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### **Supplementary Material**

#### **Improved native understorey establishment in mine waste rock in Australia's wet-dry tropics**

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**Table S1: Details of waste rock analyses for the Trial Landform ( $n = 6$ ) and material used in the shadehouse at CDU ( $n = 3$ ).**

Attribute	Extractant	Method	Units	TLF	CDU	
pH	(1:5 Water)	4A1		$8.6 \pm 0.2$	$8.1 \pm 0.1$	
pH	(1:5 CaCl <sub>2</sub> )	4B2		$7.9 \pm 0.2$	$7.4 \pm 0.0$	
EC	(1:5 Water)	3A1	dS m <sup>-1</sup>	$0.08 \pm 0.02$	$0.08 \pm 0.00$	
Organic C		6A1	g kg <sup>-1</sup>	$<1.5 \pm 0.0$	VL $<1.5 \pm 0.0$	VL
NH <sub>4</sub> <sup>+</sup>	KCl	7C2b	mg kg <sup>-1</sup>	$2.05 \pm 0.50$	VL $0.84 \pm 0.02$	VL
NO <sub>3</sub> <sup>-</sup>	KCl	7C2b	mg kg <sup>-1</sup>	$2.17 \pm 0.79$	VL $1.43 \pm 0.09$	VL
K	Colwell	18A1	mg kg <sup>-1</sup>	$63 \pm 4$	L $76 \pm 1$	L
P	Colwell	18A1	mg kg <sup>-1</sup>	$6.5 \pm 1.3$	VL $7.3 \pm 0.4$	VL
Cl	1:5 water	5A2b	mg kg <sup>-1</sup>	$10.3 \pm 0.3$	$<10 \pm 0.0$	
S	KCl	10B3	mg kg <sup>-1</sup>	$32.6 \pm 12.3$	$39.7 \pm 1.5$	
Ca	Amm. Acet.	15D3	cmol(+)kg <sup>-1</sup>	$2.2 \pm 0.4$	$1.8 \pm 0.0$	
K	Amm. Acet.	15D3	cmol(+)kg <sup>-1</sup>	$0.16 \pm 0.01$	$0.19 \pm 0.00$	
Mg	Amm. Acet.	15D3	cmol(+)kg <sup>-1</sup>	$2.9 \pm 0.4$	$4.6 \pm 0.1$	
Al	KCl	15G1	cmol(+)kg <sup>-1</sup>	$< 0.10 \pm 0.00$	$< 0.10 \pm 0.00$	
Na	Amm. Acet.	15D3	cmol(+)kg <sup>-1</sup>	$0.057 \pm 0.007$	$0.037 \pm 0.015$	
CEC		15J1	cmol(+)kg <sup>-1</sup>	$5.40 \pm 0.82$	L $6.53 \pm 0.11$	L
Sodicity		Calculation	%	$1.2 \pm 0.2$	$1.0 \pm 0.0$	
Cu	DTPA	12A1	mg kg <sup>-1</sup>	$0.68 \pm 0.27$	$1.57 \pm 0.03$	
Fe	DTPA	12A1	mg kg <sup>-1</sup>	$5.5 \pm 1.2$	$6.1 \pm 0.7$	
Mn	DTPA	12A1	mg kg <sup>-1</sup>	$1.65 \pm 0.29$	L $0.75 \pm 0.10$	L
Zn	DTPA	12A1	mg kg <sup>-1</sup>	$0.125 \pm 0.043$	L $0.317 \pm 0.052$	L
Bo	Hot CaCl <sub>2</sub>	12C2	mg kg <sup>-1</sup>	$0.39 \pm 0.06$	L $0.22 \pm 0.00$	L
Texture				Loamy Sand	Loamy Sand	
Silt			%	$7.9 \pm 0.5$	$8.3 \pm 0.4$	
Clay			%	$4.6 \pm 0.6$	$9.5 \pm 0.4$	
Sand			%	$87.5 \pm 0.8$	$82.2 \pm 0.4$	

Nutrient values that may affect plant growth (Landon 2014) are noted as low (L) or very low (VL). Method as described in Rayment and Lyons (2011). Soil texture analysis as described in: Gee and Or (2002). Attributes with L (low) or VL (very low) would likely be deficient for plant growth (Landon 2014).

**Table S2: Seed weight and seed germination results for the eight trial species.**

Species	Seed weight (mg)	Seed germination (%)
	Mean $\pm$ s.e.	Mean $\pm$ s.e.
<i>Alloteropsis semialata</i>	$2.3 \pm 0.2$	$45 \pm 6$
<i>Aristida holathera</i>	$9.0 \pm 0.6$	$61 \pm 7$
<i>Eriachne armittii</i>	$0.6 \pm 0.0$	$39 \pm 4$
<i>Eriachne obtusa</i>	$0.4 \pm 0.0$	$42 \pm 6$
<i>Acacia gonocarpa</i>	$7.0 \pm 0.1$	$46 \pm 5$
<i>Galactia tenuiflora</i>	$22.3 \pm 0.3$	$55 \pm 15$
<i>Indigofera saxicola</i>	$3.3 \pm 0.1$	$58 \pm 4$
<i>Tephrosia oblongata</i>	$9.6 \pm 0.0$	$35 \pm 7$

**Table S3: Treatment effects on shadehouse seedling emergence.**

Species	Treatment	Control	Fertiliser	Sand	Litter	OM	Mixed
<i>A. semialata</i>	Control		0.075	0.049*	0.075	<0.001***	0.010**
	Fertiliser	0.075		0.997	1.000	0.075	0.972
	Sand	0.049*	0.997		0.997	0.091	0.972
	Litter	0.075	1.000	0.997		0.075	0.972
	OM	<0.001***	0.075	0.091	0.075		0.286
	Mixed	0.010**	0.972	0.972	0.972	0.286	
<i>A. holathera</i>	Control		0.981	0.981	0.981	<0.001***	0.839
	Fertiliser	0.981		0.981	0.839	<0.001***	0.981
	Sand	0.981	0.981		0.981	<0.001***	0.839
	Litter	0.981	0.839	0.981		<0.001***	0.406
	OM	<0.001***	<0.001***	<0.001***	<0.001***		<0.001***
	Mixed	0.839	0.981	0.839	0.406	<0.001***	
<i>E. armitii</i>	Control		1.000	1.000	1.000	1.000	0.881
	Fertiliser	1.000		0.993	1.000	1.000	0.671
	Sand	1.000	0.993		0.997	0.999	0.988
	Litter	1.000	1.000	0.997		1.000	0.752
	OM	1.000	1.000	0.999	1.000		0.824
	Mixed	0.881	0.671	0.988	0.752	0.824	
<i>E. obtusa</i>	Control		0.989	0.989	0.865	0.978	0.865
	Fertiliser	0.989		1.000	0.989	0.806	0.989
	Sand	0.989	1.000		0.989	0.806	0.989
	Litter	0.865	0.989	0.989		0.319	1.000
	OM	0.978	0.806	0.806	0.319		0.319
	Mixed	0.865	0.989	0.989	1.000	0.319	
<i>A. gonocarpa</i>	Control		<0.001***	<0.001***	0.039*	<0.001***	0.355
	Fertiliser	<0.001***		<0.001***	<0.001***	<0.001***	<0.001***
	Sand	<0.001***	<0.001***		<0.001***	0.355	<0.001***
	Litter	0.039*	<0.001***	<0.001***		<0.001***	0.249
	OM	<0.001***	<0.001***	0.355	<0.001***		<0.001***
	Mixed	0.355	<0.001***	<0.001***	0.249	<0.001***	
<i>G. tenuiflora</i>	Control		0.740	<0.001***	0.052	0.085	0.369
	Fertiliser	0.740		<0.001***	0.088	0.048*	0.488
	Sand	<0.001***	<0.001***		<0.001***	0.004**	<0.001***
	Litter	0.052	0.088	<0.001***		<0.001***	0.488
	OM	0.085	0.048*	0.004**	<0.001***		0.001**
	Mixed	0.369	0.488	<0.001***	0.488	0.001**	
<i>I. saxicola</i>	Control		0.615	<0.001***	0.903	<0.001***	0.029*
	Fertiliser	0.615		0.002**	0.615	<0.001***	0.224
	Sand	<0.001***	0.002**		<0.001***	0.182	0.211
	Litter	0.903	0.615	<0.001***		<0.001***	0.035*
	OM	<0.001***	<0.001***	0.182	<0.001***		0.001**
	Mixed	0.029*	0.224	0.211	0.035*	0.001**	
<i>T. oblongata</i>	Control		0.864	0.003**	0.907	0.093	0.982
	Fertiliser	0.864		<0.001***	0.602	0.008**	0.864
	Sand	0.003**	<0.001***		0.014*	0.711	0.003**
	Litter	0.907	0.602	0.014*		0.288	0.907
	OM	0.093	0.008**	0.711	0.288		0.093
	Mixed	0.982	0.864	0.003**	0.907	0.093	

Model results of adjusted p-values after pairwise comparisons (\*  $P < 0.05$ ; \*\*  $P < 0.01$ ; \*\*\*  $P < 0.001$ ).

**Table S4: Treatment effect on trial landform seedling emergence.**

Species	Treatment	Control	Fertiliser	Sand	Litter	OM	Mixed
<i>A. semialata</i>	Control		0.974	0.165	0.132	0.113	0.974
	Fertiliser	0.974		0.208	0.075	0.165	0.974
	Sand	0.165	0.208		0.001**	0.940	0.280
	Litter	0.132	0.075	0.001**		<0.001***	0.071
	OM	0.113	0.165	0.940	<0.001***		0.165
	Mixed	0.974	0.974	0.280	0.071	0.165	
<i>E. armitii</i>	Control		1.000	0.916	0.916	0.997	0.677
	Fertiliser	1.000		0.916	0.916	0.997	0.677
	Sand	0.916	0.916		0.409	0.916	0.916
	Litter	0.916	0.916	0.409		0.898	0.180
	OM	0.997	0.997	0.916	0.898		0.715
	Mixed	0.677	0.677	0.916	0.180	0.715	
<i>G. tenuiflora</i>	Control		0.220	0.001**	0.011*	0.011*	0.429
	Fertiliser	0.220		0.077	<0.001***	0.380	0.429
	Sand	0.001**	0.077		<0.001***	0.424	0.015*
	Litter	0.011*	<0.001***	<0.001***		<0.001***	<0.001***
	OM	0.011*	0.380	0.424	<0.001***		0.115
	Mixed	0.429	0.429	0.015*	<0.001***	0.115	
<i>I. saxicola</i>	Control		0.702	0.027*	0.459	0.198	0.027*
	Fertiliser	0.702		0.099	0.147	0.508	0.099
	Sand	0.027*	0.099		0.001**	0.508	1.000
	Litter	0.459	0.147	0.001**		0.007**	0.001**
	OM	0.198	0.508	0.508	0.007**		0.508
	Mixed	0.027*	0.099	1.000	0.001**	0.508	

Model results of adjusted *P*-values after pairwise comparisons (\*, *P* < 0.05; \*\*, *P* < 0.01; \*\*\*, *P* < 0.001).

**Table S5. PERMANOVA and PERMDISP results for the shadehouse plant heights.**

Species	Factor	Pseudo- <i>F</i> (df)	<i>P</i> -value	PermDISP <i>P</i> -value
<i>A. semialata</i>	Treatment	15.57 (5)	0.001	0.001
	Time	145.68 (8)	0.001	
	Pot (Tr)	1.93 (24)	0.015	
	Plant (Pot(Tr))	31.67 (89)	0.001	
	Time × Treatment	13.2 (40)	0.001	
	Time × Pot (Tr)	3.15 (192)	0.001	
	<i>A. holathera</i>	Treatment	20.68 (5)	
Time	60.73 (8)	0.001		
Pot (Tr)	2.72 (24)	0.004		
Plant (Pot(Tr))	2.95 (90)	0.001		
Time × Treatment	4.45 (40)	0.001		
Time × Pot (Tr)	1.94 (177)	0.001		
<i>E. armitii</i>	Treatment	16.32 (5)	0.001	0.001
Time	18.63 (8)	0.001		
Pot (Tr)	2.64 (24)	0.002		
Plant (Pot(Tr))	50.49 (87)	0.001		
Time × Treatment	4.44 (40)	0.001		
Time × Pot (Tr)	3.49 (192)	0.001		
<i>E. obtusa</i>	Treatment	18.98 (5)	0.001	
Time	104.05 (8)	0.001		
Pot (Tr)	2.76 (18)	0.030		
Plant (Pot(Tr))	21.04 (26)	0.001		
Time × Treatment	12.99 (40)	0.001		
Time × Pot (Tr)	2.53 (136)	0.001		
<i>A. gonocarpa</i>	Treatment	4.74 (5)	0.005	0.001
Time	59.90 (8)	0.001		
Pot (Tr)	2.91 (24)	0.002		
Plant (Pot(Tr))	8.62 (87)	0.001		
Time × Treatment	3.03 (40)	0.001		
Time × Pot (Tr)	2.97 (192)	0.001		
<i>G. tenuiflora</i>	Treatment	29.88 (5)	0.001	
Time	87.43 (8)	0.001		
Pot (Tr)	0.44 (24)	0.989		
Plant (Pot(Tr))	125.08 (86)	0.001		
Time × Treatment	1.63 (40)	0.015		
Time × Pot (Tr)	1.38 (184)	0.001		
<i>I. saxicola</i>	Treatment	6.44 (5)	0.002	0.001
Time	146.71 (8)	0.001		
Pot (Tr)	1.75 (24)	0.054		
Plant (Pot(Tr))	39.33 (84)	0.001		
Time × Treatment	5.21 (40)	0.001		
Time × Pot (Tr)	1.41 (192)	0.007		
<i>T. oblongata</i>	Treatment	4.67 (5)	0.006	
Time	36.28 (8)	0.001		
Pot (Tr)	6.47 (17)	0.001		
Plant (Pot(Tr))	24.37 (67)	0.001		
Time × Treatment	5.01 (40)	0.001		
Time × Pot (Tr)	7.88 (136)	0.001		

Unique permutations &gt; 994.

**Table S6: PERMANOVA and PERMDISP results for directly sown plant heights for the trial landform. Unique permutations > 997 (with the exception of *E. armittii*).**

Species	Factor	Pseudo- <i>F</i> (df)	<i>P</i> -value	PermDISP <i>P</i> -value
<i>A. semialata</i>	Treatment	0.42 (4)	0.783	0.185
	Time	13.54 (3)	0.001	
	Plot (Tr)	2.86 (13)	0.010	
	Plant (Plot(Tr))	9.92 (31)	0.001	
	Time × Treatment	0.66 (11)	0.734	
	Time × Plot (Tr)	4.80 (37)	0.001	
	<i>E. armittii</i>	Treatment	17.89 (3)	
Time	0.43 (3)	0.754		
Plot (Tr)	0.03 (1)	0.708		
Plant (Plot(Tr))	57.77 (2)	0.017		
Time × Treatment	0.13 (5)	0.964		
Time × Plot (Tr)	26.95 (3)	0.040		
<i>G. tenuiflora</i>	Treatment	2.58 (4)	0.048	0.177
	Time	6.85 (3)	0.002	
	Plot (Tr)	3.73 (18)	0.001	
	Plant (Plot(Tr))	15.11 (85)	0.001	
	Time × Treatment	1.75 (12)	0.206	
	Time × Plot (Tr)	1.50 (51)	0.063	
	<i>I. saxicola</i>	Treatment	3.39 (3)	
Time		13.32 (3)	0.001	
Plot (Tr)		4.78 (8)	0.006	
Plant (Plot(Tr))		4.24 (15)	0.018	
Time × Treatment		0.71 (9)	0.648	
Time × Plot (Tr)		2.81 (11)	0.071	

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