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The Aeration of Buffalo Slurry Reduces Soil GHGs Emissions and Improves Spinach Plant Growth

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Introduction

Recently, many studies have been carried out to find innovative solutions for mitigating the impact of livestock farming on GHG emission. Most of them regard manure management and novel techniques for animal waste treatment (*i.e.* the anaerobic digestion and aerobic treatment). This study investigates the effectiveness of aerobic treatment on the liquid fraction of buffalo slurry: 1) in reducing CO_2 and N_2O emissions following the application on soil 2) in improving agronomic traits of spinach plants.

Materials and Methods

Characteristics of slurry. Liquid fraction (LF) of slurry was collected in flasks and cold stored until utilization. Some aliquots were pre-treated (AS) by insufflating air into the flasks for 24h at 0.8 L min^{-1}, other aliquots were untreated (US).

Agronomic traits and metals content. Agronomic traits and heavy metals content were determined on spinach plants sown in pots. Plants were irrigated twice a week with 50 ml of tap water and fertilised weekly. Control and US plants received 30.0 mg N provided by 50 ml of a commercial nutrient solution and US slurry, respectively. AS plants were fertilised with 50 ml of pre-treated slurry, receiving a lower N amount.

GHG measurements. Soil CO_2 and N_2O fluxes were measured in pots (0.30m diameter and 0.15m height). 150 ml of untreated and pre-treated slurry were spread on soil and CO_2 and N_2O emissions were monitored through the static chamber technique using 0.20m diameter and 0.10m height chambers. CO_2 measurements were performed 30 min. after slurry application while N_2O measurements were performed 3h, 21h, and 23h after spreading the slurry on soil.

Statistical analysis. A one-way analysis of variance (ANOVA) was performed to compare the effect of treatments on plant growth and metal content, and GHG emissions from soil.

Results

Table 1: Dry matter production in control (Ctr) plants and fertilised plants with untreated slurry (US) and pre-treated slurry (AS).

Tratemenrs	Total biomass (g_{dw} $plant^{-1}$)	Shoot (g_{dw} $plant^{-1}$)	Root (g_{dw} $plant^{-1}$)
Ctr	$1.69±0.23^a$	$0.94±0.18^a$	$0.75±0.10^a$
US	$2.69±0.49^b$	$1.55±0.23^b$	$1.15±0.27^b$
AS	$3.68±0.06^c$	$1.57±0.12^b$	$2.11±0.12^c$

Table 2: Heavy metal content in control (Ctr) plants and fertilised plants with untreated slurry (US) and pre-treated slurry (AS).

Treatments	Pb (mg $kg^{-1}{}_{dw}$)		Cd (mg $kg^{-1}{}_{dw}$)		Cu (mg $kg^{-1}{}_{dw}$)		Zn (mg $kg^{-1}{}_{dw}$)	
	Root	Leaves	Root	Leaves	Root	Leaves	Root	Leaves
Ctr	$69.5±1.6^a$	$57.8±2.0^a$	$29.4±6.1^a$	$32.9±3.4^a$	$44.4±5.4^a$	$12.0±0.3^a$	$140.3±11.7^a$	$102.2±1.8^a$
US	$98.6±5.9^b$	$92.0±1.4^b$	$17.5±1.4^b$	$26.2±3.4^b$	$54.3±3.2^b$	$15.6±0.8^b$	$107.2±3.7^b$	$105.1±7.9^a$
AS	$71.0±12.4^a$	$28.1±2.7^c$	$16.6±3.4^b$	$18.9±3.3^c$	$51.8±4.7^b$	$8.3±0.3^c$	$80.7.2±14.3^c$	$77.3±2.0^b$

Table 3: CO_2 and N_2O emission from control (Ctr) and fertilised soil with untreated slurry (US) and pre-treated slurry (AS).

Treatments	CO_2 (mg C-CO_2 m^{-2} h^{-1})		N_2O $_{3h}$ (µg N-N_2O m^{-2} h^{-1})	N_2O $_{21h}$	N_2O $_{23h+H2O}$
Ctr	$0.76±0.002^a$		$0.17±0.48^a$	$-0.16±0.085^a$	$-0.82±0.095^a$
US	$21.79±0.75^b$		$13.3±1.73^b$	$13.18±0.95^b$	$24.22±0.28^d$
AS	$8.36±0.30^c$		$8.82±0.48^c$	$9.39±0.47^c$	$16.47±1.90^e$

Conclusions

The pre-treated slurry results a good fertiliser as it improves spinach growth and reduces the heavy metals content in edible parts of plant.
The aeration process of liquid fraction of slurry promotes a reduction in the ammonia content (the substrate for nitrification), mitigating N_2O emission from soil.
The overall data show that the aerobic treatment of the liquid fraction of slurry subjected to 24 hours of air insufflating might represent a valid strategy to recycle animal wastes and utilise treated slurry as fertiliser.

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