

Gasified Rice Hull Biochar Affects Nutrition and Growth of Horticultural Crops in Container Substrates

Nitrogen (N), phosphorus (P), and potassium (K) are the primary nutrients applied to container crops. With some forms of nutrients becoming expensive and with limited availability this research explored the use of a gasified rice hull biochar (GRHB) as an alternative source to provide phosphate and potassium to container crops. A laboratory and greenhouse study was conducted to determine the quantity and timing of phosphate and K release from GRHB, and its effectiveness in providing supplemental nutrients to container crops.

Glass jars were filled with 200 mL of deionized water and 5.4 g GRHB. Each day, a 15 mL sample was removed from each jar for analysis. Geranium (*Pelargonium xhortorum* 'Maverick Red'), pansy (*Viola xwittrockiana* 'Mammoth Blue Deep Dazzle'), sunflower (*Helianthus annuus* 'Pacino Gold'), zinnia (*Zinnia elegans* 'Oklahoma White'), and tomato (*Lycopersicon lycopersicum* 'Mega Bite') were grown in a standard moss:perlite (85:15, by vol) commercial soilless substrate.

Control plants were fertilized with 7.1 mM N, 0.7 mM P, and 1.4 mM K using ammonium nitrate (NH₄NO₃) and potassium phosphate (K₂HPO₄). Other treatments received 0, 5, or 10% GRHB (Table 1) and fertilized with 7.1 mM N using NH₄NO₃.

Both nutrients reached maximum concentration in 4 to 5 days and remained constant over time (Figure 1). Gasified rice hull biochar had little effect on substrate pH over the course of the experiment. While the five crops grown in this study were of similar size and lacked any signs of nutrient deficiency when amended with GRHB, foliar concentrations of P and K were low when the source was from pre-incorporated GRHB (Table 2). This product provides readily available phosphate and K when incorporated at 5 or 10% and has potential to replace some P and K fertilizers added to irrigation systems. Additional work with higher rates for meeting plant needs over longer production periods is needed.

Figure 1. Phosphate and K release from gasified rice hull biochar (GRHB) in a water solution.

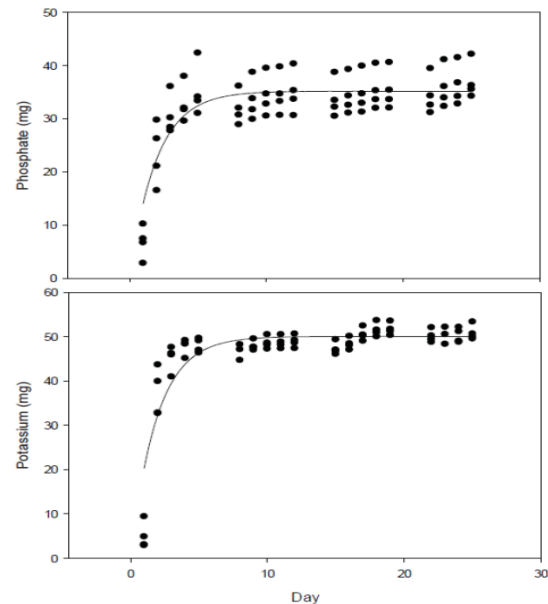


Table 1. Chemical properties of gasified rice hull biochar prior to substrate amendment.

	Units	Value
pH		10.54
Carbon	(%)	17.68
Nitrogen		0.18
Phosphorus		0.30
Potassium		0.98
Calcium		0.35
Magnesium		0.15
Sulfur		0.03
Silicon		11.72
Boron	mg·kg ⁻¹	10.36
Copper		8.42
Iron		197.3
Manganese		541.0
Molybdenum		ND ^a
Zinc		46.34

^aNot detectable.

Nutrient	Treatment	Fertilizer applied	Sunflower		Tomato			Zinnia			Geranium	Pansy	
			2 WAP ^a	4 WAP	6 WAP	2 WAP	4 WAP	6 WAP	2 WAP	4 WAP	6 WAP	6 WAP	6 WAP
%													
Phosphorus	Control	NH ₄ NO ₃ + K ₂ HPO ₄	0.61	0.67	0.68	0.85	0.79	0.68	0.88	0.99	0.85	0.41	0.73
	GRHB 0%	NH ₄ NO ₃	0.38	0.19	0.15	0.22	0.11	0.09	0.25	0.14	0.09	0.08	0.11
	GRHB 5%	NH ₄ NO ₃	0.63	0.45	0.28	0.72	0.32	0.14	0.77	0.35	0.15	0.14	0.23
	GRHB 10%	NH ₄ NO ₃	0.70	0.59	0.45	0.86	0.53	0.24	0.86	0.73	0.31	0.22	0.33
	Linear rate response ^b			L***	L***	L***	L***	L***	L***	L***	L***	L***	L***
	LSD _{0.05} ^w		0.04	0.05	0.07	0.15	0.05	0.04	0.08	0.06	0.08	0.03	0.07
	Recommended range		0.7–0.8 ^a			0.31–0.46 ^a			0.74 ^a			0.33–0.51 ^a 0.37–0.64 ^a	
Potassium	Control	NH ₄ NO ₃ + K ₂ HPO ₄	3.65	3.88	4.16	4.22	3.66	2.74	4.27	3.54	3.05	1.97	4.33
	GRHB 0%	NH ₄ NO ₃	2.28	1.81	1.89	2.48	2.04	2.34	2.16	1.71	1.79	1.55	2.55
	GRHB 5%	NH ₄ NO ₃	4.72	3.79	2.53	4.77	2.58	1.63	5.60	3.12	1.56	1.41	2.69
	GRHB 10%	NH ₄ NO ₃	5.21	4.82	3.68	5.54	4.07	2.07	6.70	5.23	2.33	2.14	3.37
	Linear rate response			L***	L***	L***	L***	L***	L**	L***	L***	L**	L*
	LSD _{0.05}		0.26	0.33	0.45	0.79	0.46	0.15	0.56	0.49	0.30	0.35	0.66
	Recommended range		5.4–6.3			3.5–5.1			3.3			3.2–3.4 2.4–2.9	

Table 2. Foliar phosphorus and potassium concentration on dry weight basis for sunflower, tomato, zinnia, geranium, and pansy.

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