

Innovative Strategies for the Valorization of Mussel Waste as a Liming Agent

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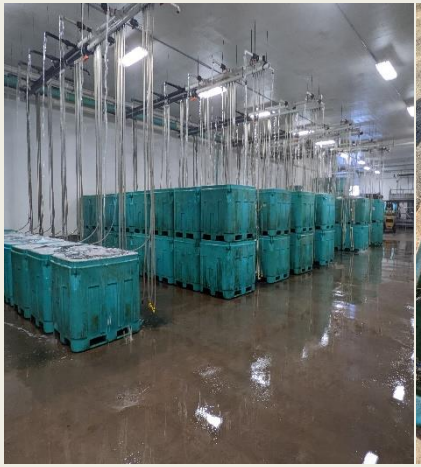
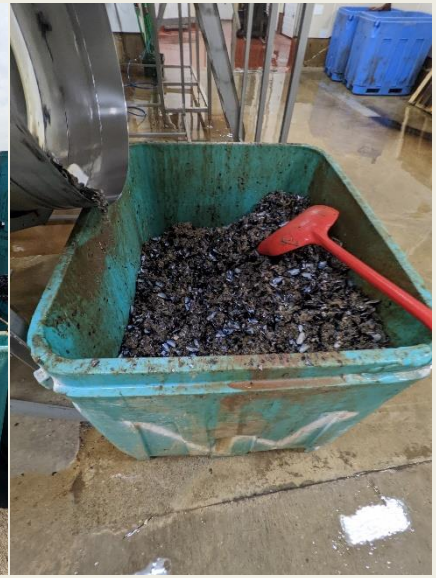
Innovation Waste Management Research Program

Introduction

- Global shellfish production reached 17.5 million tonnes in 2018 (FAO, 2021);
- Growth in the Atlantic Canadian shellfish industry has almost tripled since 1995 to annual harvests of 33,133 tonnes (DFO, 2020);
- PEI's mussel production, with 90 operations and 1,000+ employees, contributes over CAD $60 million to the local economy (Fisheries and Oceans Canada, 2020).

Introduction



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- PEI is Canada's leading blue mussel producer, harvesting 22,730 tonnes annually from 4,451 hectares, about 80% of the national total (PEI Mussels, 2021; ACOA, 2020; PEI Aquaculture Alliance, 2020);
- The shellfish industry, including mussels, clams, quahogs, and oysters, generates 7,000 to 9,000 tonnes of solid waste annually;
- PEAqua Farms Inc., a top-three mussel producer in North America, produces 9,072 tonnes of mussels and 2,770 tonnes of solid waste annually.

Introduction

- Mussel wastes are either landfilled or applied to agricultural land, if locally available.
- Based on commercial waste disposal costs of $115 per tonne (IWMC - PEI Government, 2021), the annual cost to this sector of aquaculture represents a potential cost of **$888,410**.
- Mussel shells consist of up to 95-96% of their weight being $CaCO_3$ (Chakraborty et al., 2020).

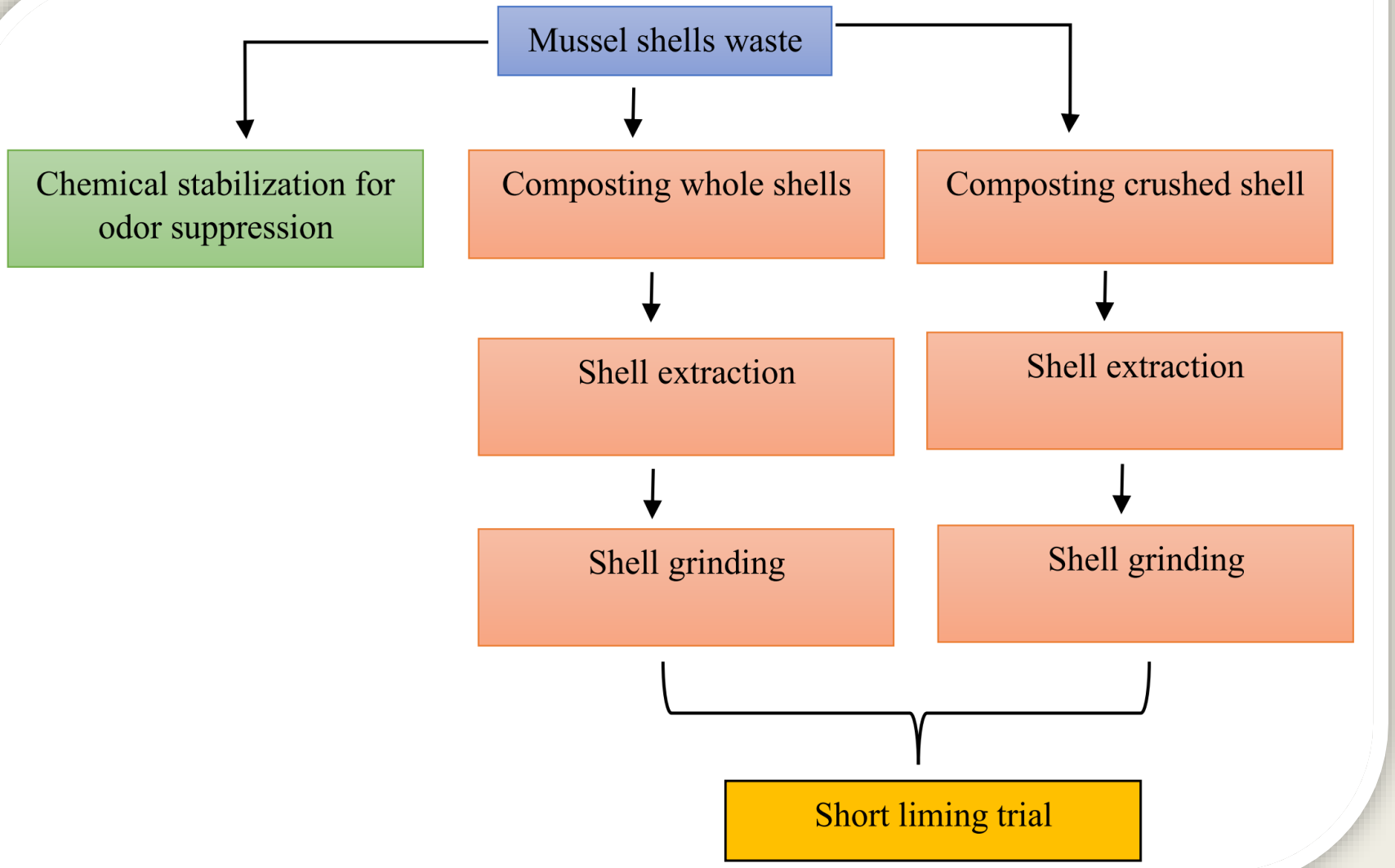
Introduction

- $CaCO_3$ as agricultural lime holds a global market size of CAD$54.8 billion, primarily sourced through mining and quarrying(Grand View Research, 2020).

- Recovering lime from mussel and other shellfish is a viable, sustainable, and eco-friendly recycling method that provides secondary income.

- Processing all mussel and shellfish shells in PEI into agricultural lime could generate up to $6 million annually at $240 per tonne (current retail market rates for 1 tonne totes).

Research Pathway



Short-term liming experiment

- Assess the short-term liming effect of mussel shells at different fineness levels.

Mesh #	Inches	mm
10	0.0787	2
20	0.0331	0.841
40	0.0165	0.4
70	0.0083	0.21

- Eight-week incubation (destructive analysis)
- Soil: pH 5.42 and Target pH of 6.5
- Soil Type: Sandy-loam

Table 1-Physicochemical properties of the different ground mussel shell powders, lime and gypsum used for the experiment.

Parameter	M10		M40		M70		Lime		Gypsum	
	As is basis	Dry basis	As is basis	Dry basis	As is basis	Dry basis	As is basis	Dry basis	As is basis	Dry basis
Dry Matter (%)	99.37	-	97.97	-	98.00	-	98.68	-	98.40	-
Calcium (%)	41.09	41.35	35.98	36.73	31.55	32.19	18.45	18.70	18.51	18.81
$CaCO_3$ (%)	102.72	103.37	89.96	91.82	78.87	80.48	46.13	46.75	46.26	47.02
Magnesium (%)	0.11	0.11	0.15	0.15	0.16	0.16	9.98	10.11	0.83	0.85
MgCO3 (%)	0.37	0.37	0.52	0.53	0.55	0.56	34.61	35.07	2.90	2.94
Neutralizing Value (%)	103.15	103.80	90.58	92.46	79.52	81.14	87.18	88.35	49.69	50.50
Solubility (%)	97.70	98.32	95.76	97.74	94.44	96.37	88.43	89.61	78.16	79.43

Table 2-Calculation amount of each amendment used for pH trial

Dry Basis	M10	M20	M40	M70	Lime	Gypsum
Neutralizing Value	103.80	-	92.46	81.14	88.35	50.5
Amendment applied (g)	0.0241	0.0256	0.0270	0.0308	0.0283	0.0495
Total weight amendment and soil	10.0241	10.0256	10.0270	10.0308	10.0283	10.0495
Grams of water to 22%	2.2053	2.2056	2.2059	2.2068	2.2062	2.2109
Final weight (g)	12.2294	12.2312	12.2330	12.2376	12.2345	12.2604

Mussels Shells Sieved to M20

Mussels Shells Sieved to M40

M20 application into vials

M70 application into vials

Set-up Process

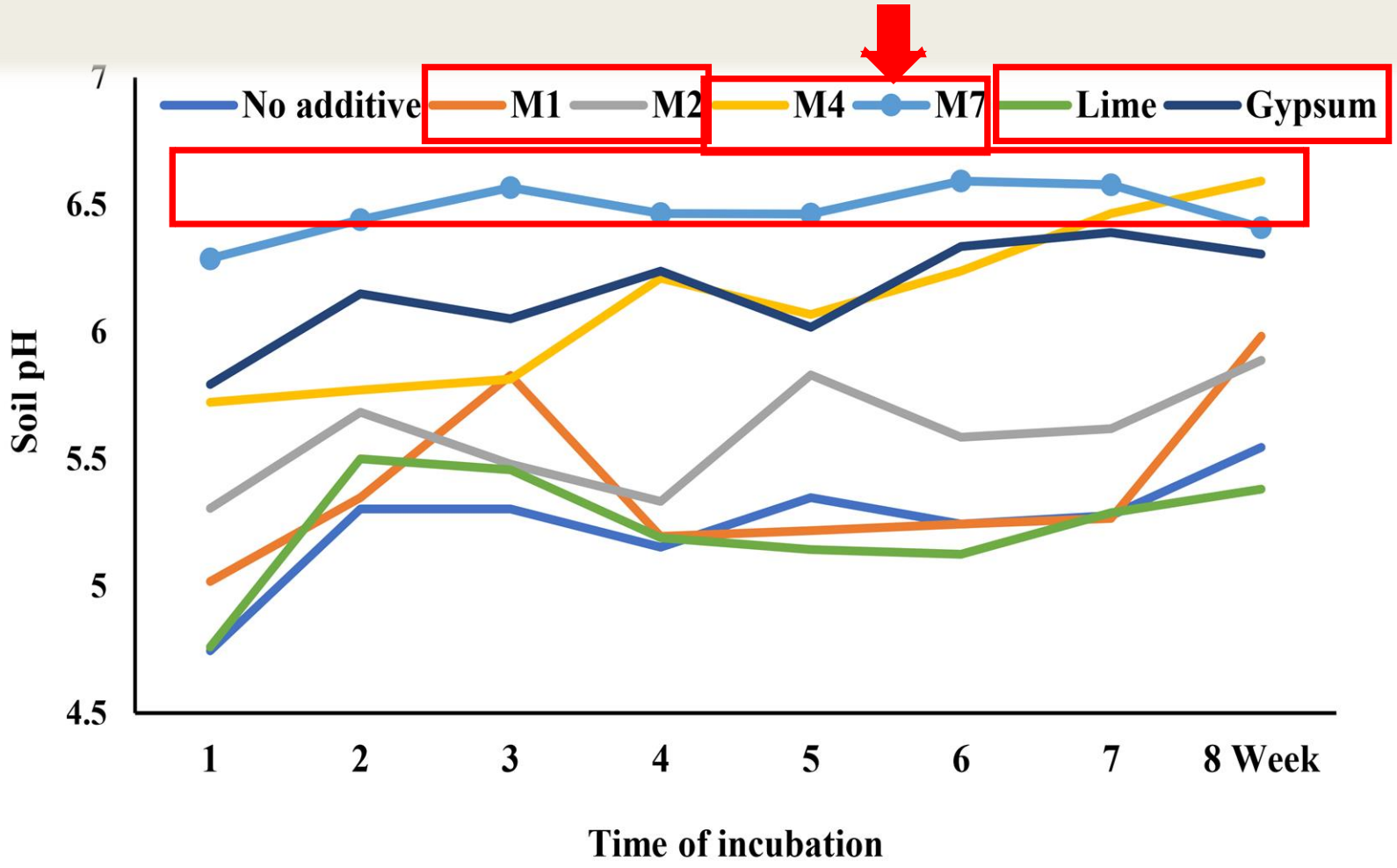


Figure 1- Effect of six different amendments on soil pH values during incubation time

Hydrated lime effects on the volatiles derived from mussel shell

- Mussel shell waste is being stored in large storage containers prior to disposal or collection by local farmers.
- This study aimed to assess hydrated lime stabilization for reducing odors from mussel shell sources at this stage.
- The experiments were organized into two stages, each comprising 18 buckets.

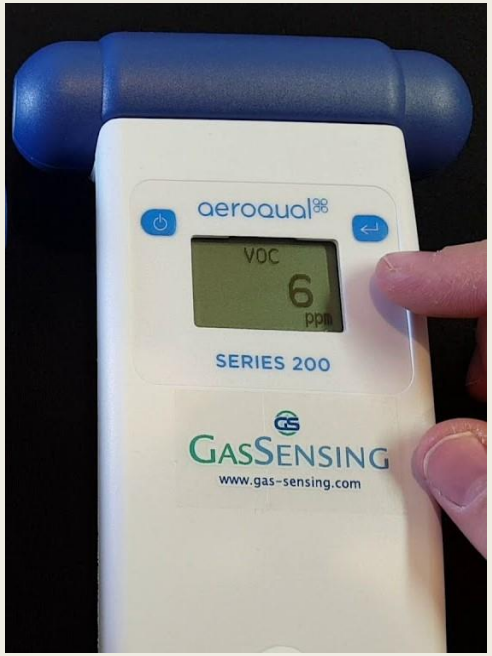
Hydrated lime effects on the volatiles derived from mussel shell

- Treatments: Dried and Liquid Mussel Debysser waste
- 2 kg of mussel shell liquids in the liquid treatments.
- 2%, 3%, 4%, and 5% hydrated lime in both dried and liquid treatments.
- Two control groups, one for dried and one for liquid treatments in each setup
- Careful mixing after the application of treatments

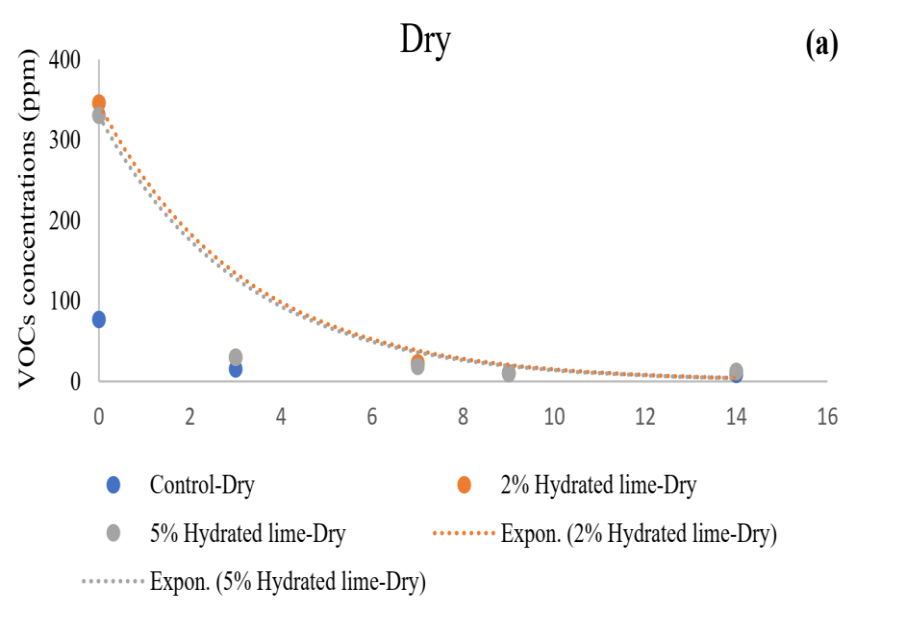
Hydrated lime effects on the volatiles derived from mussel shell

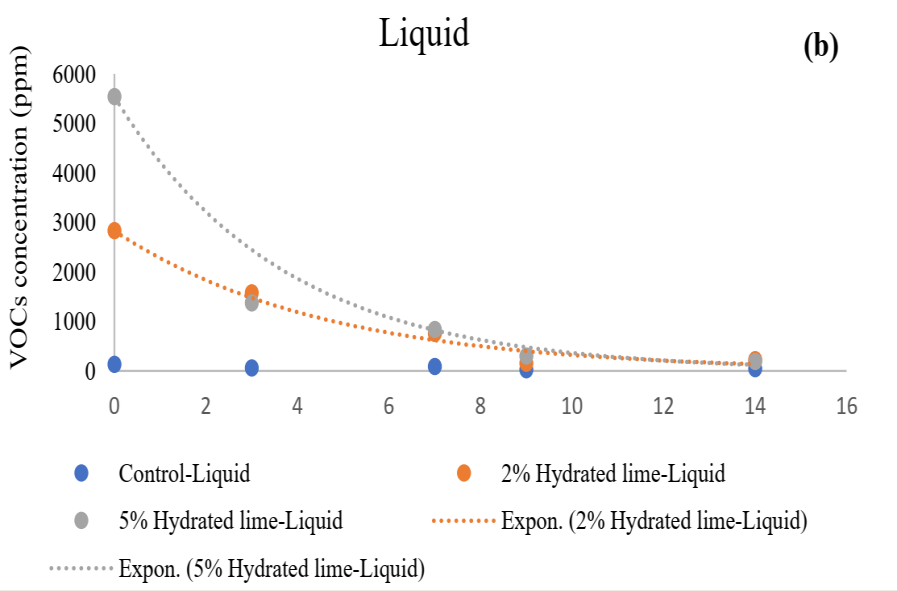
- The experiments were carried out over a period of 10 days.

- VOCs emissions were monitored at 15, 30, 45, and 60 seconds in every other day.
- CO_2 datalogger sensors were employed.

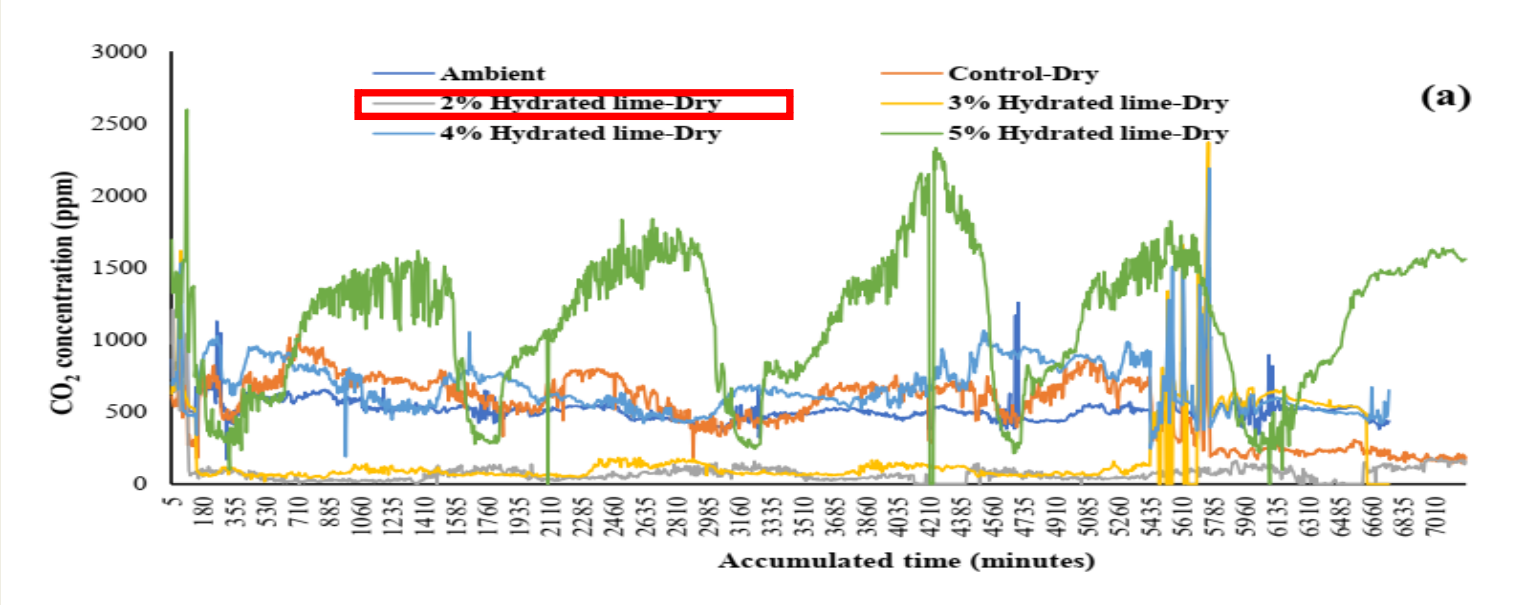


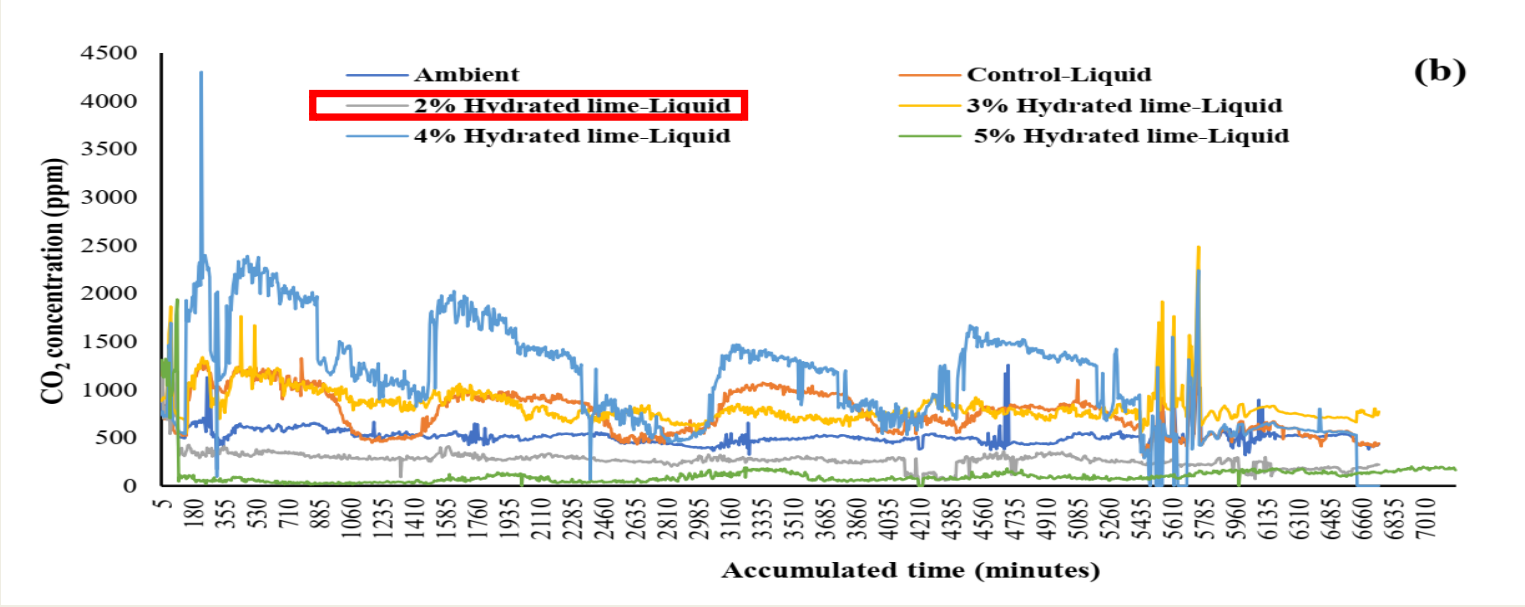
Hydrated lime effects on the VOC concentrations





Hydrated lime effects on the CO_2 concentrations





Summary

- All mussel shell amendments raised soil pH compared to the control. Fine powder increased pH faster than coarse powder, with M70 showing the highest pH throughout the incubation.
- For effective CO_2 suppression and cost-efficiency, apply 2% hydrated lime in both dried and liquid treatments.
- The VOC compositions based on the headspace of each treatment should be analyzed.
- A short-term crop trial in a controlled greenhouse with grow lights and mussel shell as a liming agent is recommended.

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THANK YOU

QUESTIONS?

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