Wood ash and Sludge: Potential Liming and Nutrient Sources for Newfoundland Podzolic Soils

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Introduction

- Newfoundland and Labrador produce only 10 % of its food requirement.
- Highly acidic and coarse sandy texture soils, short growing season and extreme weather conditions are the main reasons for low production in NL province.
- There is need of such inputs that can be use as soil amendment to raise soil pH and can improve fertility status of the soil.
- Corner Brook Pulp and Paper mill produces 10000 t/ year of wood ash and 5000 t/year of paper sludge every year which is currently being disposed to landfill sites. Landfilling practice is expensive and have environmental concerns (Lou and Nair, 2008).
- Wood ash and paper sludge can be use as soil amendment which ultimately can reduce disposal cost, increase soil pH and supply mineral nutrients to soil (Etiegni et al., 1991).

Objectives

- To evaluate the effect of wood ash and sludge alone and in combination with biochar on
  - germination, growth and yield of annual ryegrass and kale
  - heavy metal and nutrient uptake in plants
  - heavy metal and mineral nitrogen concentrations, pH, and C:N ratios in soil

Materials and Methods

- Greenhouse experiment was conducted at Wooddale research center by using two soils (soil 1 = 5.2 pH, soil 2 = 5.6 pH) 4 amendments including limestone, wood ash (WA), paper sludge (SL), wood ash + sludge, and two biochar rates. Two crops kale (var. Winterbor) and annual ryegrass (var. Tetila) were selected for greenhouse experiment with randomized complete block design (RCBD) as experimental design.
- The soil used in this study was be collected from the 0 – 15 cm depth of an agricultural field located at/near Wooddale Agriculture and Forestry Development Center. Soil was air dried on plastic sheets, passed through a 4mm sieve and homogenized prior to use.
- Bulk soil for each biochar rate or mill amendment was homogenized with respective amendment. Amended soil was weighed into pots at the rate of 2 to 5 kg of soil and was mixed with respective treatment.
- Each pot was watered to 60% WFPS with tap water and was left for 72 hours for soil stabilization. After 72 hours, six seeds of each crop were directly sown into the pots at 1cm depth.
- Annual ryegrass was harvested after 55 days of sowing and kale was harvested after 90 days of sowing.
- At each harvest, the above ground biomass was harvested by cutting the plants at the soil surface. Plants were carefully rinsed with the ultra-pure water to remove any adhering soil and oven-dried at 60 °C for 72 h prior to weighing and grinding for elemental analysis. After harvest, the soil in each pot was thoroughly mixed and a sample (~500-g dry wt.) was air-dried and passed through a 2-mm sieve prior to laboratory analysis (Katanda, 2014).
- Calculations and statistical analysis were carried out using R 3.0.2
- One-way analysis of variance (ANOVA) followed by Tukey's HSD (honest significant difference) test was performed to reveal significant differences in biomass production in both crops for two soils.

Results

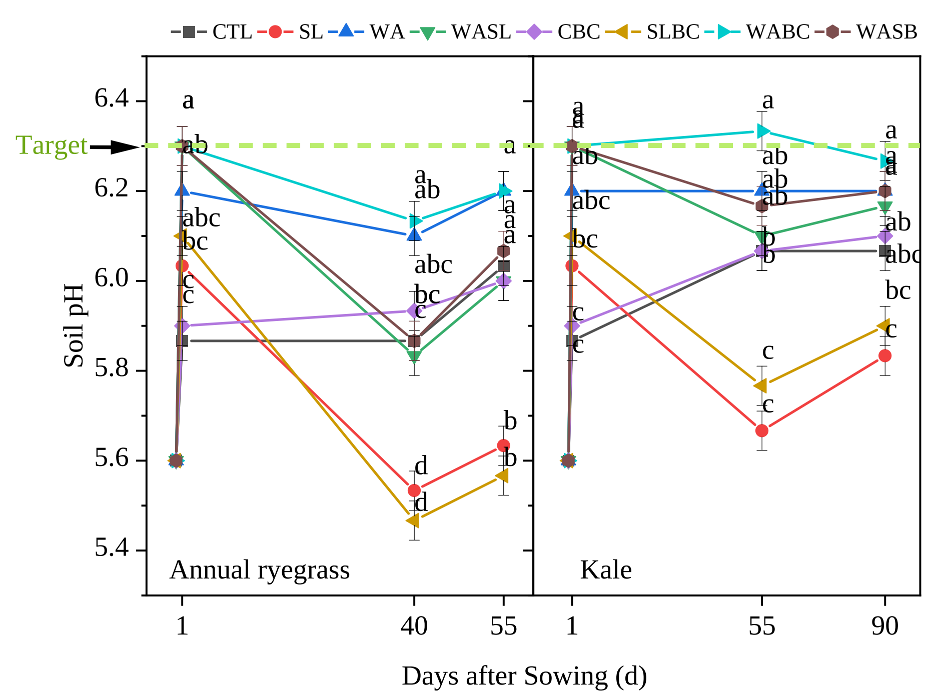

Figure 1. Temporal variation in soil pH of both crops for soil 1 whereas limestone (CTL), wood ash (WA), sludge (SL), wood ash + sludge (WASL), limestone + biochar (CBC), wood ash (WA), sludge + biochar (SLBC), wood ash + sludge + biochar (WSBC) are the experimental treatments. Error bars represent ± SE, n = 3.

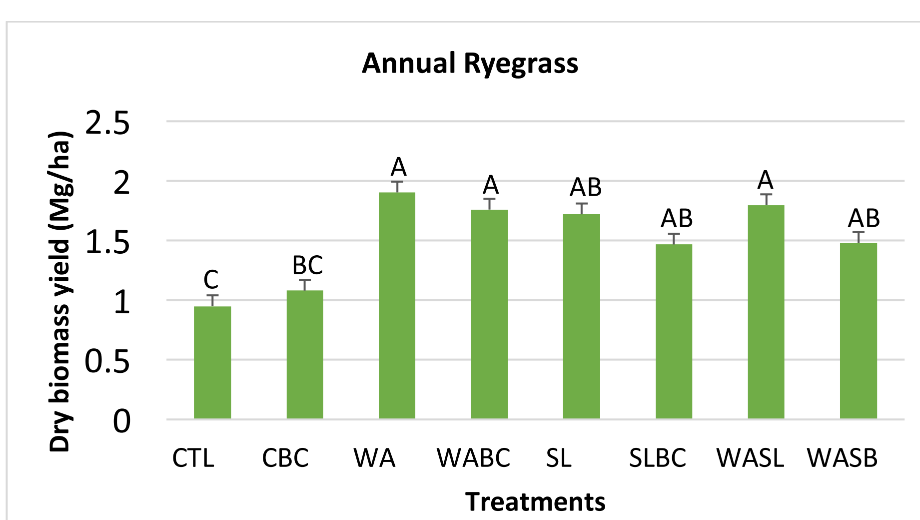

Figure 2. Dry biomass yield of annual ryegrass crop for soil 1 whereas limestone (CTL), wood ash (WA), sludge (SL), wood ash + sludge (WASL), limestone + biochar (CBC), wood ash (WA), sludge + biochar (SLBC), wood ash + sludge + biochar (WSBC) are the experimental treatments. Error bars represent ± SE, n = 3.

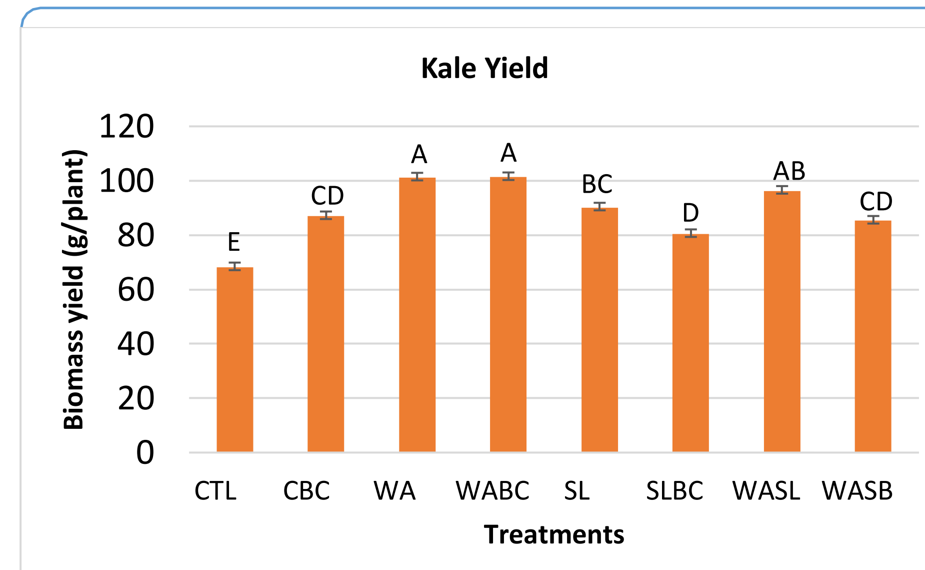

Figure 3. Fresh biomass yield of kale crop for soil 1 whereas limestone (CTL), wood ash (WA), sludge (SL), wood ash + sludge (WASL), limestone + biochar (CBC), wood ash (WA), sludge + biochar (SLBC), wood ash + sludge + biochar (WSBC) are the experimental treatments. Error bars represent ± SE, *n* = 3.

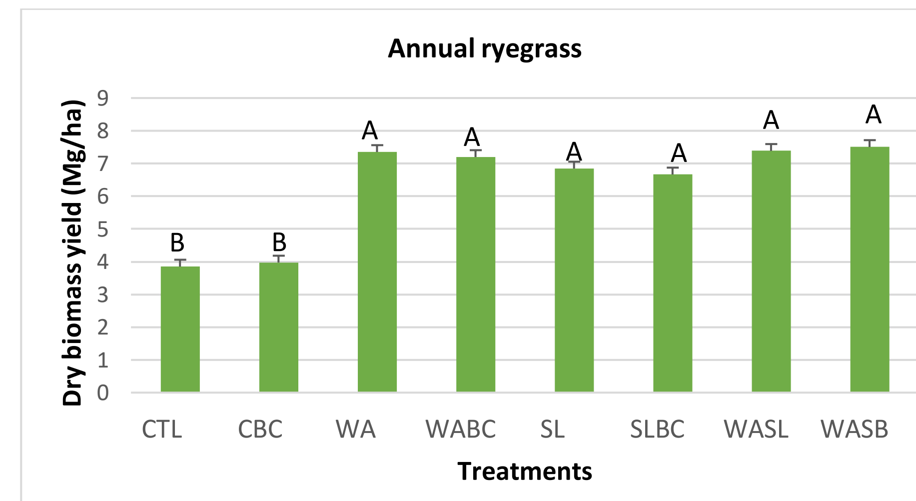

Figure 4. Dry biomass yield of annual ryegrass crop for soil 2 whereas limestone (CTL), wood ash (WA), sludge (SL), wood ash + sludge (WASL), limestone + biochar (CBC), wood ash (WA), sludge + biochar (SLBC), wood ash + sludge + biochar (WSBC) are the experimental treatments. Error bars represent ± SE, n = 3

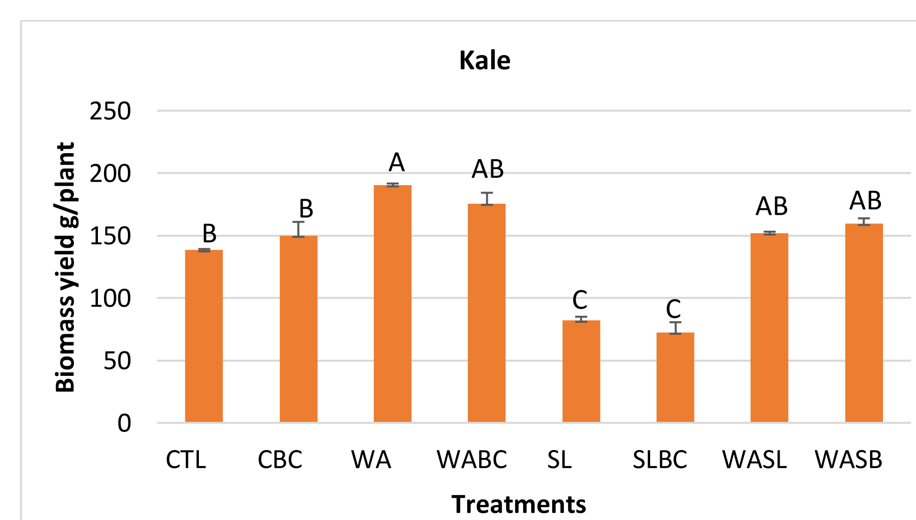

Figure 5 Fresh biomass yield of kale crop for soil 2 whereas limestone (CTL), wood ash (WA), sludge (SL), wood ash + sludge (WASL), limestone + biochar (CBC), wood ash (WA), sludge + biochar (SLBC), wood ash + sludge + biochar (WSBC) are the experimental treatments. Error bars represent ± SE, n = 3.

Conclusion

- Results showed that sludge did not significantly increase pH and therefore it may not be suitable as a liming material at the rates applied in this study
- Wood ash was efficient in achieving the target pH (6.3), which suggests that it can be use as liming material
- Treatments with wood ash and sludge showed superior agronomic performance and produced significantly higher yields as compared to the control (limestone only) except soil 2 kale crop where wood ash and its combination have the highest yield among the other treatments. This indicates that these amendments have potential agronomic benefits in kale and annual ryegrass production

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