The role of earthworms in the decomposition of kelp (*Laminaria digitata*) when used as a soil amendment

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Introduction

In coastal communities, there is a long history of composting kelp species including *Laminaria digitata* with dung for use as a fertiliser.

Earthworms along with other soil fauna and microbial populations play a key role in the decomposition of organic fertilisers and the cycling of macro- and micro-nutrients (*Figure 1).*

The use of kelp as a fertiliser on low grade, but historically cultivated soils, shows potential as a sustainable amendment for food production in the modern era. Can the action of earthworms further enhance sustainability?

How does the action of earthworms in the decomposition of kelp effect key soil properties and crop yields?

Previous work has clearly demonstrated how additions of kelp enhance productivity in the field and controlled glasshouse conditions, on a variety of crops. Freshly applied kelp had a much greater (P= 3.39932E-05) impact on potato yield than composted mixed kelp-dung or dung fertiliser (*Figure 2*). However, analysis of key soil properties revealed that kelp-dung resulted in the largest shift in soil characteristics associated with enhanced crop productivity.

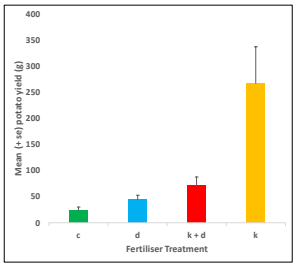
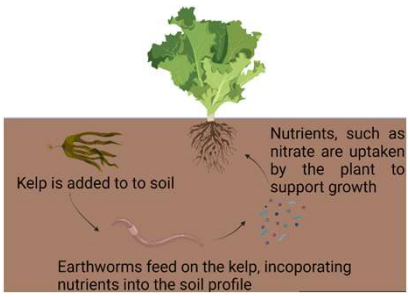


Figure 2. Mean potato (Var: Arran Pilot) yields by fertiliser treatment: c - control, d - dung, k + d - kelp + dung, k - kelp

In addition, kelp has been found to be palatable to earthworms (Butt *et al.*, 2020. Environmental Science and Pollution Research, 27, pp. 33493-9). Preliminary studies also showed that the palatability of kelp to earthworms is dependant on earthworm and kelp species, the level of kelp decomposition, earthworm density and the level of kelp additions.

Figure 1. The role of earthworms in the decomposition of organic soil amendments, to promote crop growth.



Methods

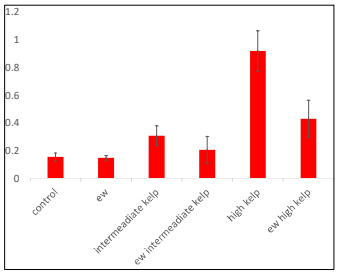
A suite of experiments was designed to assess the feeding behaviour and growth of earthworms in response to kelp as a food source and how this impacted soil properties and crop growth. In 2022, a fully factorial mesocosm experiment was conducted. Three differing levels of fresh kelp additions (no additions, intermediate additions and high additions, equivalent to 0, 50 and 100 kg N/ha respectively), were added to 750 ml pots containing either no earthworms or two adult *Lumbricus terrestris,* with five replicate mesocosms per treatment.

After four weeks the earthworms were carefully removed from the mesocosm taking care not to disturb the substrate and the biomass. The earthworms in mesocosms which contained kelp gained mass, whereas the earthworms in the control, no additions mesocosms lost mass. At this stage two *Lactuca sativa 'Salad Bowl'* lettuce were added to each mesocosm, and subsequently transferred to a growth chamber. After 4 weeks the crop was harvested, yield and root biomass determined, and key soil properties analysed.

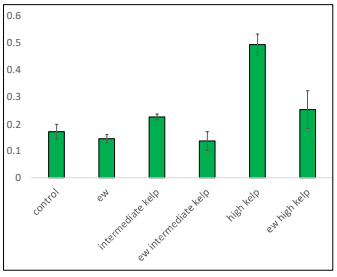
Results

Figure 3 displays mean fresh mass (g) for above ground and below ground biomass, nitrate values are mean ppm, and soil moisture is given as a percentage. Error bars show standard deviation. Treatments containing earthworms are denoted by "ew".

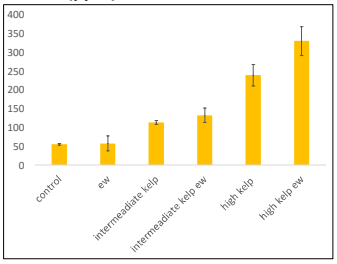
Figure 3. ***Above ground biomass (g)***



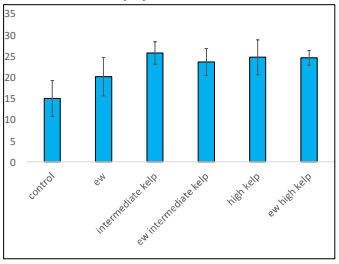
Below ground biomass (g)



Nitrate (ppm)



Soil Moisture (%)



Discussion

The results show that *Lumbricus terrestris* increases nitrate concentrations in soils fertilised with kelp. However, the highest yields were observed in systems where earthworms were not present. This could be due to the effect of earthworms on plant growth hormones e.g. auxins which are present in fresh kelp but are rapidly degraded. However, it is possible that the earthworms translocate the nutrients away from the plant roots resulting in lower plant growth.

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