Farming on the edge of the Atlantic

- Resilience of a calcareous sandy soil to amendment with organic and synthetic fertilizer

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Introduction

Calcareous sandy soils are utilized for agriculture in many parts of the world. Crofting, traditionally a low-intensity agricultural system, is practised on calcareous sandy soils with low organic C called 'machair', in NW Scotland and Ireland (Fig. 1). Cultivation includes shallow ploughing, using kelp (seaweed) as a fertilizer and soil conditioner (Fig. 2). The natural vegetation regenerates between cultivations (Angus, 2001). During the previous decade, deeper ploughing and partial substitution of kelp with inorganic NPK fertilizer has occurred in response to socio-economic pressures. The effects of these changes on the machair, much of which is classified as protected natural areas, are not known.

Objectives: To examine what effects these changes have had on soil stability and microbial biomass and activity on the machair.

Figure 1: Machair fields

Figure 2: Kelp on beach

Materials and methods

A field experiment in 2007/08 examined how ploughing and fertilizers affects soil microbiology, aggregation and stabilization.

Site: A second year barley field on the island of South Uist (57.3, -7.4)

Treatments: Ploughing and fertilizer (NPK fertilizer and/or kelp at quantities used by crofters (n=4))

Sampling: 4 times from May to September, from both top- and subsoil

Properties quantified: Soil aggregation (water stable aggregates, aggregate stability), soil water retention (at pF2), microbial community structure (microbial fatty acids (FA)) and functional capacity (b-glucosidase activity).

Results and discussion

- Some significant differences between fertilizer treatments occurred for most of the properties studied, but these were small compared with the differences between sampling times (Fig. 3)
- Fertilizer treatment effects were not consistent between sampling times
- Generally fertilizers decreased aggregation, water retention, microbial biomass and activity relative to the unamended control (Table 1)
- Of the properties measured, only water retention and saprotropic fungal FA were in a few cases significant effected by ploughing.

Table 1: Fertilizer effects relative to unamended control treatment: Fertilizer treatment significantly increases (↑) or decreases (↓) value of variable relative to control, or no significant difference (-) between fertilizer and control. For each combination of fertilizer, stratum and property measured, the four symbols represent the four sampling times: 6, 37, 88 and 125 days after harrowing, as read left to right.

		β-glucosidase activity	Total fatty acids	Saprotrophic fungal fatty acids	Aggregate stability	WSA >1mm	Water retention pF2	Soil water content
NPK	Topsoil	----	-↑--	----	↓na - na	↓--↓	----	----
	Subsoil	---↑	↑---	↓---	- na - na	----	----	↑--↑
Kelp+NPK	Topsoil	----	-↑--	--↓-	- na - na	↓--↓	↓-↓-	-↑↓-
	Subsoil	-↓--	-↓--	↓---	↓na - na	----	-↓--	↑-↓-
Kelp	Topsoil	--↓-	----	-↓↓-	↓na - na	↓---	↓-↓-	--↓-
	Subsoil	-↓--	-↓↓-	↓↓--	↓na ↑na	--↓-	↑↓--	--↓-

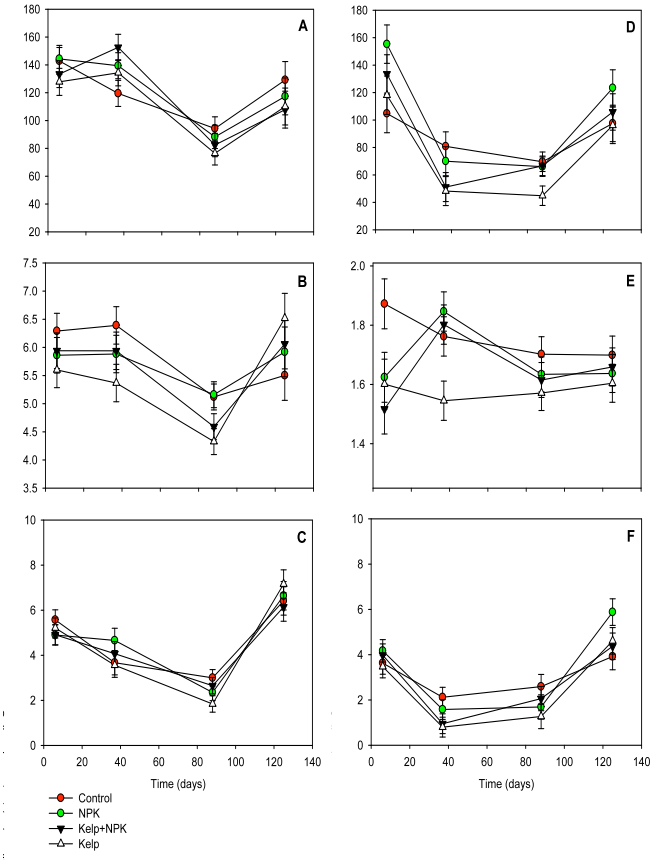

Figure 3: Fertilizer effects on microbiological parameters. A-C: Topsoil; D-F: Subsoil. A & D: Total fatty acids; B & E: Saprotrophic fungal fatty acids; C & F: β-glucosidase activity. Error bars indicate sed.

Conclusions

- Fertilizer amendments did not shift the values of the measured properties outside the ranges found during the season for the control, indicating resilience
- The lack of response to organic fertilizer is surprising, and in contradiction to findings by Haslam and Hopkins (1996), who found an increase in pore volume, aggregate stability, microbial activity and biomass following addition of kelp to a sandy soil in amounts similar to those used in the present study.
- We propose that the machair soil does not respond to fertilizer in a growing season because the soil is at an equilibrium level characterised by low stability and an average level of microbial activity and biomass.

Acknowledgements
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References

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