Physicochemical and Biological Changes of Compost Inoculated with Pseudomonas Aeruginosa AACL and Rock Phosphate: Implications for P Availability

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ABSTRACT

INTRODUCTION

Phosphorus (P) is an important nutrient for plant growth (Raimi *et al*., 2024). Although soil contains plentiful amounts of P, yet its availability in soil is often limited due to its conversion into insoluble forms. Soil phosphorus is mainly in the form of inorganic phosphate, which is not readily available for plant uptake Reddy *et al*. (2024). Phosphate-solubilizing bacteria (PSB) like *Pseudomonas aeruginosa* can transform insoluble phosphates into soluble forms of phosphorus through the production of phosphatase, phytase, organic acids, chelation, mineralization, and by lowering soil pH (Bachtiar *et al*., 2024; He *et al*., 2024). This study focuses on enhancing phosphorus availability by combining PSB inoculation with rock phosphate (RP) in compost.

OBJECTIVE

The goal of this study was to design compost enriched with PSB (*Pseudomonas aeruginosa* AAC1) and rock phosphate (RP) to improve phosphorus availability for agricultural use.

METHODOLOGY

Four compost piles were prepared with RP and 30:1 carbon-to-nitrogen (C: N). Out of these, two piles were inoculated with PSB strain *Pseudomonas aeruginosa* AAC1 (RP + AAC1) while two piles were left un-inoculated and served as control (RP). The physicochemical, microbiological and heavy metal analysis was performed.

RESULT

The physicochemical assessment of the designed compost revealed that the addition of RP and inoculation of *P. aeruginosa* AAC1 (RP + AAC1) significantly ($p < 0.05$) increased the composting temperature (over 58 °C), calcium (36.84%), magnesium (35%) and available P contents (43.50%) (Figure **1** & Table **1**) indicating the solubilization of inorganic P, Ca and Mg bound phosphates However, the addition did not significantly ($p > 0.05$) influence the carbon (C), carbon to nitrogen (C/N) ratio, organic matter, and ash content but significantly ($p < 0.05$) reduced the moisture content (41%) and pH (up to 5.4). After 60 days, all compost piles reached maturity at temperature ranges of 27-30 °C, pH level between 7.2–7.6, and moisture content 31-35%. Scanning electron microscopy and energy-dispersive X-ray spectrometry (SEM-EDS) confirmed the presence of elements including carbon (C), oxygen (O), magnesium (Mg), aluminum (Al), silicon (Si), calcium (Ca), and P (P) in the compost. Microbiological monitoring revealed the survival of *P. aeruginosa* AAC1 during the composting process even at higher temperatures (~58 °C) (Figure **2**). Indigenous bacterial populations were recovered within the range of 10^9 - 10^{14} $CFUg^{-1}$. Compost was also safe in regard to heavy metal concentrations.

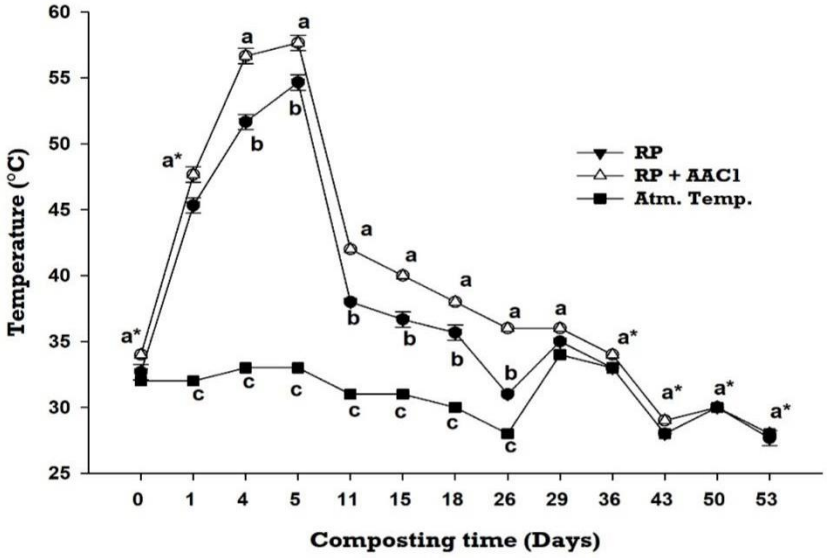

Figure 1. Temperature profile of compost pile amended with rock phosphate only (RP) and rock phosphate with *Pseudomonas aeruginosa* AAC1 (RP + AAC1).

Table 1. Chemical Monitoring of Compost piles after 0, 30, and 60 Days of Inoculation.

Days	Treatments	C %	N %	C/N ratio	O.M %	Ash%	Ca %	Mg %	Available P %
0	RP	23.8^{a}	0.77^{a}	30.90^{a}	64^{a}	36^{a}	1.30^{a}	0.12^{a}	3.04^{a}
	RP +AAC1	22.9^{a}	0.74^{a}	30.94^{a}	62^{a}	38^{a}	2.70^{b}	0.21^{b}	3.97^{a}
30	RP	18^{b}	0.97^{b}	18.55^{b}	48^{b}	52^{b}	3.61^{c}	0.43^{c}	4.01^{b}
	RP + AAC1	14^{b}	0.98^{b}	14.28^{b}	40^{b}	60^{b}	5.94^{d}	0.67^{d}	6.47^{c}
60	RP	14.4^{b}	1.0^{b}	14.40^{b}	26^{c}	74^{c}	5.10^{d}	0.52^{cd}	5.27^{bc}
	RP + AAC1	11.4^{b}	1.2^{c}	10.50^{b}	21^{c}	79^{c}	7.90^{e}	0.75^{e}	7.17^{d}

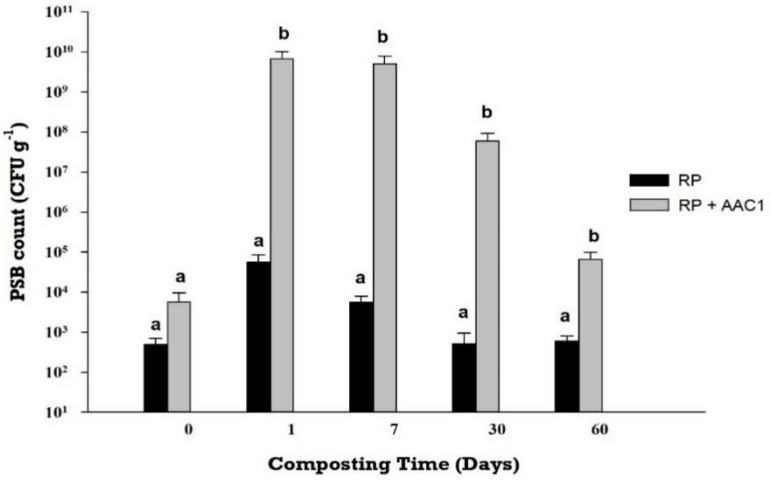

Figure 2. Variations in the enumeration of PSB count between compost piles amended with rock phosphate only (RP) and rock phosphate with *Pseudomonas aeruginosa* AAC1 (RP + AAC1).at different time intervals.

CONCLUSION

This study demonstrates that the combination of *Pseudomonas aeruginosa* AAC1 and rock phosphate in compost significantly improves phosphorus availability, making it an effective phosphatic biofertilizer for sustainable agriculture. The results suggest that this method can reduce dependency on chemical fertilizers, offering an eco-friendly alternative to enhance soil fertility.

ACKNOWLEDGMENT

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