Effect of root litter quality on carbon turnover and soil microbiology in topsoil and subsoil horizons

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- Deep-rooted crops (>1 m) may contribute to climate change mitigation by stimulating soil organic carbon (SOC) storage in deep soil layers.
- Microbial activity is the key driver of carbon (C) turnover in soils. However, the quality and quantity of SOC in subsoils is often poor and limit microbial activity. Yet, input of fresh organic C from deep root growth may stimulate microbial activity in subsoils.
- The resulting interaction between fresh C input and microbial activity may be essential for sequestration of stable SOC from remains of soil microorganisms.
- Here, we studied root chemical composition and C turnover in topsoil and subsoil. We looked for correlations between C losses and root C quality in initial (1 wk) and later (20 wk) phases of C turnover.

Soil was sampled at seven depths from a 0-300 cm profile at a temperate sandy loam soil under grass. Selected properties for 20, 60 & 300 cm depth are shown below.

Depth	Horizon	C	N	pH	Clay	Silt	Sand	Redox
(cm)		(mg g^{-1})	(mg g^{-1})		(%)	(%)	(%)	(mV)
20	Ap	21.4	1.60	5.4	7.7	29.9	58.6	575
60	Bw1	1.8	0.13	4.9	9.6	26.0	64.0	587
300	C2	0.4	0.03	5.1	12.0	25.5	62.4	648

Root material was isolated from seven plant species and analyzed for C, N, hemicellulose, cellulose and lignin (LI). Red marking indicates roots used for soil incubations.

Species (and abbreviation)	C (mg g^{-1})		N (mg g^{-1})		C/N ratio		LI (mg g^{-1})	
	0-30	>30	0-30	>30	0-30	>30	0-30	>30
Medicago sativa (Ms)	**431**	**341**	**23**	**18**	**18**	**18**	**39**	**46**
Artemisia vulgaris (Av)	**420**	**354**	**7**	**4**	**57**	**84**	**106**	**44**
Silphium perfoliatum (Sp)	419	409	14	10	30	40	97	73
Echium vulgare (Ev)	403	341	9	8	44	40	89	112
Isatis tinctoria (It)	**417**	408	**11**	11	**38**	35	**29**	65
Rumex crispus (Rc)	**425**	397	**6**	10	**69**	40	**59**	147
Miscanthus giganteus (Mg)	**445**	417	**8**	6	**56**	70	**162**	105

Loss of C was measured from soil (20, 60 & 300 cm) after incubation for 1-20 weeks (20°C) with different roots. References were soil incubated with water or glucose + nutrients.

Further studies are being made of CO_2 production, β-glucosidase activity, substrate induced respiration and microbial DNA profiles.

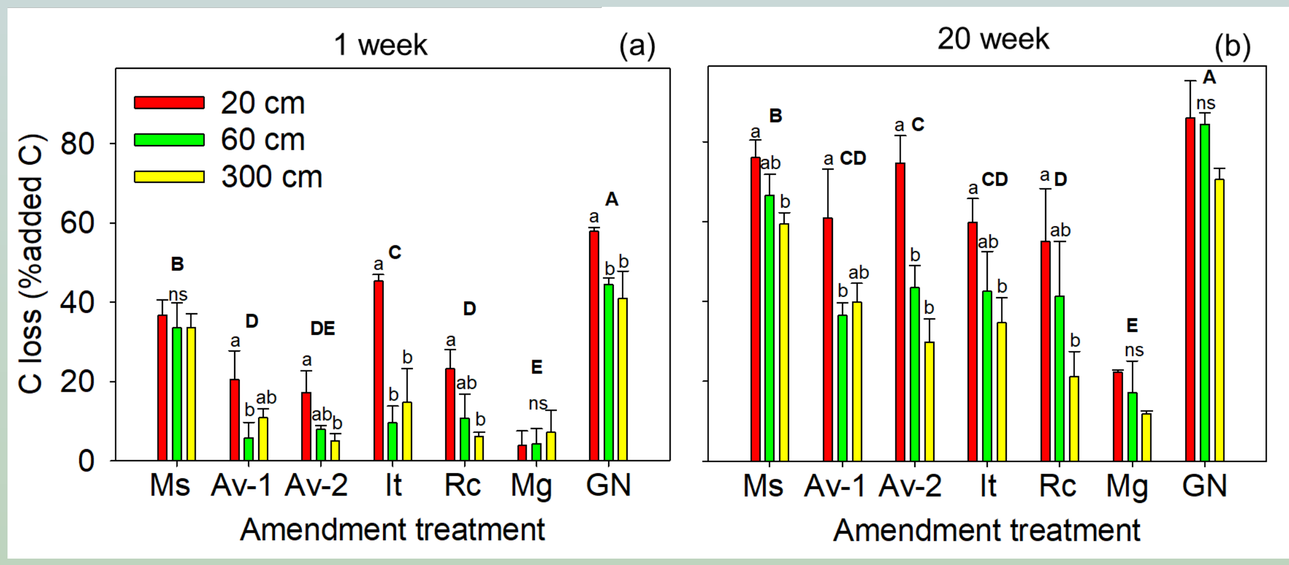

Fig 1. Carbon loss (% of added C) from soil incubated with roots or glucose + nutrients (GN) for (a) 1 and (b) 20 weeks.

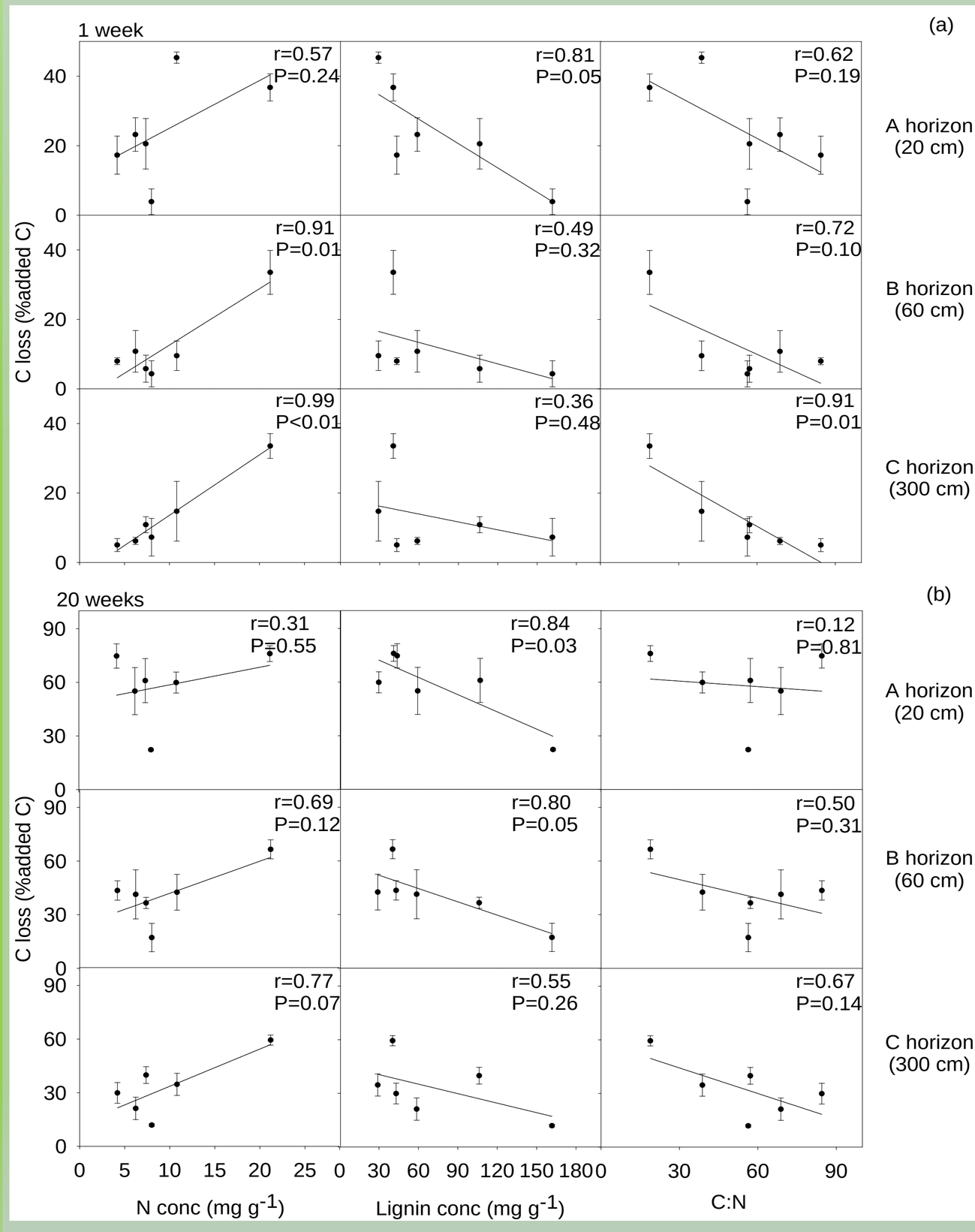

Fig. 2. Correlations between soil C loss and root litter quality after (a) 1 and (b) 20 weeks of incubation. Quality indicators shown are total nitrogen (N), lignin, and the root C to N ratio.

Conclusions

- Notable root-derived C mineralization occurred in subsoil horizons, although topsoils had higher C losses (Fig. 1).
- The initial C mineralization (1 week) varied among root materials, which could be partly related to the root chemical quality, notably the N content, which suggests that root N facilitated rapid microbial activity (Fig. 2a).
- Lignin demonstrated more significant correlation to C loss after 20 weeks, especially in topsoil, indicating that lignin content of the root litter may be more important in regulation of decomposition in the longer term (Fig. 2b).

Acknowledgment: Deep Frontier (http://deepfrontier.org/)