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Responses to phosphorus among wheat genotypes

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Supplementary Table 1. A list of wheat varieties and their origin used in at least one experiment during 2009-2012

Genotype	Type	Origin	Genotype	Type	Origin	Genotype	Type	Origin
AGTScythe	cultivar	SA	Eradu	cultivar	SA	Seri	cultivar	CIMMYT
Amery	cultivar	WA	Espada	cultivar	SA	Sokoll	cultivar	CIMMYT
Annuello	cultivar	Vic	Excalibur	cultivar	SA	Spear	cultivar	SA
Aroona	cultivar	SA	Frame	cultivar	SA	Stilletto	cultivar	SA
Axe	cultivar	SA	Gamenya	cultivar	NSW	Strzelecki	cultivar	Qld
Babax	cultivar	CIMMYT	Gladius	cultivar	SA	Sunlin	cultivar	NSW
Bencubbin	cultivar	WA	Gutha	cultivar	WA	Tamaroi	durum cultivar	NSW
Berkut	cultivar	CIMMYT	H45	cultivar	NSW	Toropi	landrace	Brazil
Brookton	cultivar	WA	Halberd	cultivar	SA	Trident	cultivar	SA
BTSchomburgk	cultivar	SA	Hartog	cultivar	Qld	Trintecinco	cultivar	Brazil
C2AUSSN-05-10	synthetic	Australia	Janz	cultivar	Qld	UA28	breeding line	CSIRO
C2AUSSN-05-32	synthetic	Australia	Kea_Bct_Fct	breeding line	CIMMYT	UA47	breeding line	CSIRO
Cadoux	cultivar	WA	Kite	cultivar	NSW	Warigal	cultivar	SA
Carazinho	cultivar	Brazil	Krichauff	cultivar	SA	WCD2-011301	breeding line	CSIRO
Carnamah	cultivar	WA	Kukri	cultivar	SA	WCD2-640109	breeding line	CSIRO
Catalina	cultivar	NSW	Luan	cultivar	CIMMYT	Westonia	cultivar	WA
CIMMYT 06 28	synthetic	CIMMYT	Mace	cultivar	SA	WID801	durum breeding line	SA
CM11683	synthetic	CIMMYT	Machete	cultivar	SA	WID902	durum breeding line	SA
CM73815	synthetic	CIMMYT	Magenta	cultivar	Vic	Wilgoyne	cultivar	WA
Condor	cultivar	NSW	Maringa	cultivar	Brazil	Wyalkatchem	cultivar	WA
Correll	cultivar	SA	Molineux	cultivar	SA	Yitpi	cultivar	SA
Drysdale	cultivar	NSW	Oxley	cultivar	Qld			
EGA Gregory	cultivar	NSW	RAC875	breeding line	SA			
EGA Eagle Rock	cultivar	WA	Schomburgk	cultivar	SA			
Egret	cultivar	NSW	Scout	cultivar	SA			

Supplementary Table 2. Summary of sites where there was significant genetic variation in grain yield, grain number per m^2, kernel weight and NDVI at the two rates of P and the response to P

Year and site	Grain yield			Grain number			Kwt			NDVI		
	P0	P30	Response	P0	P30	Response	P0	P30	Response	P0	P30	Response
2009												
Halidon	ns	*	ns							ns	*	ns
Mallala	*	*	*							*	*	*
2010												
Halidon	*	*	*							*	*	*
Mallala	*	*	*							*	*	*
Tumby Bay	ns	*	ns				*	*	*	ns	*	ns
2011												
Halidon	ns	*	ns							ns	*	ns
Mallala	*	*	*	*	*	*	*	*	*	*	*	*
Tumby Bay	*	*	*	*	*	*	*	*	*	*	*	*
2012												
Karoonda	*	*	*	*	*	*	*	*	*	*	ns	ns
Mallala	*	*	*	*	*	*	*	*	*	*	*	*
Tumby Bay	*	*	*	*	*	*	*	*	*	*	*	*

Supplementary Table 3. Grain yield , HI, P concentration in grain and straw, PHI and P utilisation efficiency of selected wheats in 2009 at Mallala

Variety	Grain yield		Total P uptake	HI	P concentration				PHI	P utilisation efficiency	
					Grain		Straw			Biomass	Grain
	Minus P	Plus P			Minus P	Plus P	Minus P	Plus P			
	kg/ha			(%)	(mg/kg)				(%)	kg DM/kg P	kg grain/kg P
Axe	2563	2883	9.7	40.6	2933	3133	337	393	88.3	692	281
BT Schomburgk	1733	1967	8.0	33.7	2683	3233	567	773	75.5	701	236
Eradu	1942	2171	8.4	36.8	3133	3400	420	490	84.2	674	248
Frame	2458	2550	11.1	28.5	3167	3400	380	453	80.2	833	230
Krichauff	2229	2546	9.7	35.5	2933	3333	443	563	81.5	701	249
Mace	2488	2712	9.2	39.7	2933	3067	323	483	88.0	716	283
Spear	2233	2383	10.1	32.2	2967	3433	463	620	78.0	722	234
Warigal	1800	1800	10.5	23.7	3333	3900	510	900	67.8	739	175
WCD2-640109	1817	2300	10.0	36.2	3301	3599	726	723	81.2	615	217
Westonia	2092	2338	9.0	38.9	3001	3199	567	640	83.3	641	254
F prob											
Variety	P<0.001		P<0.006	P<0.001	P<0.001		P<0.001		P<0.001	P=0.034	P<0.001
Variety x P	P=0.061		ns	ns	ns		P=0.008		ns	ns	ns
LSD (P=0.05)											
Variety	213		1.39	5.51	267.3		38.7			108.1	
Variety x P[A]	(a) 180; (b) 242				ns		(a) 122.2 (b) 141.1		4.54	ns	29.0
P treatment											
Minus P	2134		8.4	35.3	3038		394		82.5	667	258
Plus P	2365		10.7	33.9	3370		474		79.1	741	224
F prob	P<0.001		P<0.001	ns	P<0.001		P<0.001		P<0.001	P=0.002	P<0.001
LSD (P=0.05)	57.1		0.46	1.75	75.1		33.7		1.65	41.9	9.7

[A] LSD is for (a) comparisons within the same Variety and (b) all other comparisons.

Supplementary Table 4. Grain yield , HI, P concentration in grain and straw, PHI and P utilisation efficiency of selected wheats in 2011 at Mallala. Varieties were selected on the basis of their P responsiveness in NDVI.

Variety	Grain yield		Total P uptake	HI	P concentration				PHI	P utilisation efficiency	
					Grain		Straw			Biomass	Grain
	Minus P	Plus P			Minus P	Plus P					
	kg/ha			(%)	(mg/kg)				(%)	kg DM/kg P	kg grain/kg P
AGTScythe	2001	2373	10.3	37.6	3833	3733	543	637	81.1	565	217
Annuello	1866	2156	10.1	34.2	3633	3967	583	673	75.9	587	201
Axe	2016	2342	9.1	42.8	3500	3667	353	470	86.7	568	243
BTSchomburgk	1752	2141	9.2	33.7	3400	3667	577	640	74.7	631	212
Carazhino	1274	1532	10.1	19.7	4733	4933	487	633	68.0	726	141
Correll	1837	2190	9.6	34.9	3700	3567	553	653	76.4	604	211
Frame	1733	1982	11.1	27.5	3967	4167	617	803	68.6	617	169
Gladius	2170	2426	9.8	41.1	3300	3600	463	607	81.9	582	239
H45	1863	2223	9.1	37.3	3367	3500	520	643	78.0	612	229
Halberd	1708	2054	9.8	32.6	3467	3833	613	843	70.9	598	196
Hartog	1634	1967	10.2	31.6	4067	3767	750	680	71.8	566	185
Janz	1825	2175	9.9	32.5	3567	3867	480	673	75.7	630	205
Krichauff	2057	2359	11.5	29.7	3600	3700	523	700	70.7	676	195
Kukri	1907	2170	9.9	34.6	3700	3900	460	627	78.7	600	208
Magenta	1697	2052	10.8	28.8	4067	4300	550	700	73.2	612	175
Oxley	1610	1863	11.0	26.6	4033	4267	650	840	66.6	609	162
RAC875	1752	1929	9.8	34.2	3500	3867	747	903	69.8	558	191
Warigal	1370	1829	10.0	28.1	3767	4233	747	920	64.9	586	164
Wyalkatchem	1822	2378	9.3	39.1	3600	3633	433	580	82.1	583	227

Yitpi	1.7593	2.0348	10.4	31.3	3867	4000	560	800	72.4	593	185
F prob											
Variety	P<0.001		ns	P<0.001	P<0.001		P<0.001		P<0.001	P<0.001	P<0.001
Vareity x P	ns		ns		ns		ns				
LSD (P=0.05)											
Variety	199.7			4.40	323.6		150.4		7.11	62.9	29.7
Variety x P	ns				ns		ns				
P treatment											
Minus P	1783		8.9	32.6	3722		561		75.9	637	206
Plus P	2109		11.3	33.2	3908		701		72.9	573	189
F prob	P<0.001		P<0.001	ns	P<0.001		P<0.001		P<0.001	P<0.001	P<0.001
LSD (P=0.05)	36.9		0.32		74.6		31.5		1.60	16.2	6.3

[A] LSD is for (a) comparisons within the same Variety and (b) all other comparisons.

Supplementary Table 5. Grain yield , HI, P concentration in grain and straw, PHI and P utilisation efficiency of selected wheats in 2011 at Tumby Bay

Variety	Grain yield		Total P uptake	HI	P concentration				PHI	P utilisation efficiency		
					Grain		Straw					
	Minus P	Plus P			Minus P	Plus P	Minus P	Plus P		Minus P	Plus P	
	kg/ha			(%)	(mg/kg)				(%)	kg DM/kg P		kg grain/kgP
Annuello	2052	3821	10.3	44.7	2409	2609	184	199	91.4	849	779	364
Carazinho	2105	2833	8.6	30.1	2800	3233	161	194	88.0	1033	919	294
Correll	2066	4140	8.2	43.1	2500	2300	236	180	89.8	828	916	376
Janz	1704	3197	7.4	41.8	2600	2800	213	267	88.9	838	749	332
Kukri	1878	3156	7.1	41.3	2533	2567	196	178	90.5	871	870	359
Magenta	2624	4473	9.2	40.8	2200	2467	204	160	89.5	1052	863	385
Maringo	2286	3366	9.0	34.6	2567	3133	121	174	91.0	1115	801	324
Toropi	2247	2740	10.2	21.2	3067	3633	143	220	83.2	1319	1065	251
Trintecenco	1912	2569	9.9	20.2	3033	4067	143	243	82.6	1432	966	239
Warigal	1423	3052	6.5	38.7	2433	2633	206	227	88.1	977	844	349
F prob												
Variety	P<0.001		ns	P<0.001	P<0.001		P=0.028		P<0.001	P<0.001		P<0.001
Variety x P	P<0.001		ns	ns	P=0.014		P=0.036		ns	P=0.008		ns
LSD (P=0.05)												
Variety	1247		1.39	2.86	111		42.9		2.81	106.0		31.9
Variety x P[A]	(a) 387; (b) 1269		ns	ns	(a) 394; (b) 352		(a) 65.7 (b) 61.1		ns	(a) 174.8; (b) 157.3		ns
P treatment												
Minus P	2030		6.2	34.9	2614		181		88.2	1031		342
Plus P	3335		11.1	36.4	2944		204		88.4	877		312
F prob	P<0.001		P<0.001	ns	P<0.001		P=0.028		ns	P<0.001		P<0.001
LSD (P=0.05)	122.4		0.67	1.75	124.6		33.7			55.3		15.7

[A]LSD is for (a) comparisons within the same Variety and (b) all other comparisons.

Supplementary Table 6. Correlations between total shoot biomass at the start of stem elongation (GS31-32) and at maturity and total P uptake and P utilisation efficiency ($PUtE_{DM}$) at two rates of P.

Values in parentheses are the partial correlations between biomass and utilisation efficiency. Significance is shown as: * *P* < 0.001; ** *P* < 0.01 and * *P* < 0.05.**

	Mallala 2009		Mallala 2011		Tumby Bay 2011	
	0 P	30 P	0 P	30 P	0 P	30 P
Biomass at GS31-32						
Total P uptake	0.97***	0.97***	0.89***	0.80***		
P utilisation efficiency	-0.32 (0.98)	0.40 (0.99)	0.47* (0.99)	0.54*(0.99)		
Biomass at maturity						
Total P uptake	0.72*	0.83**	0.76***	0.83***	0.84**	0.81**
P utilisation efficiency	0.80**(0.98)	0.85**(0.99)	0.75***(0.99)	0.64**(0.99)	0.90***(0.99)	0.76**(0.99)