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Lomi Earth indoor growth experiment

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Summary: This report provides an overview of the growth room pot experiment commissioned by Pela. This experiment was designed to assess how Lomi Earth influenced the grow of three crop species: Barley, Basil, and Pea, and how it influenced measures of soil health. Both potting soil and a poor-quality soil that had a high sand content were assessed. Further, Lomi Earth treatments included combinations with microbial pods, bulking agents, and inoculation of naturally occurring soil microbiome, and was also compared to compost. For all the species, the Lomi + natural soil microbiome addition resulted in the largest plants. It appears as though the Lomi pods and bulking agent did not result in higher growth. Further, these Lomi benefits were not apparent in the poor-quality soil. There appears to be an important interaction between Lomi Earth and a diverse soil microbiome that results in greater soil health and enhanced plant growth.

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Background

Pela commissioned an experiment to assess the influence of Lomi Earth on the growth of common crop plant species (Barley, Basil, and Pea). This request was to determine the effect of adding Lomi Earth to plants that costumers might want to grow. Adding Lomi Earth amendment to potting soil will undoubtedly introduce undecomposed organic matter. This material could have some beneficial effects, such as increasing water holding capacity. However, the impacts on nutrient availability to plants is unclear because potting soil is already rich in material and the Lomi Earth likely requires time for decomposition to proceed. The Lomi Earth might also alter the soil in ways that are harmful to plant growth, such as changing the pH or increase the salt content of soils.

Pela provided several additives designed to make Lomi Dirt more beneficial and attractive as a soil amendment. The addition of Lomi pods is meant to seed the Lomi Earth with beneficial bacterial that aid in the decomposition process. Pela also uses a bulking agent that adds a stabilizing component to Lomi earth that might be quite variable depending on Lomi input materials. We assessed the effects of Lomi Earth on the growth of plants in sterilized potting soil with pod and bulking agent additions. We also included wild soil microbiome inoculations. For all trials, we used the standard recipe 8 as the Lomi feedstock (Table 1).

Table 1: Feedstock recipe 8

Food item	Weight (g)
Carrot	91
Coffee grounds	77
Cucumber	157
Iceberg lettuce	189
Pineapple	179
Water	50
Total weight	743

In order to determine if Lomi Earth was of differential value for poor quality soils, a series of experiments in soil with high sand content was also run. Here, the expectation was that if Lomi Earth had minimum benefit for the plants in potting soil, because of the high nutrient content of potting soil, we might see more of an effect in poor soil.

Experimental design and analyses

After a couple of weeks of sterilizing soil and producing Lomi Earth, the experiment began the first week of August 2022. The pots were sown with multiple seeds, and after germination, all but one of the seedlings was removed. Plants were watered regularly, and grew under a 12 hour day-night cycle.

The treatments included 400 grams of soil, either totally potting soil or sandy soil, or 360 g of these soils plus 40 g of Lomi Earth. There were a total of 17 different treatments, including a potting soil and poor soil control (Tabel 2). All treatment by species combinations were replicated three times, resulting in 153 pots.

Table 2: The treatments used in the experiment.	
Code	**Treatment**
PS	Potting Soil (sterlized)
PS_I	Potting Soil (sterlized) + Inoculant (unsterlizied)
PS_C	Potting Soil (sterlized) + Compost
PS_Lomi	Potting Soil (sterlized)+ Lomi Gro (no pods)
PS_Lomi_pod	Potting Soil (sterlized) + Lomi Gro (with pods)
PS_C_I	Potting Soil (sterlized) + Inoculant (unsterlizied) + Compost
PS_Lomi_I	Potting Soil (sterlized) + Inoculant (unsterlizied) + Lomi Gro (no pods)
PS_Lomi_IP	Potting Soil (sterlized) + Inoculant (unsterlizied) + Lomi Gro (with pods)
PS_Lomi_BA	Potting Soil (sterlized) + Lomi Gro (with pods) + Bulking Agent
PS_Lomi_I_BA	Potting Soil (sterlized) + Inoculant (unsterlizied) + Lomi Gro (with pods) + Bulking Agent
PS_Lomi_unster	Potting Soil (unsterlized) + Lomi Gro (with pods)
Poor	Poor quality soil (sterlized)
Poor_C	Poor quality soil (sterlized) + Compost
Poor_Lomi	Poor quality soil (sterlized) + Lomi Gro (no pods)
Poor_Lomi_pod	Poor quality soil (sterlized) + Lomi Gro (with pods)
Poor_Lomi_BA	Poor quality soil (sterlized) + Lomi Gro (with pods) + Bulking Agent
Poor_lomi_unster	Poor quality soil (unsterlized) + Lomi Gro (with pods)

The experiment was harvested on the 9th week. Plants were removed from the soil and separated into aboveground and belowground (root) tissues. Roots were individually rinsed to remove the remaining soil. These plant materials were dried in drying ovens at 65°C for two days and weighed. Soil samples from each pot were sent to A&L Canada Laboratories for soil analysis, which included 31 different soil variables (Table 3).

Analyses included simple linear models to compare differences between treatments for each species individually. Further, least significant differences post-hoc tests were employed to determine which treatments were statistically significantly different from one another.

Table 3: The 31 soil variables analysed for this experiment.		
pH	Copper (Cu) ppm	%Mg (Percent Base Saturation)
Lime Index	Boron (B) ppm	%Ca (Percent Base Saturation)
Available Organic Matter %	Sodium (Na) ppm	%Na (Percent Base Saturation)

Phosphorus (P) ppm	Nitrate-N (NO3-N) ppm	K (Porportional Equivalents - meq)
Potassium (K) ppm	Soluble Salt ms/cm	Mg (Porportional Equivalents - meq)
Magnesium (Mg) ppm	Chloride (Cl) ppm	Ca (Porportional Equivalents - meq)
Calcium (Ca) ppm	Moisture %	Na - Porportional Equivalents
Sulfur (S) ppm	meq/100g (CEC)	Mg/K (Cation Ratio)
Zinc (Zn) ppm	%BS (CEC)	Ca/Mg (Cation Ratio)
Manganese (Mn) ppm	% K (CEC)	
Iron (Fe) ppm	C/N Ratio	

Findings

1. *Plant biomass*
Plant biomass, in grams, was measured for the three crop species and was partitioned three ways: the total plant biomass, aboveground biomass, and belowground root biomass. All three measures showed substantial variation among treatments (Fig. 1) and all were highly significantly affected by treatment for each species (Table 4).

Table 4: The ANOVA results of the treatment effects on each biomass measure for each species.

Species	**Biomass**	$F_{16,34}$	**P-value**
Barley	Total	8.82	<0.001
	Above	11.01	<0.001
	Root	8.66	<0.001
Basil	Total	11.46	<0.001
	Above	15.06	<0.001
	Root	19.58	<0.001
Pea	Total	11.84	<0.001
	Above	6.43	<0.001
	Root	36.38	<0.001

The results for the potting soil and poor-quality sandy soil were very different. For the poor-quality soil, the Lomi amendments generally resulted in lower biomass production than the unamended poor soil (Fig. 1, Table S1). However, for the potting soil, either the Lomi Earth + soil microbiome inoculation or the Lomi Earth + soil microbiome inoculation + Lomi pod resulted in the largest total, aboveground or root biomass (Fig. 1, Table S1), often greatly exceeding both the potting soil control, potting soil with the soil microbiome inoculation, the compost addition, and the compost addition with the soil microbiome inoculation.

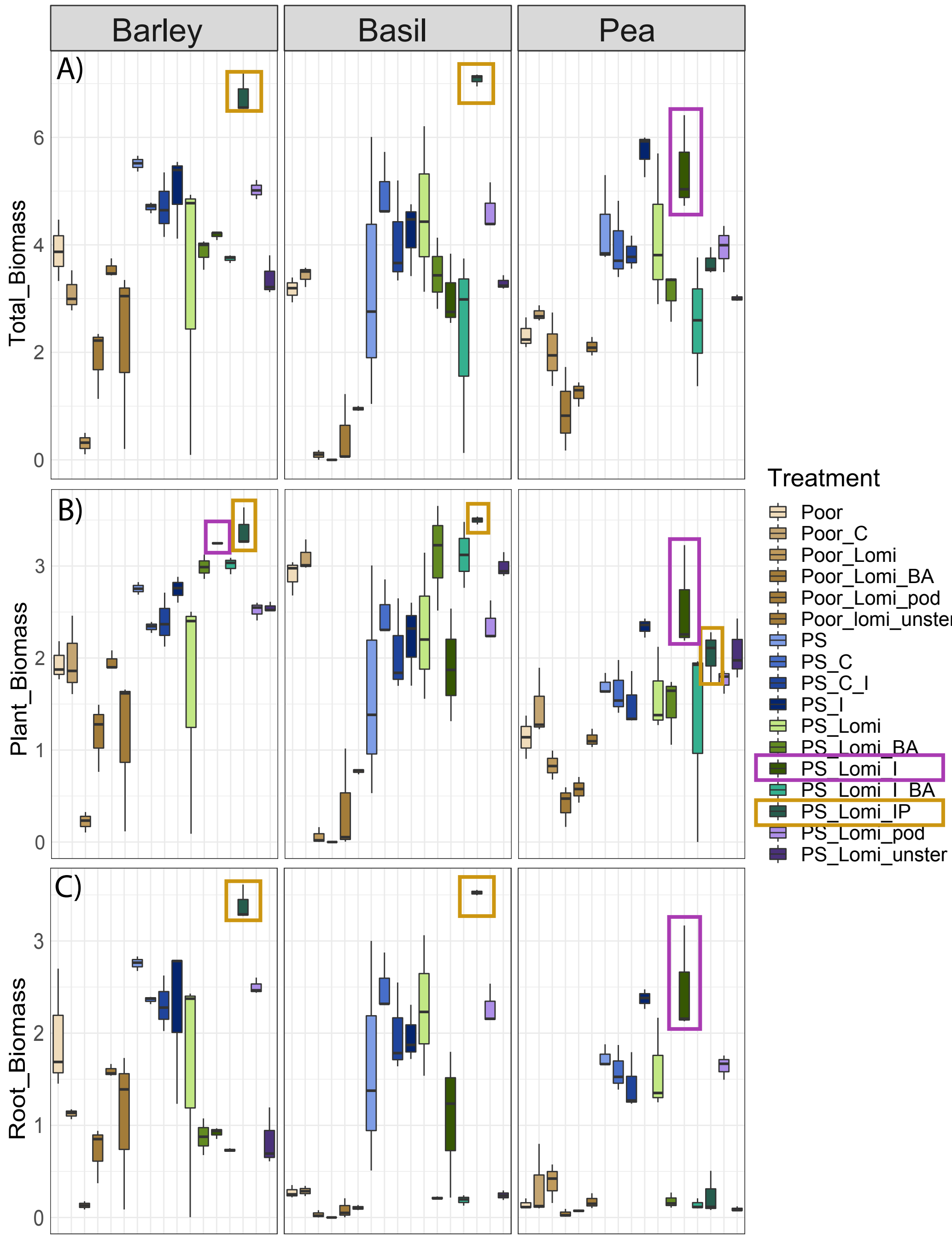

Fig. 1: (A) Total dried plant biomass (g), (B) aboveground biomass, and (C) root biomass for the three crop species across the different soil amendment treatments. The values highlighted are the Lomi Earth + soil microbiome inoculation (purple) and the Lomi Earth + soil microbiome inoculation + Lomi pod (gold). These two treatments, in most cases, provided the greatest biomass values. Post-hoc test results are provided in Table S1.

2. *Pea pod mass*

There was substantial variation peapod mass across the treatments, especially for treatments that included some form of Lomi Earth amendment (Fig. 2). Interestingly, the peapod mass from the poor-quality soil was generally not lower than the potting soil control (see Table S2). Like with the biomass measures, the Lomi Earth + soil microbiome inoculation + Lomi pod treatment outperformed most others. However, the Lomi Earth + bulking agent also appeared to result in larger peapods, though this treatment also was quite variable.

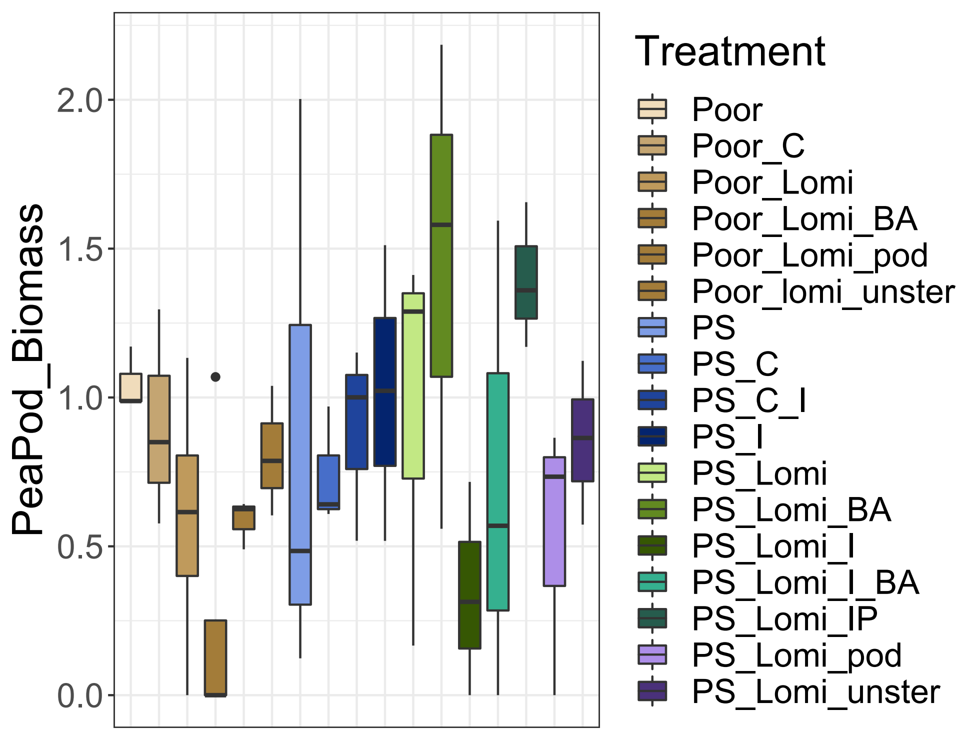

Fig. 2: Pea pod mass across the different treatments. Post-hoc test results are provided in Table S1.

3. *Soil variables*

There was substantial variation in soil chemical values between treatments (Fig. S1), but it is difficult to pull out any general patterns besides some clear differences between potting soil treatments and the poor-quality soil. Some of the key nutrients, like K, N, and P, there is some evidence that Lomi addition will increase these. However, the signal is not consistent across treatments.

Overall interpretation

Across these analyses, a common pattern emerges, namely that Lomi Earth, when combined with an inoculation of natural soil microbiome appears to have a beneficial effect on crop plant size. In many instances Lomi Earth with the inoculation outperforms compost and other Lomi amendments. Further, the benefits of the Lomi amendment were not present with the poor quality soil.

The mechanisms are not precisely identified in this analysis. I hypothesize that the Lomi Earth amendment is a substrate that contains ample resources for bacterial growth as it is decomposed in the soil. It seems as though the Lomi Pods are not sufficient to supply the necessary microbial community to realize the benefit of Lomi Earth. Further, there isn't much evidence that the bulking agent improves plant growth. What is really surprising is the strong interaction between the natural soil microbiome and Lomi Earth. These results reinforce what was seen with the farm trials, that natural microbial communities might flourish with Lomi amendments and that over time the soil environment is enhanced and supports better plant growth.

The poor-quality soil did not benefit from Lomi addition, which was surprising. I suspect that this soil did not support the growth of a rich and diverse soil microbial community and so it is likely that the Lomi Earth was not being decomposed in this soil environment, at least not at a rate that would see benefits over a couple of months. Perhaps, over a longer period of time, the Lomi Earth benefit would be realized.

Shortcomings

These intriguing results need to be tempered against the limitations of the study. The study was a short-term experiment grown in a controlled environment. It is not clear how the environmental variation found in outdoor settings would alter these findings. Because of the number of treatments, pure replication was kept low, making it more difficult to detect real differences, although I will note all statistical tests were highly significant. Further, soil genetic sequencing would have helped to uncover which microbes appeared to flourish, allowing more precise inferences about the mechanisms at play.

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Table S1: The mean values for total, aboveground, and root dried biomass (g) and treatment groupings according to the Least Significant Differences test with different letters indicating significant differences at P < 0.05. Treatment codes are given in Table 2.

	Total biomass	groups	Total biomass	groups	Total biomass	groups
PS_Lomi_IP	6.778	a	7.080	a	3.665	cdef
PS	5.513	ab	3.269	cd	4.305	bc
PS_Lomi_pod	5.024	bc	4.644	bc	3.946	cde
PS_I	5.017	bc	4.216	bc	5.728	a
PS_C_I	4.714	bcd	4.066	bc	3.835	cde
PS_C	4.697	bcd	4.991	b	3.975	cde
PS_Lomi_I	4.180	bcde	3.046	cd	5.392	ab
Poor	3.889	cde	3.173	cd	2.329	gh
PS_Lomi_BA	3.867	cde	3.459	bcd	3.099	defg
PS_Lomi_I_BA	3.742	cde	2.287	de	2.578	fg
Poor_Lomi_pod	3.549	def	0.447	f	1.242	hi
PS_Lomi_unster	3.380	def	3.288	cd	3.008	efg
PS_Lomi	3.267	defg	4.589	bc	4.136	cd
Poor_C	3.101	efg	3.431	bcd	2.713	fg
Poor_lomi_unster	2.199	fg	0.954	ef	2.105	gh
Poor_Lomi_BA	1.899	g	0.000	f	0.908	i
Poor_Lomi	0.309	h	0.093	f	2.020	gh
	Above biomass	**groups**	**Above biomass**	**groups**	**Above biomass**	**groups**
PS_Lomi_IP	3.387	a	3.498	a	2.036	abc
PS_Lomi_I	3.248	ab	1.907	de	2.558	a
PS_Lomi_I_BA	3.012	abc	3.121	abc	1.297	de
PS_Lomi_BA	2.991	abc	3.132	ab	1.481	cde
PS	2.756	abc	1.640	e	1.701	bcd
PS_I	2.748	abc	2.207	cde	2.337	ab
PS_Lomi_unster	2.548	bcd	2.996	abc	2.064	abc
PS_Lomi_pod	2.519	cd	2.366	bcde	1.757	bcd
PS_C_I	2.401	cd	2.062	de	1.506	cd
PS_C	2.337	cde	2.489	bcd	1.640	cd
Poor_C	1.976	de	3.093	abc	1.465	cde
Poor_Lomi_pod	1.958	de	0.358	f	0.570	fg
Poor	1.942	de	2.899	abc	1.139	def
PS_Lomi	1.665	ef	2.301	cde	1.591	cd

Poor_Lomi_BA	1.178	f	0.000	f	0.411	g
Poor_lomi_unster	1.130	f	0.769	f	1.120	def
Poor_Lomi	0.221	g	0.060	f	0.833	efg
	Root biomass	**groups**	**Root biomass**	**groups**	**Root biomass**	**groups**
PS_Lomi_IP	3.391	a	3.525	a	0.234	c
PS	2.757	ab	1.629	cd	1.734	b
PS_Lomi_pod	2.502	b	2.279	bc	1.640	b
PS_C	2.361	bc	2.502	b	1.595	b
PS_C_I	2.309	bc	1.991	bc	1.433	b
PS_I	2.269	bc	1.967	bc	2.373	a
Poor	1.947	bcd	0.274	e	0.142	c
PS_Lomi	1.602	cde	2.277	bc	1.589	b
Poor_Lomi_pod	1.589	cde	0.087	e	0.073	c
Poor_C	1.125	def	0.287	e	0.341	c
Poor_lomi_unster	1.069	efg	0.105	e	0.171	c
PS_Lomi_I	0.920	efg	1.083	d	2.485	a
PS_Lomi_BA	0.876	efg	0.211	e	0.177	c
PS_Lomi_unster	0.832	efg	0.240	e	0.090	c
PS_Lomi_I_BA	0.731	fg	0.189	e	0.141	c
Poor_Lomi_BA	0.721	fg	0.000	e	0.042	c
Poor_Lomi	0.131	g	0.033	e	0.385	c

Table S2: The mean values for peapod mass (g) and treatment groupings according to the Least Significant Differences test with different letters indicating significant differences at P < 0.05. Treatment codes are given in Table 2.

	Peapod mass	groups
PS_Lomi_BA	1.441	a
PS_Lomi_IP	1.395	a
Poor	1.048	ab
PS_I	1.017	ab
PS_Lomi	0.956	abc
Poor_C	0.908	abc
PS_C_I	0.890	abc
PS	0.870	abc
PS_Lomi_unster	0.853	abc
Poor_lomi_unster	0.810	abc
PS_C	0.740	abc
PS_Lomi_I_BA	0.721	abc
Poor_Lomi	0.591	bc
Poor_Lomi_pod	0.586	bc
PS_Lomi_pod	0.533	bc
PS_Lomi_I	0.343	bc
Poor_Lomi_BA	0.264	c

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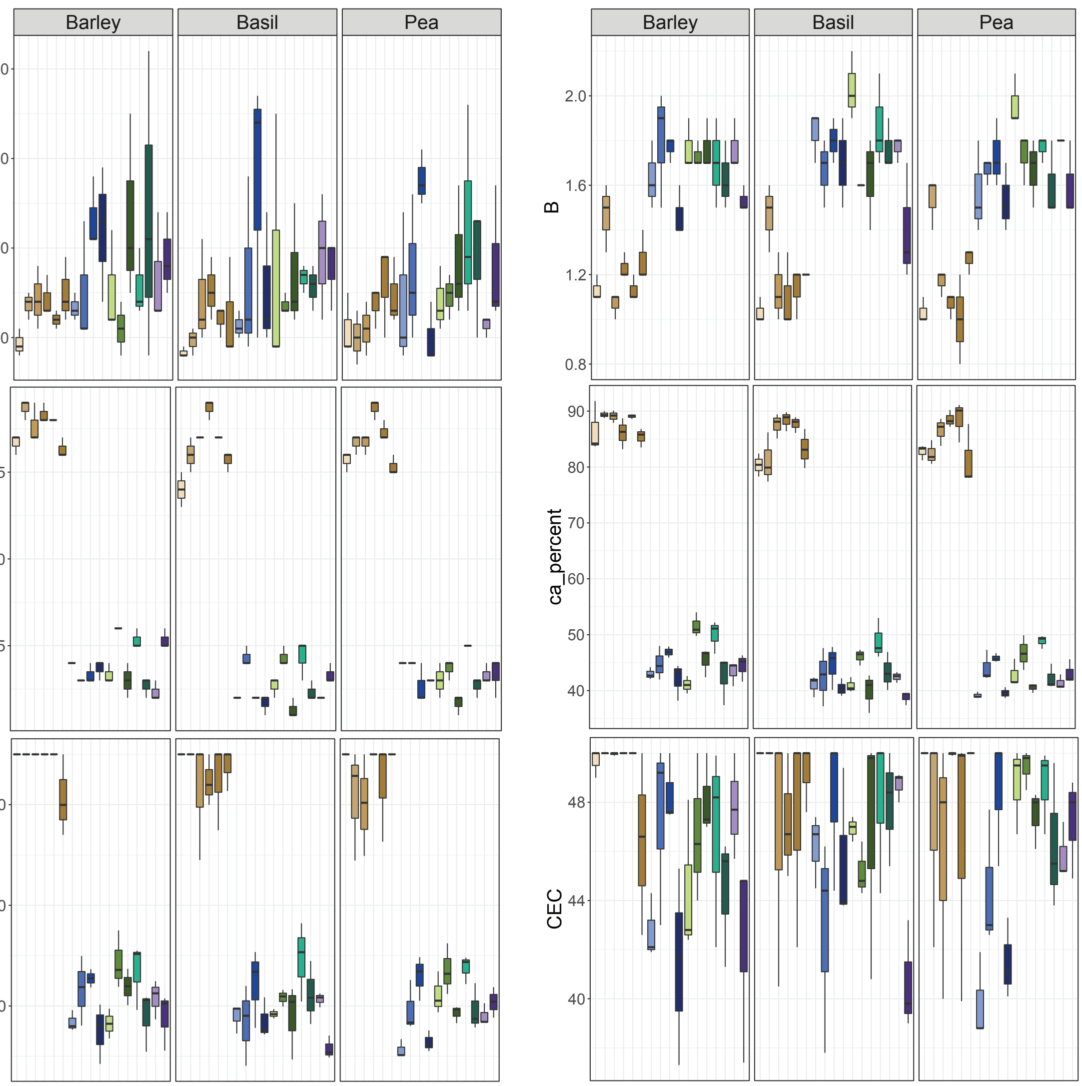
Fig. S1: Soil chemical variables across treatments for each species.



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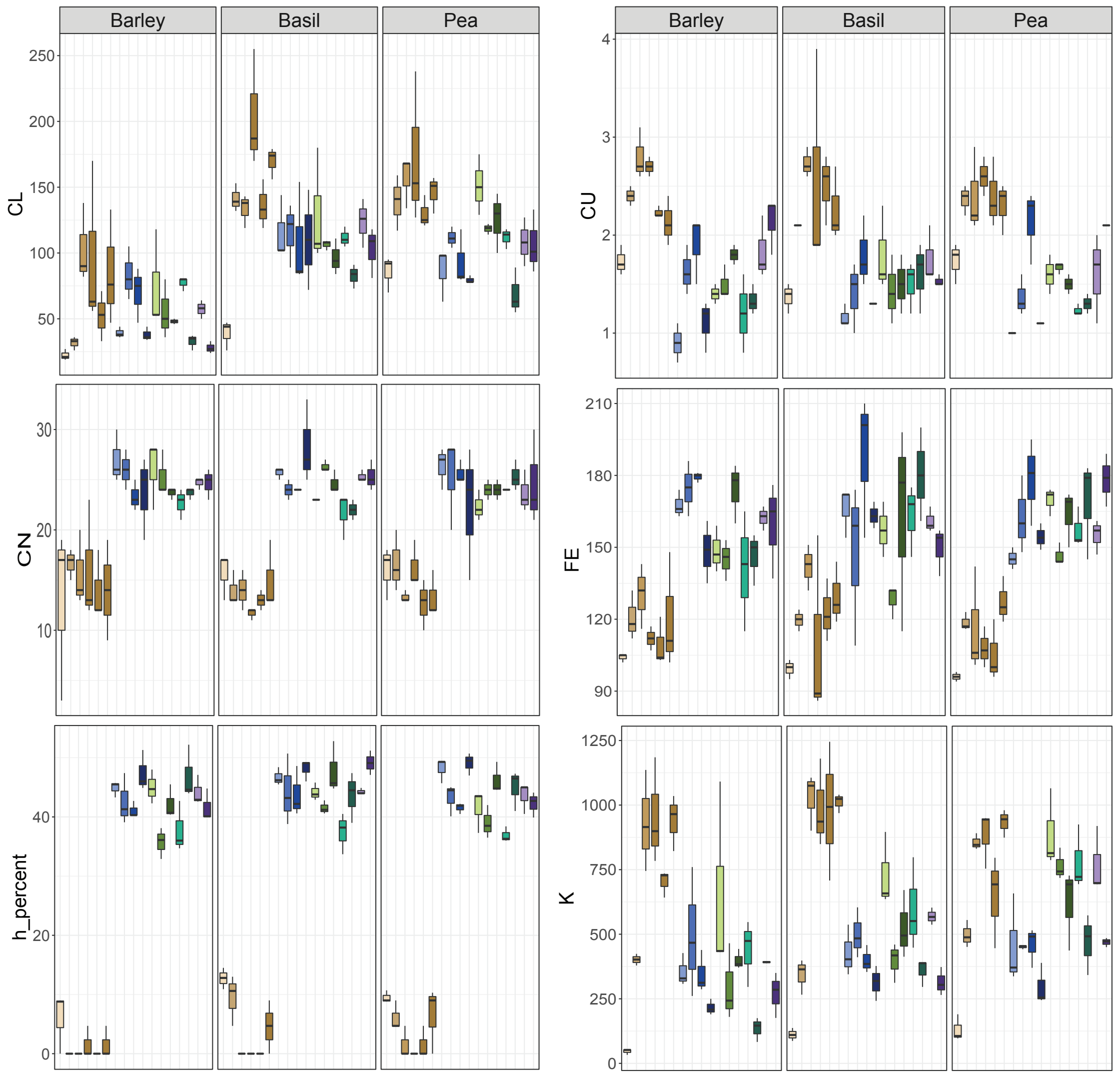

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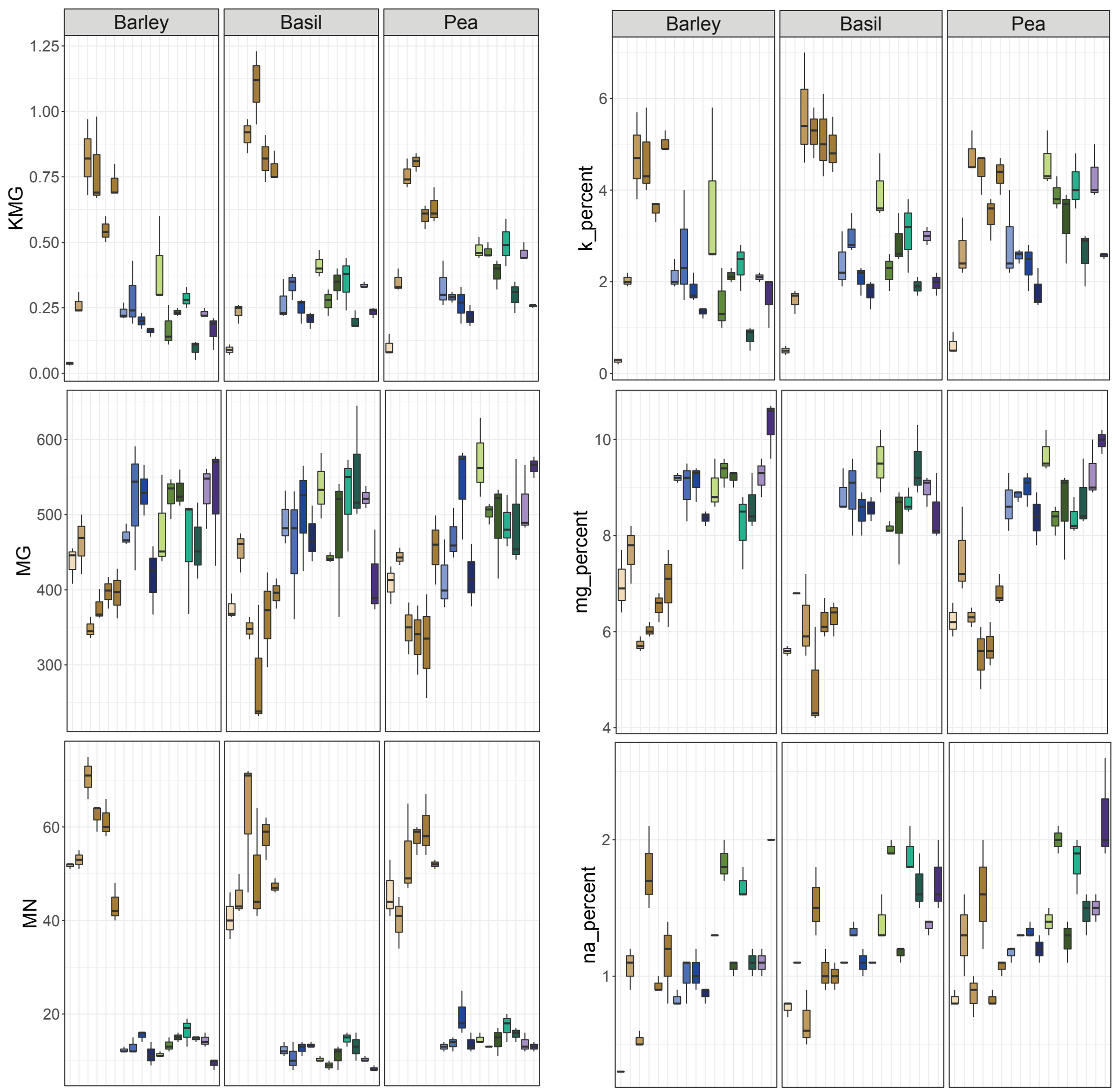

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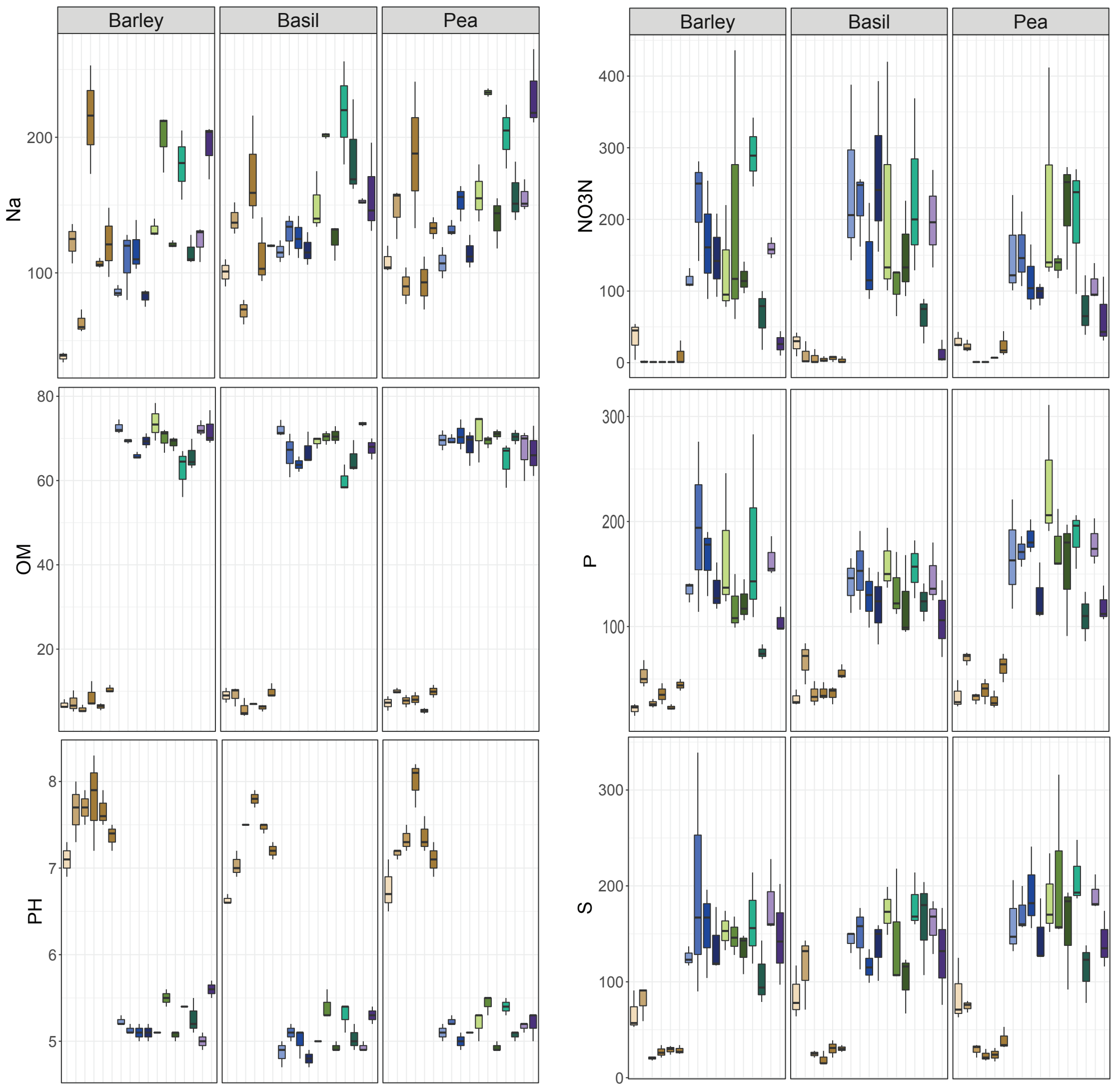

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