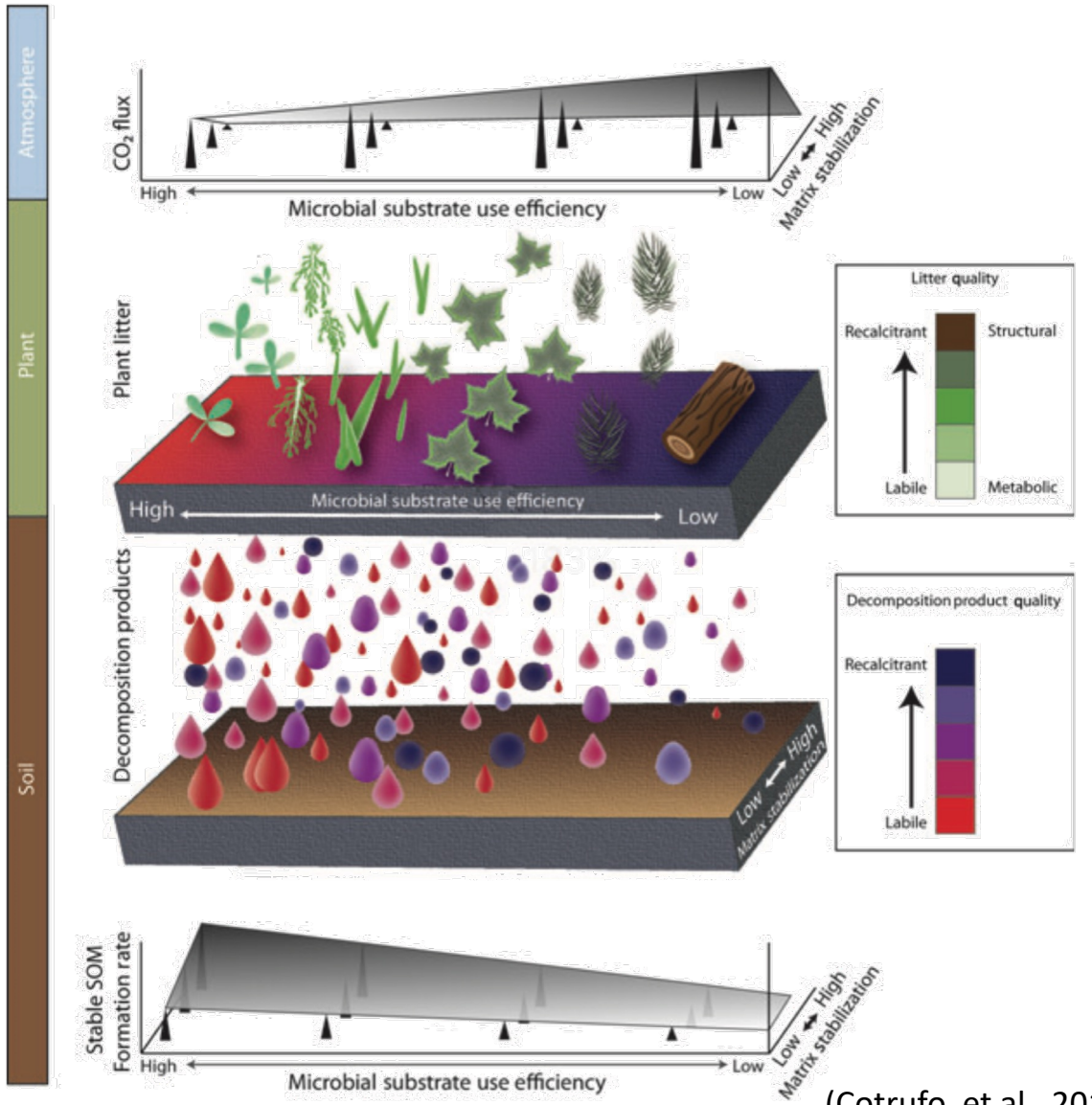
- lower recalcitrant substances
- more easily decomposed and utilized by microbial
- promote microbial growth and reproduction
- stimulating the microbial production of extracellular enzymes

Low-quality litter

- higher recalcitrant substances
- more difficulty decomposed and utilized by microbial

How litter quality affects CO_2 respiration and stable SOM formation

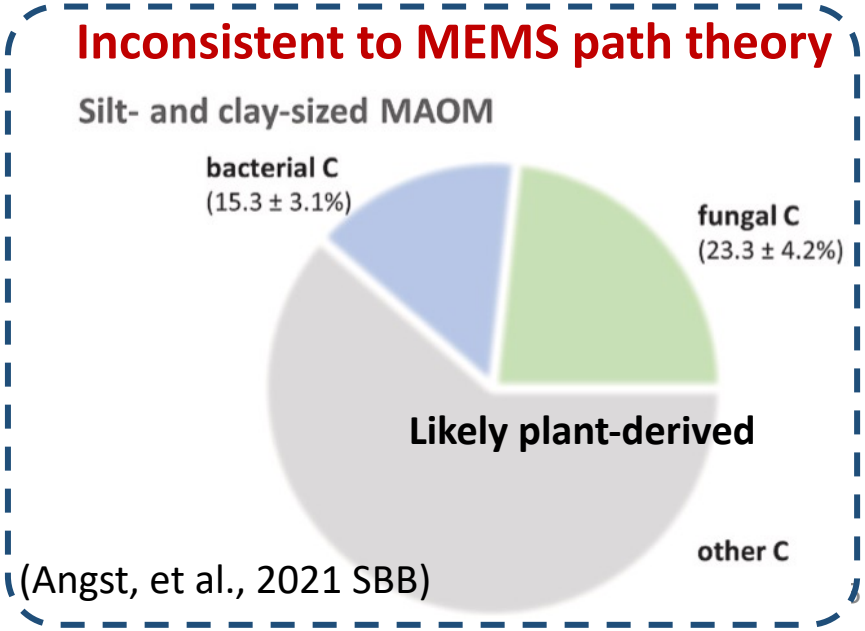
Microbial efficiency-Matrix stabilization (MEMS)



(Cotrufo, et al., 2013 GCB)

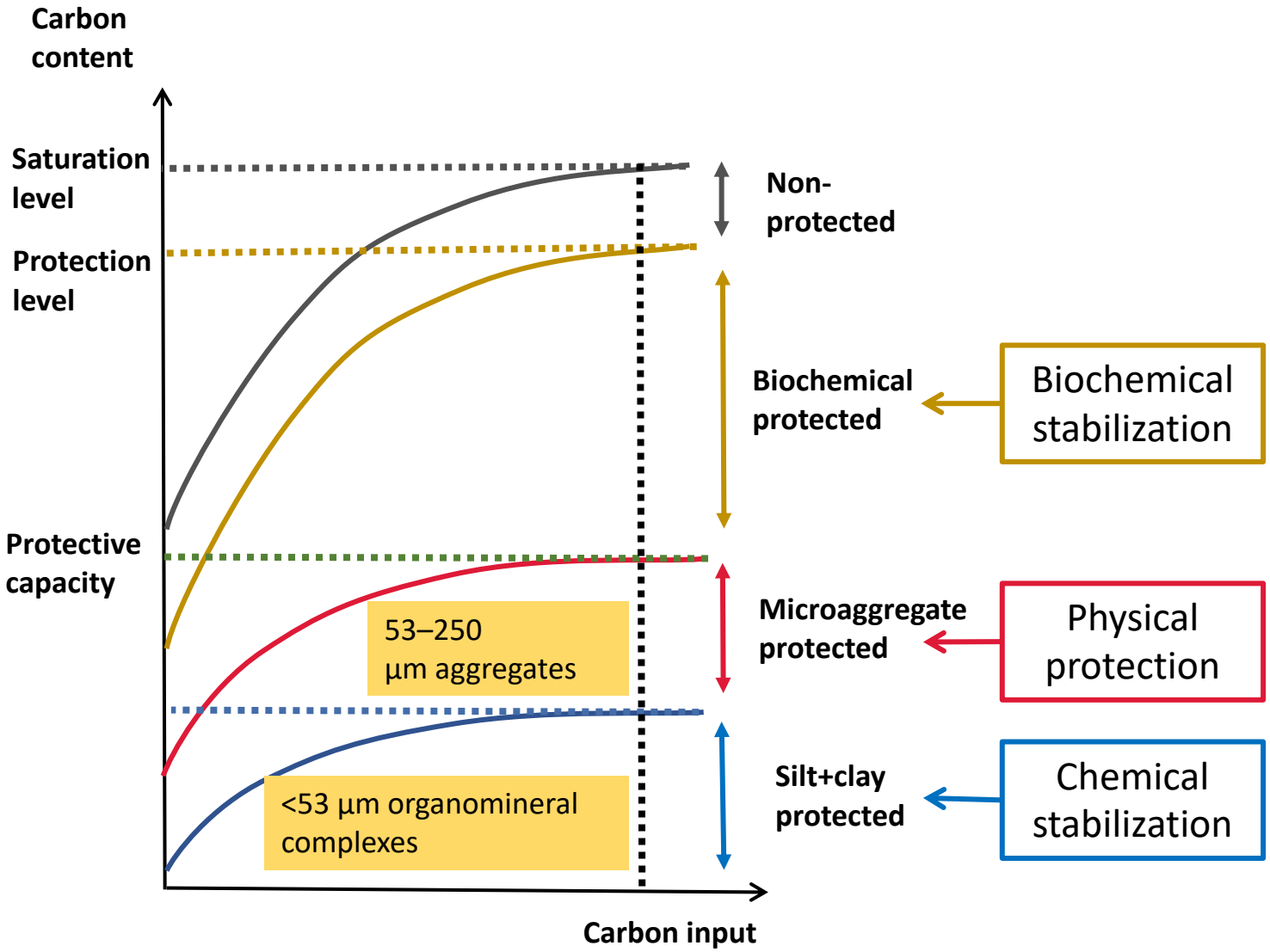
	Low quality	High quality
CUE	low	high
CO_2 respiration	more	less
DOM	low	high
Stable SOM	less	more

Inconsistent to MEMS path theory



(Angst, et al., 2021 SBB)

Soil C saturation



Biochemical stabilization

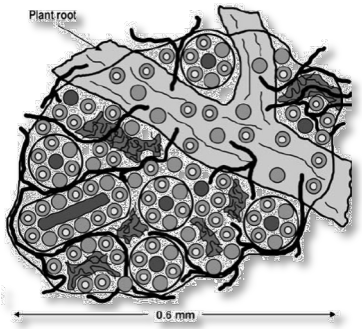
Physical protection

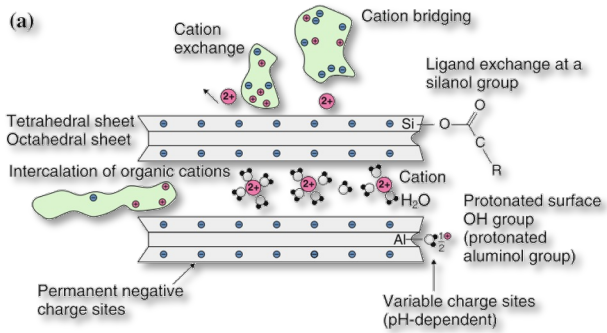
Chemical stabilization

pore space
Aggregates

surface area
Minerals

Occluded aggregate



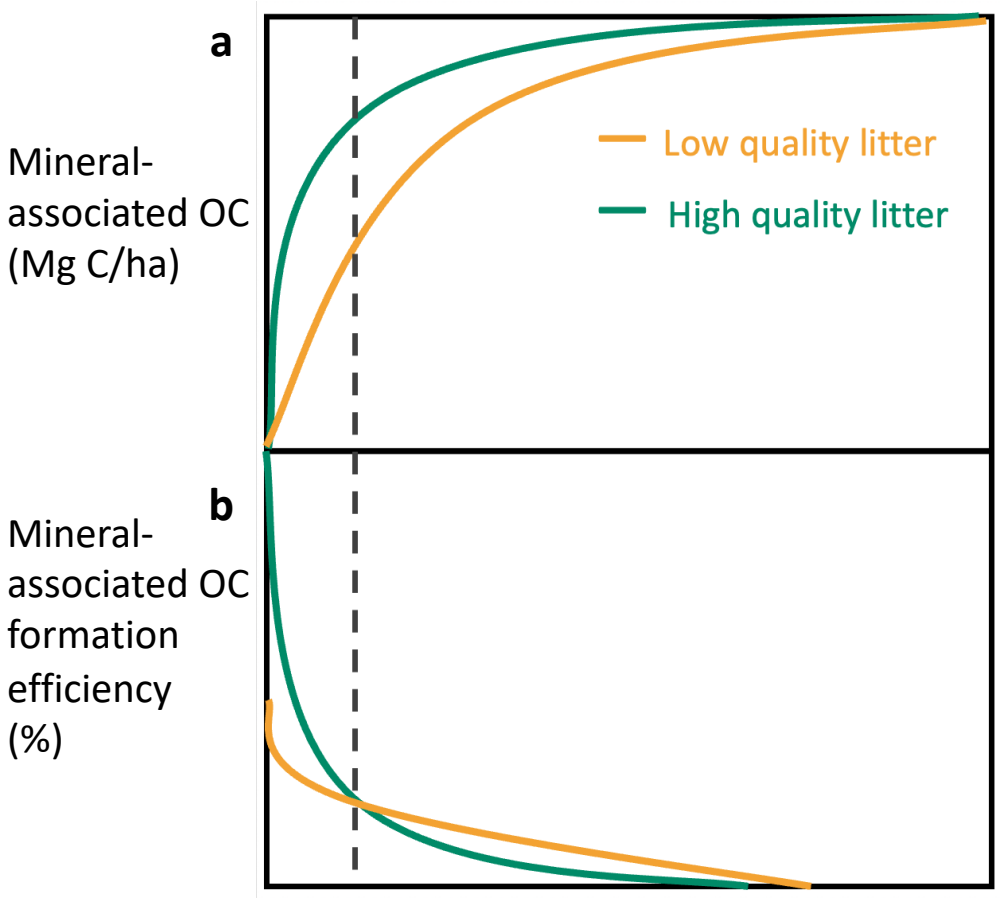


Mineral adsorption

(Six et al., 2002)

Litter quality and C saturation

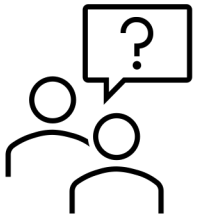
- MAOC pool was greater when high-quality litter was added relative to low-quality litter.
- The MAOC formation efficiency with different quality litter changed as the C input rate increased.



(Castellano et al., 2015)

However, the specific effects of litter quality on MAOM formation at varying C input levels are not fully understood and have yet not to be thoroughly tested.

Scientific question and hypotheses



Question 1: Which type of straw, low or high quality, prompts MAOM formation or reduces decomposition?

Hypothesis 1: According to the MEMS theory, adding high-quality straw will result in more MAOM formation and less CO_2 respiration than adding low-quality straw

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Question 2: How does the MAOM formation vary with the C input level when adding high-quality straw versus low-quality straw?

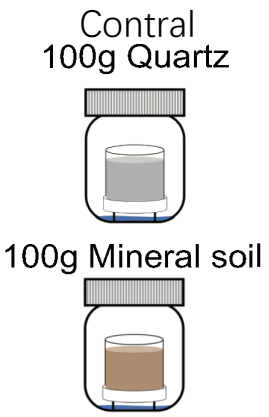
Hypothesis 2: MAOM stabilization efficiency will decrease as C input levels approach saturation, with the decline being more pronounced for high-quality litter compared to low-quality litter.

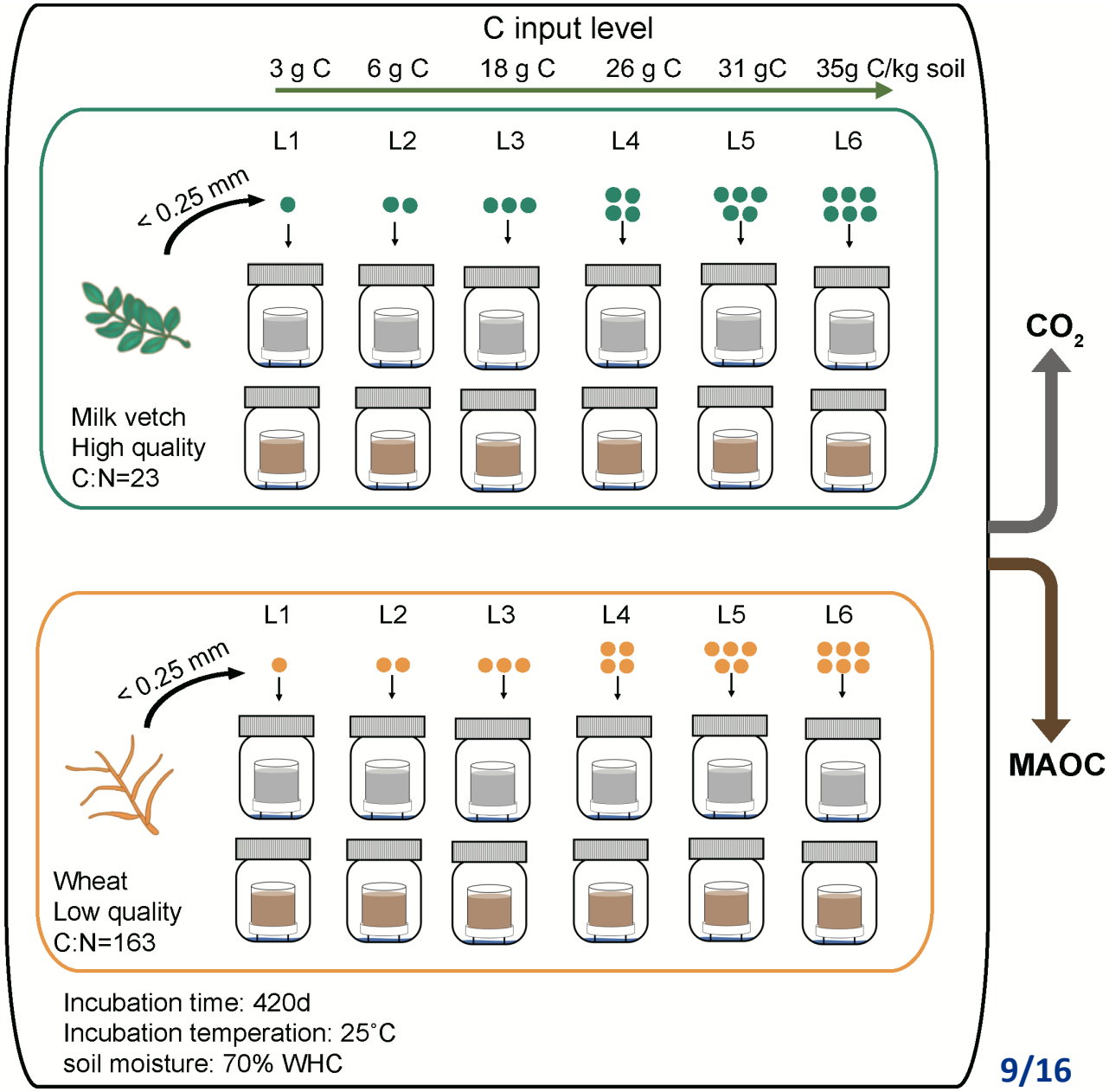
Experiment design

Mineral soil 100g	Clay (5%) (<2 um)	Illite (<2 um)	5g
	Silt (10%) (2-53 um)	Illite (2-53 um)	3g
		Montmorillonite (2-53 um)	3g
		Goethite (2-53 um)	1g
		Quartz (2-53 um)	3g
	Sand (85%) (53-250 um)	Quartz (53-100 um)	42.5g
		Quartz (100-250 um)	42.5g

Gas sampling (17 times) :
1, 3, 5, 7, 12, 20, 30, 60, 90, 120, 150, 180, 240, 300, 420d

Soil sampling (7 times) :
1, 7, 30, 90, 180, 300, 420d

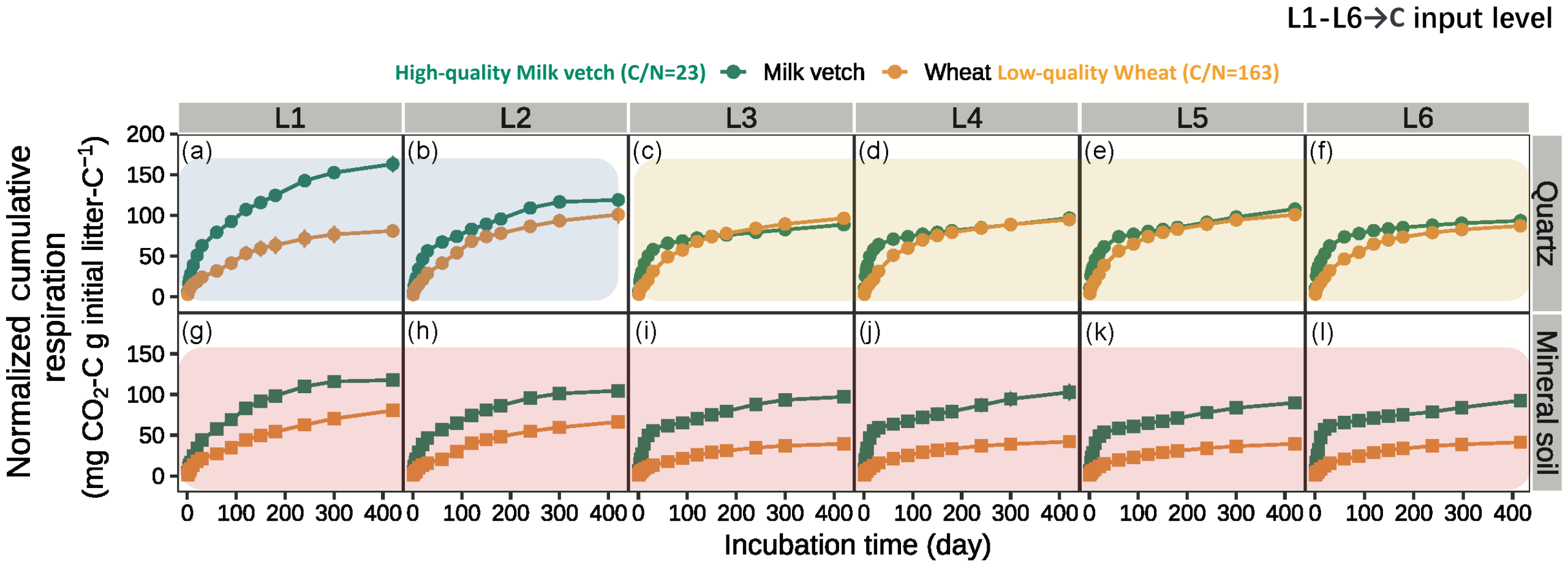




Indicator Measurement

Ecological	Indicator	Definition	Calculation Formula
MAOM formation	Mineral-associated organic matter (MAOM)	The content of the most stable carbon	——
	MAOM stabilization efficiency (SE)	The efficiency of litter conversion into MAOM	$SE_{MAOM} = \frac{MAOM - C}{C\ input}$
CO_2 respiration	Respiration rate	Mineralization rate	$F = \rho_{CO2} \times \frac{V}{M} \times \frac{dc}{dt} \times \frac{273}{T}$
	Decay rate	decomposition rate of organic matter in soil	One-pool soil C pool $R_{cum} = C_0(1 - e^{-kt})$
DOM quality	C/N ratio of DOM	Higher value, more plant-derived DOM	$C/N_{DOM} = \frac{DOC}{DTN}$
	Fluorescence index (FI)	The origin of DOC, higher values, greater microbial contribution	$FI = \frac{Em_{470}}{Em_{520}}$
	$SUVA_{254}$	Positively correlated with DOC aromaticity	$SUVA_{254} = \frac{UV_{254}}{DOC}$

CO_2 respiration during the incubation after litter addition



Quartz: L1 and L2: Milk vetch >wheat; L3-L6: Milk vetch =wheat

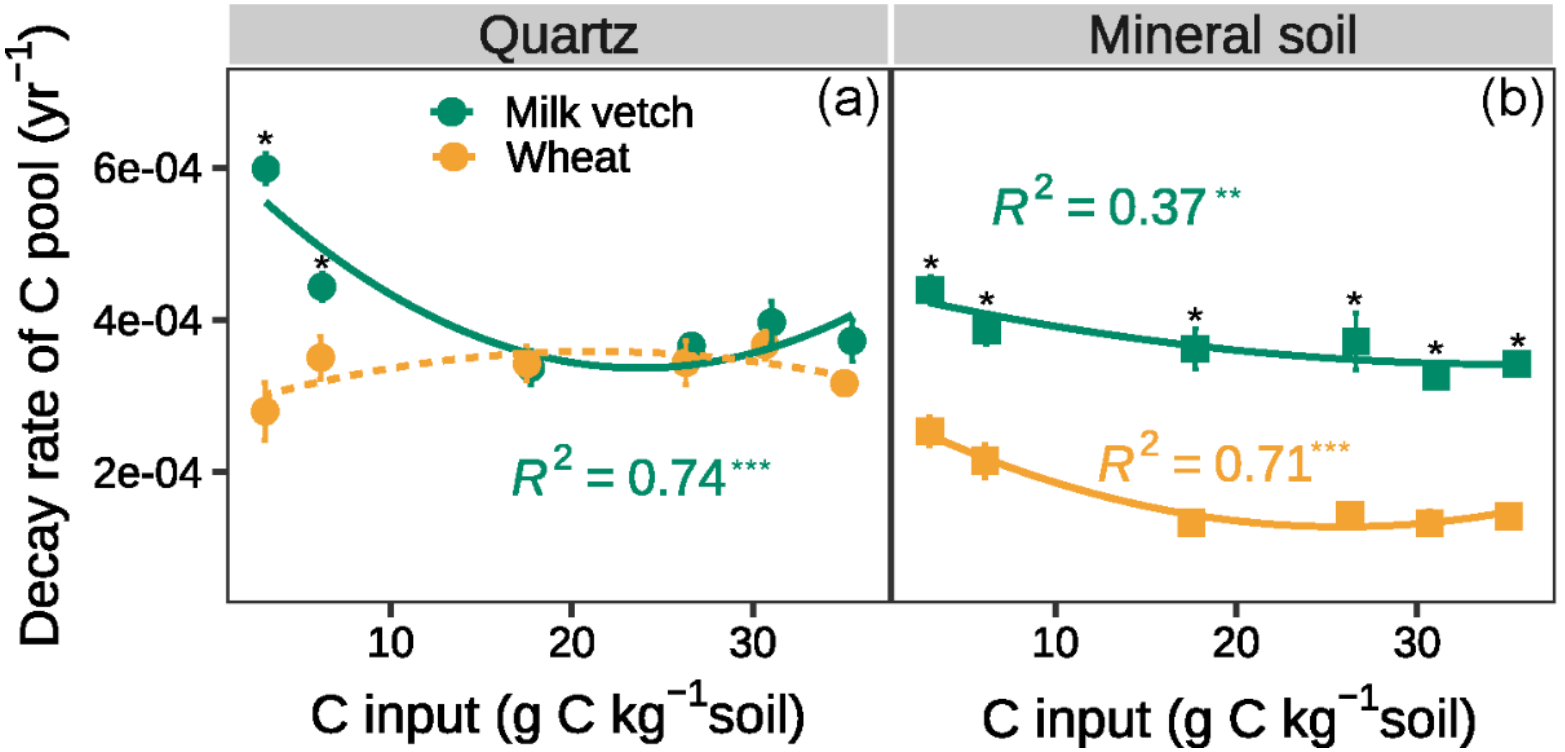
Mineral soil: L1-L6:Milk vetch > Wheat

OM decomposition is better protected by minerals in wheat straw treatments, except at the lowest input level

Decay rate——one-pool soil C model

$$R_{cum} = C_0(1 - e^{-kt})$$

High-quality Milk vetch (C/N=23) Low-quality Wheat (C/N=163)



Low-quality straw has a lower decay rate.

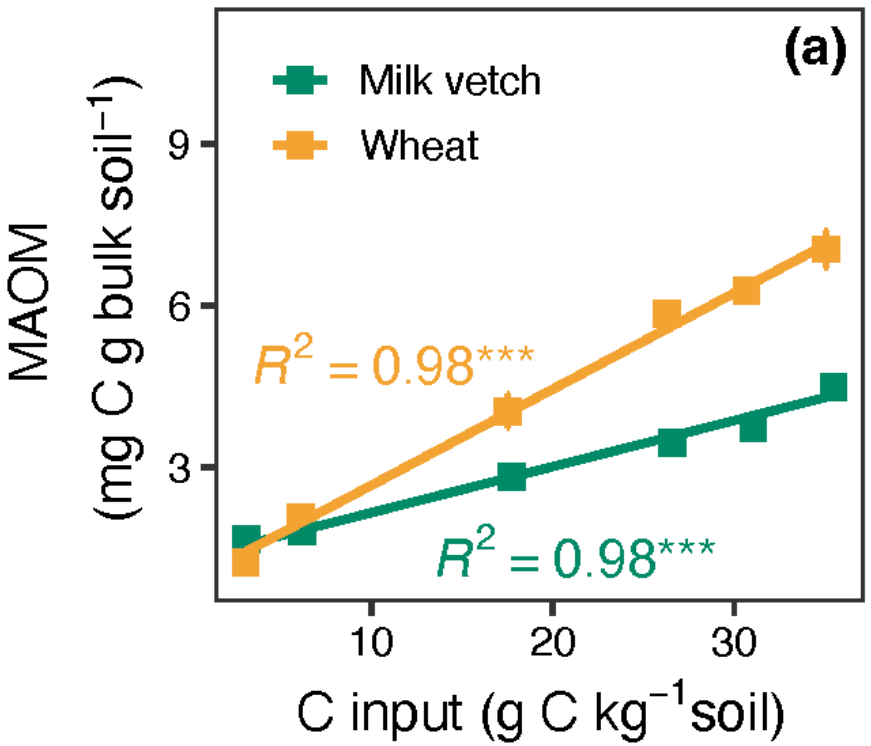
Straw quality influences decay rates, but the effects vary with the quantity of straw added.

Quartz and Mineral soil: decay rate decreased with C input level

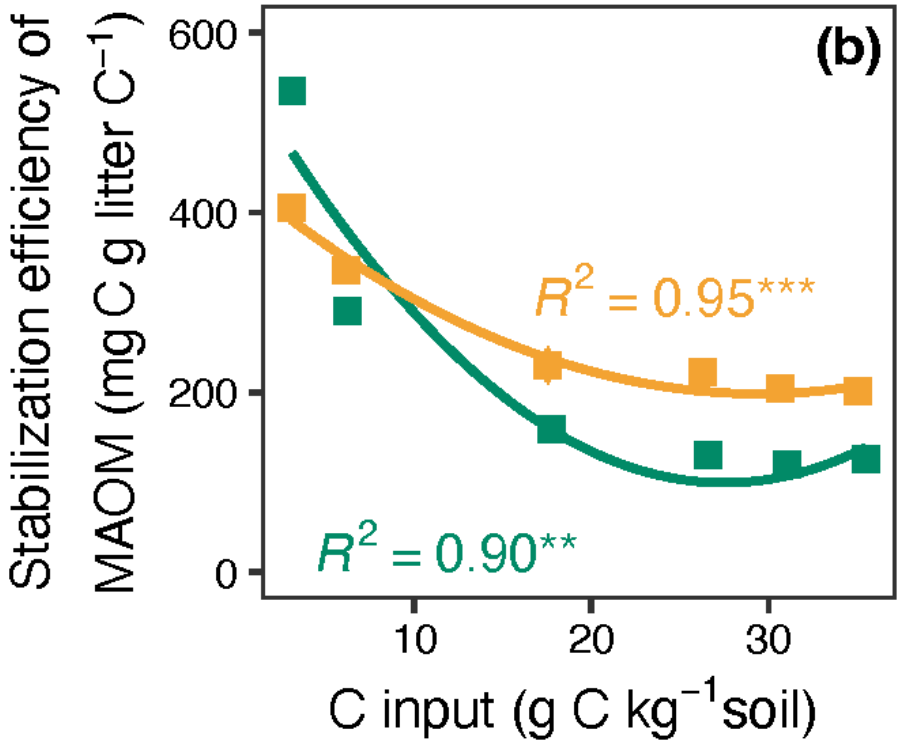
Mineral soil: Milk vetch > Wheat

MAOM and stabilization efficiency of MOAM on 420d

High-quality Milk vetch (C/N=23)



Low-quality Wheat (C/N=163)



$$SE_{MAOM} = \frac{MAOM - C}{C\ input}$$

MAOM content: increased with C input levels for both straw addition; wheat > milk vetch

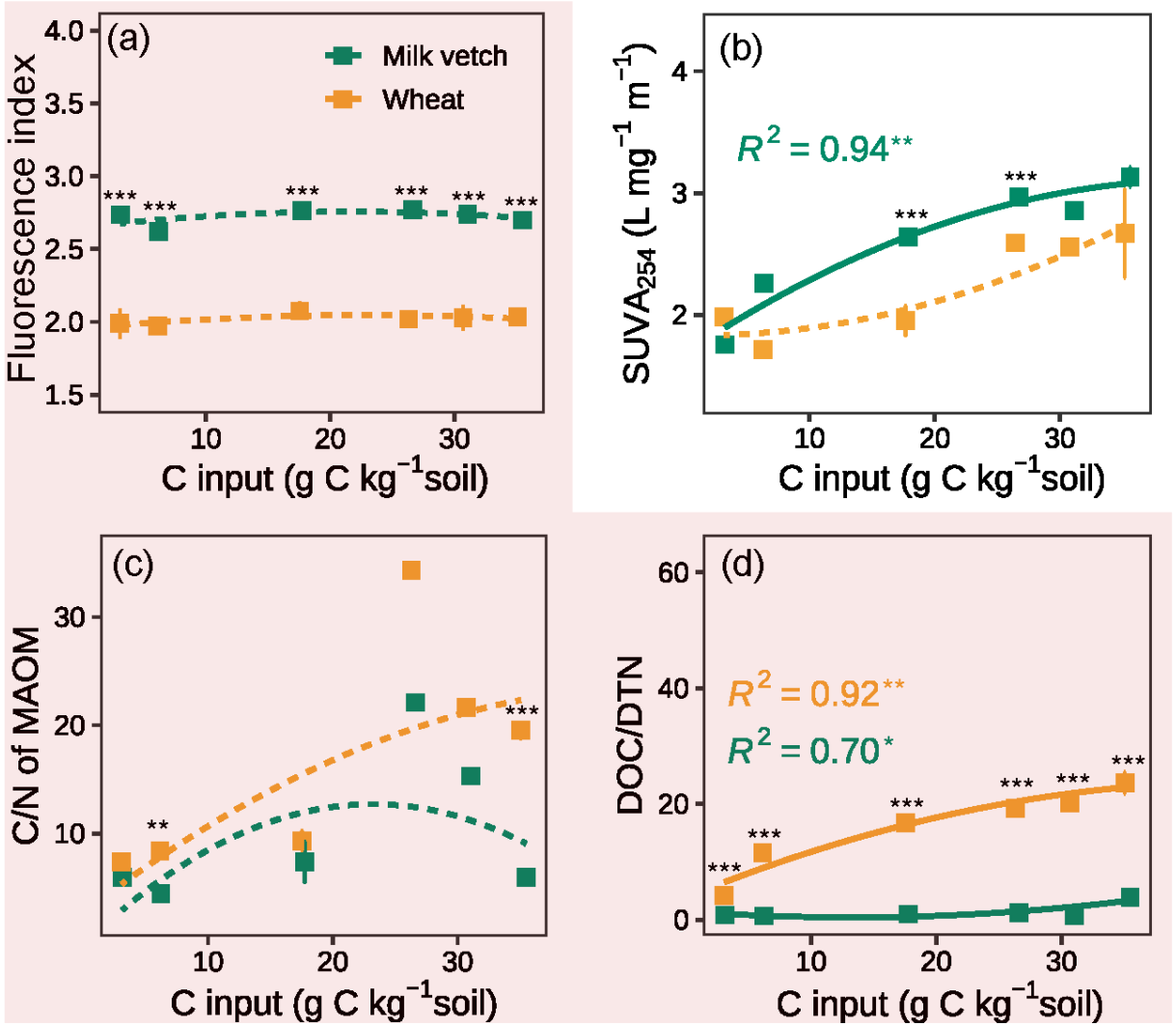
MAOM formation efficiency: decreased with input level for both straw; Wheat > milk vetch straw (L2-L6)

Low-quality straw prompts more MAOM formation than high-quality.

MAOM formation efficiency decrease with C input levels

DOM characteristics at incubation 420

High-quality Milk vetch (C/N=23)
Low-quality Wheat (C/N=163)



FI: milk vetch > wheat

high-quality litter has more microbial-derived organic matter

C/N of MAOM: Wheat > milk vetch

DOC/DTN: Wheat > milk vetch

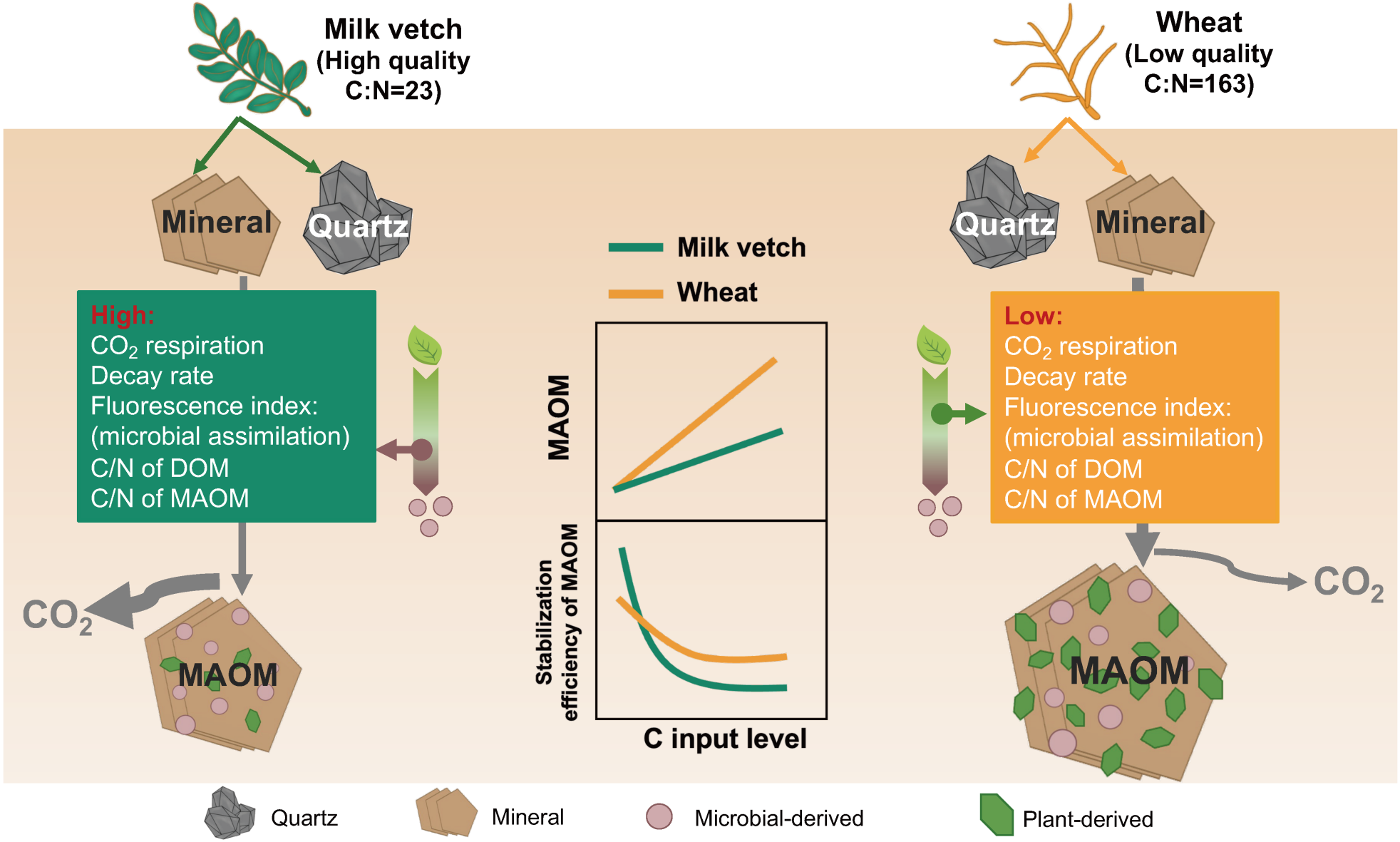
MAOM and DOM: low-quality litter has more plant-derived organic matter

SUVA$_{254}$: milk vetch> wheat (L3,L4)

High-quality litter's higher solubility produces more DOM and aromatic compounds, while low-quality litter's lower solubility limits DOM generation, resulting in lower SUVA$_{254}$ values.

Reactive minerals protect plant-derived OM in low-quality litter, enhancing MAOM and reducing respiration.

Summary


Milk vetch
(High quality
C:N=23)
Wheat
(Low quality
C:N=163)
Mineral
Quartz
Quartz
Mineral
High:
CO_2 respiration
Decay rate
Fluorescence index:
(microbial assimilation)
C/N of DOM
C/N of MAOM
Low:
CO_2 respiration
Decay rate
Fluorescence index:
(microbial assimilation)
C/N of DOM
C/N of MAOM
CO_2
CO_2
MAOM
MAOM
Milk vetch
Wheat
MAOM
Stabilization efficiency of MAOM
C input level
Quartz
Mineral
Microbial-derived
Plant-derived

Thanks for your attention!

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