Rock Dust Mine Waste as a Field Soil Amendment to Improve Soil and Crop Quality in a Boreal Climate

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Background

Newfoundland and Labrador (NL) soils are acidic, shallow and stony, with low fertility. This limits crop growth and productivity, and acts as a substantial hurdle for efforts to produce crops in such areas. Rock dust (RD), a waste product generated from mining industry is known to contain some mineral nutrients.

By incorporating RD into agricultural field soils, there may be an opportunity to recycle the material, and while improving soil quality, growth, yield and quality of vegetables in boreal climate.

We hypothesized that RD amendment in agricultural soils will enhance growth, and yield of high value crops in boreal climate.

Materials and Methods

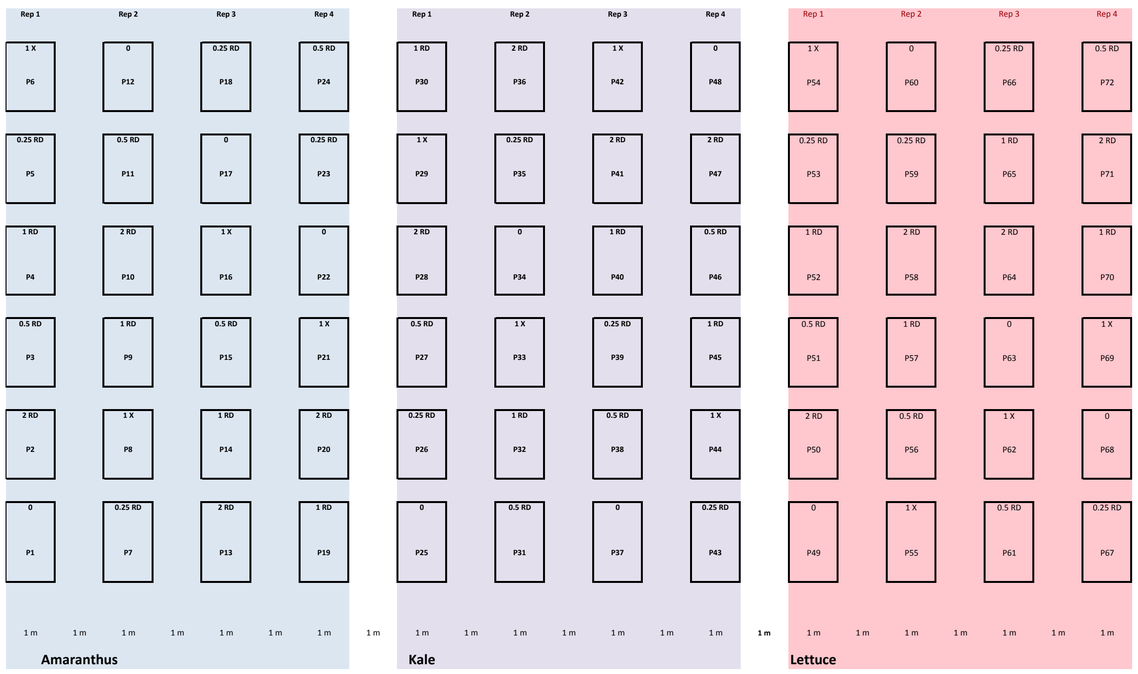


Figure 1. Field layout

This experiment was conducted at The Pynn's Brook Agrifoods research station on the West coast of Newfoundland, Canada during the 2019 and 2020 growing seasons.

The experiment variables consist of crop type and soil additive, with 4 replications per combination of variables. The field was laid out in a randomized complete block design for each crop

Amaranth, kale and lettuce were the crops grown. Lettuce in the first season was a boston variety, and the second season was romaine.

Soil additives consist of rock dust concentrations of 0.25kg/m2, 0.5kg/m2, 1kg/m2, and 2kg/m2, as well as a positive control in the form of 1kg/m2 of Huplaso (HX) (a similar product already on the market) and a negative control with no additives. RD was air dried prior to weighing and measuring for concentrations, and spread by hand in treatment zones. A motorized rototiller was employed to incorporate the RD, and mix it into the soil to an even depth of 20 cm.

The crops were transplanted from greenhouse-grown seedlings to the field as soon as weather permited, and then manually fertilized and irrigated 3 times a week with a (20-20-20) fertilizer.

Crops were harvested by hand at the end of the growing season, with plant samples collected and bagged from each plot, and soil samples collected from 3 cores taken within each plot to a depth of 20 cm.

After crops were harvested, agronomic data such as yield, total biomass, moisture content, root/shoot ratio, height and root length were collected.

Figure 2. RD prior to incorporation 2019

Figure 3. Beds at time of transplanting 2019

Figure 4. field and electric fence, 2020

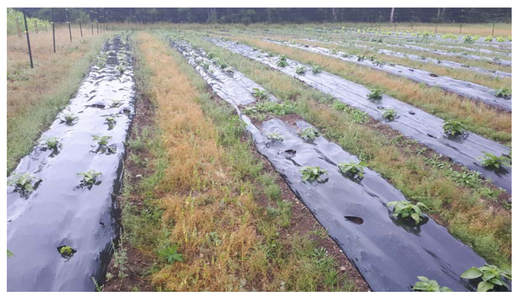


Figure 5. Amaranth Aug 26,2020

Results and Discussion

Due to the Covid-19 pandemic and lockdown, progress on the chemical analysis of plant and soil samples has been delayed, but from preliminary data, there are some observations that can be noted. Lettuce yields were quite different between seasons, presumably due to the change in variety, but the positive response of romaine to a moderate concentration of RD appears very promising.

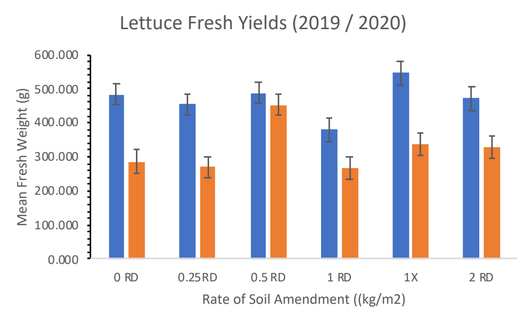
As the concentration of RD increases there does not appear to be a linear response either positively or negatively in yield from either season with any crop. If any treatment demonstrates a consistent positive effect, it is the Huplaso, which as a product already on the market, but the difference is not of statistical significance in all crops.

Unfortunately, in the 2019 growing season the kale crop was destroyed by moose browsing, which is an ongoing problem for many farms in the region. Interestingly enough, the amaranth and lettuce was completely ignored by the moose, but the reason why is not clear. In the 2020 season an electric fence was erected around the fields and there was no further damage.

As chemical analysis progresses, differences in nutritional value of crops based on soil amendment may be revealed

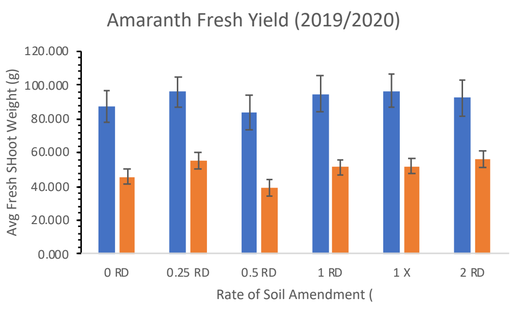
2019 Lettuce RD 1kg/m2

2019 Lettuce HX 1kg/m2



2019 Amaranth RD 0.5 kg/m2

2019 Amaranth RD 0 kg/m2



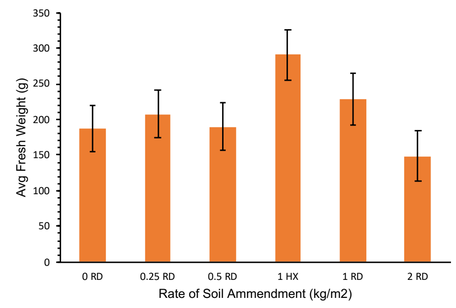
2020 Kale RD 1 kg/m2

30.5 cm avg height
260.57 g avg fresh weight

2020 Kale HX 1 kg/m2

30.71 cm avg height
372.65 g avg fresh weight

2020 Mean Fresh Kale Yield (2020)



Due to the nature of the material the rock dust is derived from, the presence of calcium (Ca) and magnesium (Mg) are the minerals of most importance. Elevated levels of these nutrients are the likely to be observed in the amended soil samples, and the quantities of those nutrients in the plant samples will be of particular interest.

Due to the small particle size of the rock dust, porosity of soil may be improved, and therefore water holding capacity. The increase in small particles may also contribute to an increase in CEC, and this combined with an increase in pH may lead to some improvements in nutritional quality in crops.

As analysis continues, more will be revealed about the implications of this material on agriculture, and what opportunities there may be for its use.

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