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Evaluation of Phytotoxicity of Manure-derived Fertilisers Using Seed Germination and Root Elongation Bioassays

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INTRODUCTION & AIM

Composting is a sustainable practice that transforms organic waste into useful inputs for agriculture, improving soil health and reducing greenhouse gas emissions (FAO, 2013).

Poultry manure, an abundant waste product from the poultry industry, is valuable for its nitrogen, phosphorus, and organic matter content (Insam et al., 2023); however, its use without proper composting can lead to phytotoxic effects due to salts, ammonia, or heavy metals (Varnero et al., Huerta Muñoz, 2015). Immature composts derived from manures can cause inhibition of germination and growth due to excess nitrogen or toxic compounds (Tiquia et al., 2002).

The aim of the study was to evaluate the phytotoxicity of poultry manure, composted and fresh, using bioassays with three plant species, assessing fertilizer effects on germination and root growth to define their viability as an agricultural input.

METHOD

This study assessed the phytotoxicity of composts derived from poultry manure through seed germination and root elongation bioassays. Three species were selected: Sunflower (*Helianthus annuus*), Mungbean (*Vigna radiata)*, and White mustard (*Sinapis alba)*.

The treatments included aereated compost mixture (poultry manure+maize stover), static compost mixture, aereated poultry manure, static poultry manure, and fresh poultry manure (Campuzano et al., 2024). Elutriates of these fertilisers were obtained (10% m/v) and then diluted to obtain concentrations of 0, 25, 50, 75 and 100% (v/v).

The seeds were disinfected and exposed to the dilutions and monitored for germination and root elongations during 4 days.

Relative growth (RGI) and germination (GI) indexes were calculated according to Bagur-González et al. (2011), with toxicity thresholds set at <70% (high), 70–100% (low), and >100% (none).

RESULTS & DISCUSSION

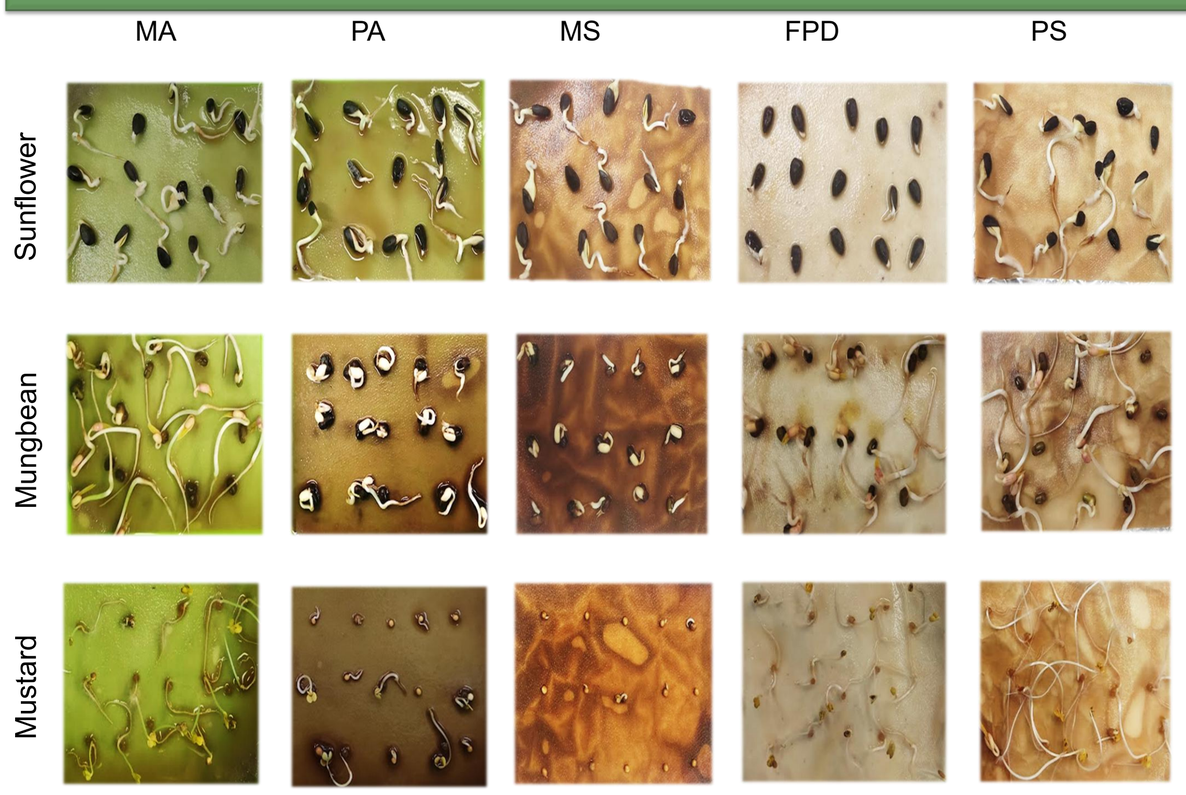

Figure 1. Germination and radicular response of seeds exposed to different fertilisers: aereated compost mixture (MA), aereated poultry manure (PA), static compost mixture (MS), fresh poultry manure (FPD) and static poultry manure (PS).

Sunflower showed low toxicity effects with composted treatments, either static (MS,PS) or aerated ones (MA, PA), with a mean RGI of 1.07±0.22 and GI of 99.5±18.26 for all concentrations studied. This species showed good ability as a bioindicator of moderately stabilized composts.

Mungbeans showed high sensitivity to most composting treatments, particularly PA (RGI:0.7±0.25; GI:74±23.54) and MS (RGI:0.62±0.36; GI:64.24±38.84), while only PS showed low toxicity (RGI:0.94±0.15; GI:94.18±13.23). For both sunflower and mungbeans, FPD decreased germination and radicle growth below 70, showing high toxicity in both indexes. Mustard had variable responses, no sensitivity to PS and MA treatments, with average RGI of 1.5 and GI of 147.32, while MS and FPD caused slightly low toxicity, and PA had high toxicity. Root elongation (RGI) was more robust than germination (GI) for detecting phytotoxicity.

Table 1. Maximum percentage of elutriate at which no inhibition effects wre observed in GI or RGI.

Treatment	Sunflower	Mungbean	Mustard
Aereated Compost	100%	50%	100%
Aereated poultry manure	50%	25%	25%
Static compost	75%	25%	50%
Fresh poultry droppings	25%	0%	75%
Static poultry manure	100%	25%	100%

CONCLUSION

Phytotoxicity was negatively associated with compost maturity, with oxygenated compost showing the least toxicity due to reduced ammonia and phenolic compounds, which probably caused the observed effects on mungbean.

Fresh and static poultry manure (partially composted) exhibited high toxicity, likely due to unstable pH and high soluble salts. Root elongation was more sensitive than germination as a phytotoxicity indicator.

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