Resilience of Soil Microbial Communities: Relationships Between Land Use, Microbial Functional Group and Applied Stress

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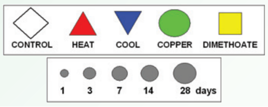
Introduction and Methods

Soil has an inherent potential to resist (stability) and recover from (resilience) environmental stresses.

We aim to provide a fundamental understanding of the underlying mechanisms involved in the stability and resilience of soil through a combination of variables related with structure and functionality of microbial communities under controlled laboratory conditions.

Soils were collected from an organic farm trial including two stages of a 6 year rotation (3rd year arable and 3rd year grass/clover) and permanent grass. All soils displayed distinct microbial community structures.

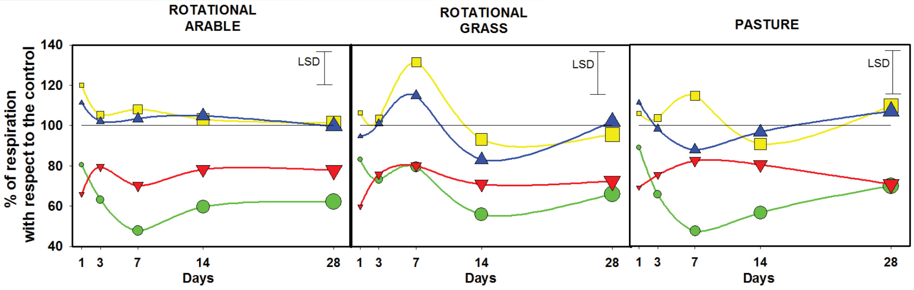


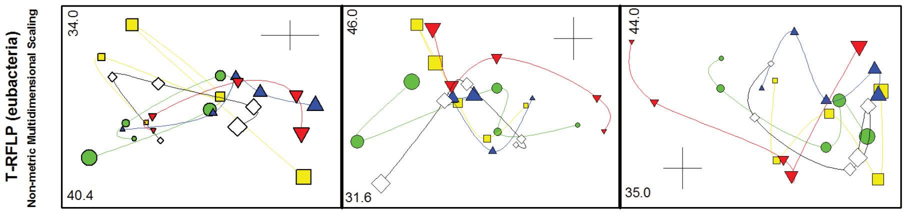
Functional stability and resilience of soil were measured following the imposition of transient temperature stress [heat (40 °C), cold (-20 °C) both for 18 h] or persistent chemical stress [$CuSO_4$ (320mg/kg)/dimethoate(2mg/kg)]. Potential respiration, nitrification and denitrification rates were assessed along with associated microbial community structure by T-RFLP of eubacterial 16S, AmoA and NirK genes.

Eubacterial structure - Respiration

Heat and copper decreased the respiration rate of soils, with no recovery after 28 days. Community structure shifted in response to time, stress and their interaction. Initial effects were more pronounced after heat and copper in rotational grass and pasture. The stressed communitites did not recover with time, especially in rotational-arable soil with copper and rotational-grass and pasture for heat.

	Source of variation						
	Time (T)		*Stress (St)*		*T x St*		*Residual*
Rotation arable	19.4	***	12.3	***	22.4	***	45.9
Rotation grass	18.0	***	12.8	***	21.0	***	48.2
Pasture	17.9	***	14.2	***	19.8	***	48.1
DISTLM (Anderson, 2000)	% variance significance * p<0.05, *** p<0.001						

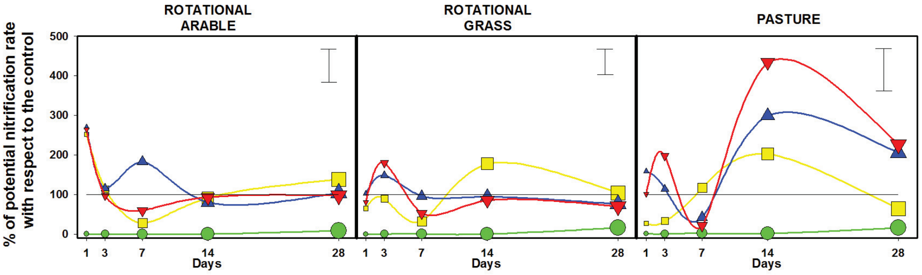


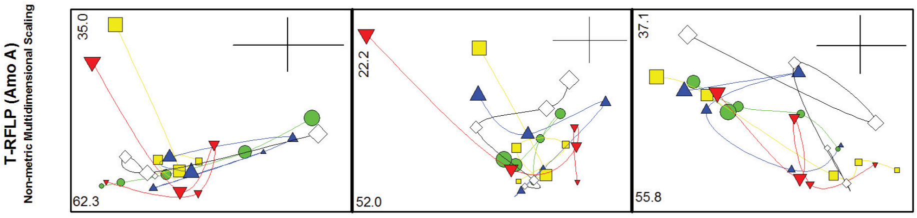


Amo A structure - Nitrification

In all soils the potential nitrification rate was drastically reduced by copper addition. In contrast the community structure was significantly affected by stress only in rotational-grass. However, all three managements showed a time×stress interaction effect. For both rotational soils the nitrifier community was strongly affected by heat and dimethoate after 28 days.

	Source of variation						
	Time (T)		*Stress (St)*		*T x St*		*Residual*
Rotation arable	17.3	***	3.3		22.7	*	56.7
Rotation grass	21.5	***	5.1	*	27.1	***	46.3
Pasture	24.2	***	4.9		19.9	*	41.0
DISTLM (Anderson, 2000)	% variance significance * p<0.05, *** p<0.001						



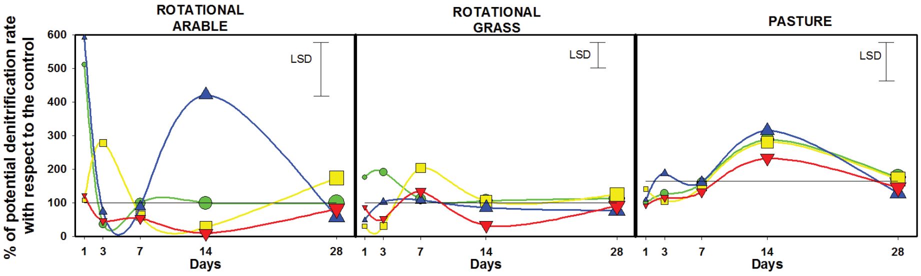


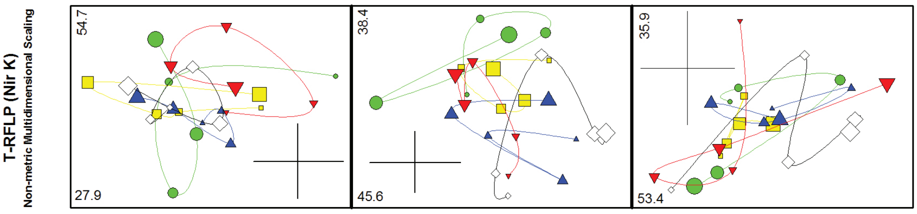
Nir K structure - Denitrification

No stress affected the potential denitrification rate in either rotational-grass or pasture soils. Activity was strongly increased after copper and dimethoate addition in rotational arable soil although the rate returned to control levels.

In general community structure was not significantly shifted in response to time, stress or their interaction, with the exception of copper addition in rotational-grass soil system.

	Source of variation						
	Time (T)		*Stress (St)*		*T x St*		*Residual*
Rotation arable	3.3		3.1		19.2		74.4
Rotation grass	4.8		10.3	*	15.5		69.4
Pasture	4.1		4.6		20.1		71.2
DISTLM (Anderson, 2000)	% variance significance * p<0.05, *** p<0.001						





Conclusions and Acknowledgements

Shifts in respiration activity and eubacterial community structure appear to be linked. This relationship does not hold for nitrification or denitrification and associated communities suggesting the relationship between functionality and microbial community structure is complex, with functional flexibility evident.

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