

10.1071/CP17406_AC
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Supplementary Material: *Crop & Pasture Science*, 2018, 69, 574–586.

Responses to phosphorus among barley genotypes

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Supplementary Table 1. Growing season (April-October) rainfall, mean values of soil pH, Colwell P, P buffering index (PBI) and electrical conductivity (EC) at the experimental sites used between 2009 and 2011. pH and EC were measured in a 1:5 soil:water extract (from McDonald et al 2015).

The critical Colwell P (Moody 2007) for wheat, adjusted for the PBI for the 0-20 cm layer, is shown in parentheses

Year/ depth	Site and major soil type ^A														
	Halidon Calcic Calcarosol/Kandosol					Mallala Supracalcic Calcarosol					Tumby Bay Brown Sodosol/Brown Chromosol				
	GSR (mm)	pH	Colwell P (mg/kg)	PBI	EC (dS/m)	GSR (mm)	pH	Colwell P (mg/kg)	PBI	EC (dS/m)	GSR (mm)	pH	Colwell P (mg/kg)	PBI	EC (dS/m)
2009	191					310									
0-20		8.1	6.7	nd	0.07		8.1	18.0	nd	0.20					
20-40		8.3	2.3	nd	0.14		8.7	7.3	nd	0.28					
40-60		8.8	3.0	nd	0.21		9.2	4.7	nd	0.41					
2010	285					331					497				
0-20		7.9	9.0 (12.0)	11.5	0.08		8.5	18.5 (30.4)	122	0.22		6.3	10.0 (22.8)	59	0.06
20-40		8.3	2.5	23.2	0.08		8.7	5.0	172	0.38		6.8	3.0	124	0.06
40-60		9.1	2.5	52.4	0.17		9.2	3.5	173	0.65		8.0	2.5	269	0.29
2011	158					302					362				
0-20		7.8	8.0 (14.9)	19.9	0.06		8.3	15.5 (36.6)	196	0.22		5.6	14.5 (20.4)	44	0.05
20-40		8.7	2.0	35.9	0.13		8.4	5.5	249	0.25		6.6	3.0	128	0.04
40-60		9.0	2.0	81.5	0.22		8.5	4.0	248	0.37		7.1	5.5	278	0.06

^A Major soil group based on soil maps from ASRIS (www.asris.gov.au) and Hall *et al* (2009) using the Australian Soil Classification (Isbell 1996)

Parent15	X	X	X	X	X			
Parent16	X	X	X	X	X		X	
Parent19	X	X	X	X	X	X	X	X
Prior A		X	X	X	X		X	
Roe	X	X	X	X	X	X	X	X
Sahara	X	X						
Scope						X	X	X
Skiff	X	X	X	X	X	X	X	X
Skipper							X	X
Sloop	X	X	X	X	X			
SloopSA						X	X	X
Stirling	X	X	X	X	X	X	X	X
Tadmor	X	X	X	X	X	X	X	X
Tantangarra	X		X	X	X	X	X	X
TR257	X	X	X	X	X	X	X	X
Triumph	X	X	X	X	X	X	X	X
VB0611							X	X
Vlamingh	X	X	X	X	X	X	X	X
WI3806-1	X	X	X	X	X	X	X	X
Wimmera							X	X
Yagan	X		X	X	X	X	X	X
Yangnong9001	X		X	X			X	X
Yarra				X	X	X	X	X
YU6472	X		X	X	X	X	X	X
Zhepi4	X		X	X	X	X	X	X

Supplementary Table 3. Grain yield, P uptake by the shoots at maturity, HI, P concentration in grain and straw, PHI and P utilisation efficiency of selected barley varieties in 2011 at Mallala

Genotype	Grain yield (t/ha)		P uptake (kg/ha)		HI (%)	P concentration (mg/kg)				PHI (%)	P utilisation efficiency (kg/kg)			
						Grain		Straw			Total biomass		Grain yield	
	0 kg P/ha	30 kg P/ha	0 kg P/ha	30 kg P/ha		0 kg P/ha	30 kg P/ha	0 kg P/ha	30 kg P/ha		0 kg P/ha	30 kg P/ha	0 kg P/ha	30 kg P/ha
Admiral	2.30	2.37	10.9	15.5	29.8	3367	4233	617	890	67.9	679	549	213	155
Buloke	2.49	2.71	12.7	14.9	35.1	3533	3867	760	1033	69.4	601	492	199	183
Chebec	2.10	2.69	11.3	16.1	34.5	3733	4033	757	987	69.7	588	477	188	179
CM67	1.64	1.68	6.3	9.0	31.6	3033	3800	413	643	74.7	795	636	260	187
CM72	1.40	1.62	6.0	9.6	28.1	3000	3867	497	667	68.6	821	662	234	173
Commander	2.71	2.93	14.6	18.3	31.3	3167	4100	730	1030	64.3	708	484	201	169
Fleet	2.73	2.96	11.4	14.6	38.1	3300	3567	543	730	76.4	611	572	247	204
Forrest	2.35	2.48	12.5	14.3	28.4	3333	3867	520	815	70.2	823	714	204	188
Gairdner	2.52	2.90	11.2	16.5	35.4	3467	3933	517	920	73.5	641	514	227	180
Galleon	2.39	2.57	10.1	14.4	34.5	3167	3800	587	903	71.4	670	533	236	180
Maritime	2.10	2.55	10.5	12.7	35.7	3767	4033	673	808	78.6	578	557	200	207
Navigator	2.03	2.56	9.5	15.7	34.2	3467	4200	683	933	71.2	605	501	214	165
O'Connor	2.42	2.75	11.3	15.9	33.9	3333	3867	673	960	69.6	638	523	220	173
Parent16	1.57	2.07	7.0	11.4	34.7	3533	4200	450	623	78.7	650	546	231	182
Skiff	2.55	2.68	11.2	14.8	34.2	3433	3967	450	680	76.4	673	563	232	186
SloopSA	2.25	2.80	9.1	14.3	39.6	3200	3800	543	873	76.9	639	492	247	199
Tantangara	2.29	2.39	11.1	14.5	31.3	3367	4100	633	893	68.5	684	523	209	166
Navigator	2.03	2.56	9.5	15.7	34.2	3467	4200	683	933	71.2	605	501	214	165
YU6472	1.46	1.82	7.3	10.7	36.1	4000	4633	563	677	79.7	557	479	204	171
Zhepi4	1.83	2.37	8.1	12.3	41.8	3833	4533	457	450	86.9	524	477	226	192
F prob.														
Genotype	P<0.001		P<0.001		n.s.	P<0.001		P=0.041		n.s.	P=0.006		n.s.	
P rate	P<0.001		P<0.001		n.s.	P<0.001		P<0.001		P=0.031	P<0.001		P<0.001	
Geno x P rate	P<0.001		n.s.		n.s.	n.s.		n.s.		n.s.	n.s.		n.s.	

Supplementary Table 4. Grain yield, P uptake by the shoots at maturity, HI, P concentration in grain and straw, PHI and P utilisation efficiency of selected barley varieties in 2011 at Tumby Bay

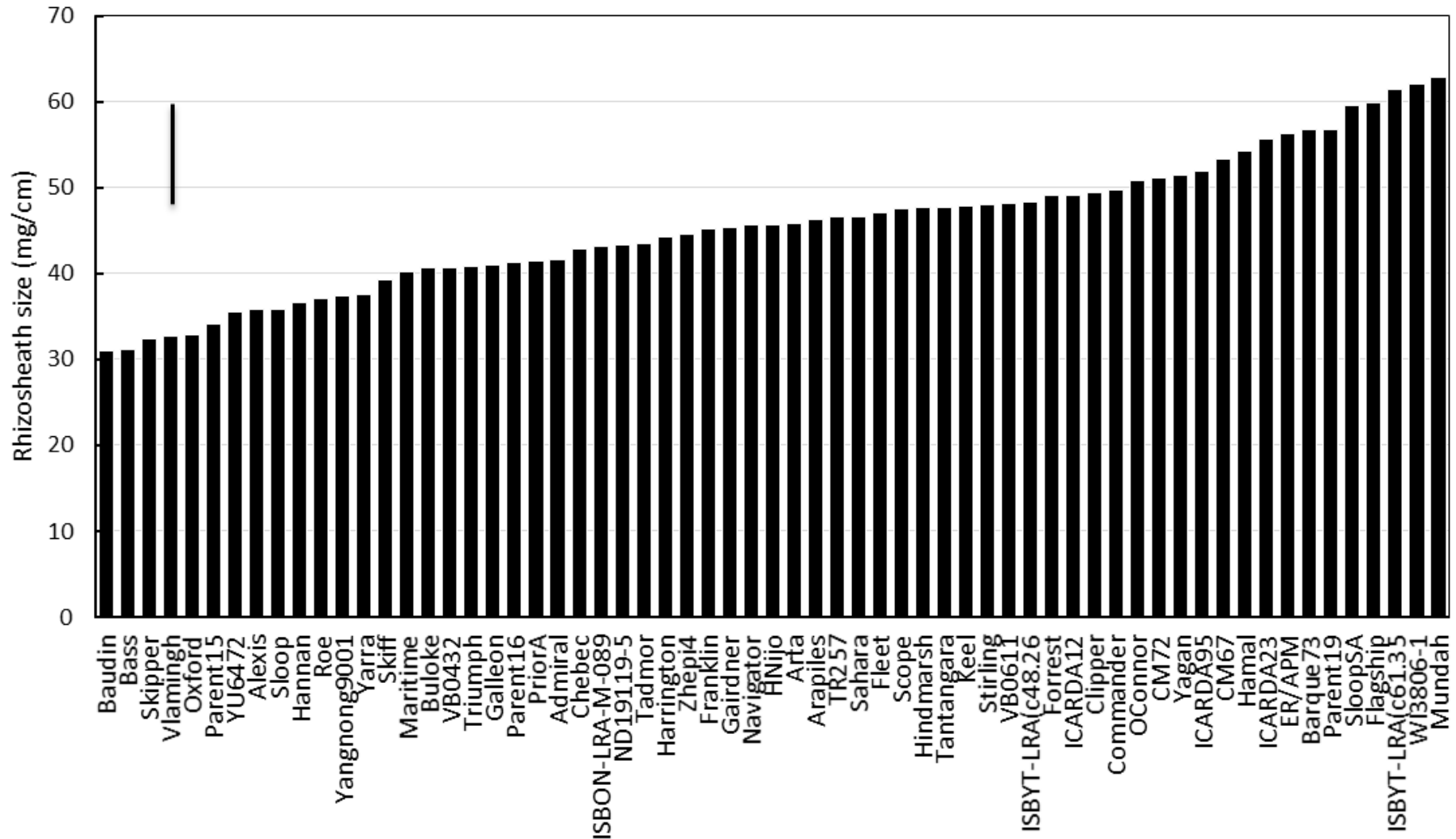
Genotype	Grain yield (t/ha)		P uptake (kg/ha)		HI (%)	P concentration (mg/kg)				PHI (%)	P utilisation efficiency (kg/kg)			
						Grain		Straw			Total biomass		Grain yield	
	0 kg P/ha	30 kg P/ha	0 kg P/ha	30 kg P/ha		0 kg P/ha	30 kg P/ha	0 kg P/ha	30 kg P/ha		0 kg P/ha	30 kg P/ha	0 kg P/ha	30 kg P/ha
Buloke	0.99	3.21	3.47	9.58	40.8	2163	2367	790	507	70.7	783	766	298	335
Chebec	0.64	2.33	2.51	7.54	38.1	2170	2367	843	610	65.1	778	737	257	314
Commander	1.43	4.03	4.17	11.14	44.1	2133	2300	610	380	78.0	787	816	343	361
Fleet	1.18	4.35	2.96	11.2	48.1	2023	2267	473	297	83.6	840	795	394	389
Galleon	1.31	3.69	3.24	8.43	52.0	2053	2067	390	293	85.9	854	802	402	435
O'Connor	0.75	2.92	2.61	9.44	40.5	2400	2600	663	557	72.9	781	692	279	311
Skiff	1.30	3.68	4.01	10.41	44.9	2233	2250	690	510	75.3	726	777	322	354
SloopSA	0.42	2.12	1.38	6.23	41.3	2223	2177	717	617	69.3	768	805	306	343
Yangnong9001	0.27	1.23	0.20	4.43	34.2	2429	2733	591	437	71.3	853	825	258	279
YU6472	0.20	1.22	0.67	4.78	33.7	2467	2967	507	513	72.4	875	743	289	254
F prob														
Genotype	P<0.001		P<0.001		P<0.001	P=0.003		P<0.001		P<0.001	n.s.		P<0.001	
P rate	P<0.001		P<0.001		P=0.026	P=0.005		P<0.001		P<0.001	n.s.		n.s.	
Geno x P rate	P<0.001		P=0.006		n.s.	n.s.		n.s.		n.s.	n.s.		n.s.	

Supplementary Table 5. Rankings of varieties (1-36) for their response to P fertiliser based on the BLUPs of P responsiveness for NDVI. To allow comparison across sites, only varieties that were present at every site were included. Ranking 1 is the most responsive variety and the sites have been ordered from most to least responsive. PUE is the P use efficiency.

Variety	Site and year						
	T. Bay 2011	T Bay 2010	Mallala 2011	Mallala 2010	Halidon 2009	Halidon 2011	Halidon 2010
NDVI at P0	0.434	0.436	0.308	0.497	0.361	0.179	0.405
Mean PUE (%)	65	71	77	90	93	98	108
Admiral	22	16	10	22	1	2	28
Alexis	25	32	8	6	21	25	7
Arapiles	21	2	32	28	15	3	30
Arta	9	21	5	4	25	7	3
Barque73	10	3	31	31	9	4	32
Buloke	12	31	12	17	22	26	13
Chebec	30	1	20	8	17	18	12
Clipper	17	9	18	23	4	10	27
CM67	20	35	1	1	32	23	1
Commander	14	4	11	13	5	15	18
Fleet	4	19	19	34	24	5	29
Franklin	29	34	22	29	14	20	31
Gairdner	13	15	13	30	19	14	24
Galleon	2	13	2	2	18	8	2
Hannan	7	17	35	35	27	29	35
Hindmarsh	35	8	34	27	28	35	33
Keel	3	6	27	32	33	21	22
Maritime	24	10	9	9	3	11	14
Mundah	19	18	21	3	16	33	5
Navigator	15	28	25	25	31	31	19
O'Connor	18	25	3	11	6	6	11
Oxford	8	14	15	15	30	27	10
Parent19	11	26	7	10	26	28	4
Roe	26	5	26	24	13	24	26
Skiff	16	7	28	33	11	9	34
Stirling	23	20	23	5	23	17	6
Tadmor	1	11	6	12	20	16	8
Tantangarra	6	30	4	26	8	1	20
TR257	27	27	14	20	2	12	25
Triumph	33	33	16	21	7	22	23
Vlamingh	31	23	24	16	29	32	17
WI3806-1	28	12	30	18	10	13	21
Yagan	5	29	17	14	12	19	15
YU6472	34	22	33	7	35	34	9
Zhepi4	32	24	29	19	34	30	16

Supplementary Table 6. Rankings of varieties (1-34) for their response to P fertiliser based on the BLUPs of P responsiveness for grain yield. To allow comparison across sites, only varieties that were present at every site were included. Ranking 1 is the most responsive variety and the sites have been ordered from most responsive to least responsive. PUE is the P use efficiency.

Variety	Site and year						
	Halidon 2011	T. Bay 2010	Halidon 2009	Mallala 2011	Mallala 2009	Mallala 2010	Halidon 2010
Yield at P0 (t/ha)	0.39	2.12	0.71	2.26	2.73	3.50	1.91
Mean PUE (%)	52	55	69	89	95	98	104
Admiral	16	11	2	33	28	16	25
Alexis	30	25	15	32	10	13	6
Arapiles	18	12	13	24	24	4	10
Arta	10	28	25	6	1	34	24
Barque73	23	5	5	29	13	3	7
Buloke	11	6	16	18	25	26	4
Chebec	4	14	7	2	11	15	5
Clipper	21	4	6	11	19	8	30
CM67	31	29	34	20	29	2	31
Commander	12	2	4	28	18	9	26
Fleet	24	21	31	10	30	7	23
Franklin	5	15	23	25	14	25	11
Gairdner	14	9	1	15	31	21	13
Galleon	6	27	32	26	7	29	27
Hannan	9	10	14	21	2	31	33
Hindmarsh	22	17	26	19	15	30	16
Keel	17	22	18	22	6	27	1
Maritime	13	16	3	5	26	18	2
Mundah	28	20	17	9	22	14	17
Navigator	29	3	9	7	20	10	28
O'Connor	15	19	21	17	34	5	14
Oxford	33	1	24	34	32	1	20
Parent19	34	30	27	27	5	6	3
Roe	26	8	8	16	8	11	12
Skiff	19	13	20	31	33	17	19
Stirling	7	23	12	23	16	19	21
Tadmor	8	32	29	30	27	32	32
TR257	32	31	28	4	12	24	18
Triumph	1	24	10	14	3	33	34
Vlamingh	3	7	11	3	17	28	9
WI3806-1	20	18	22	13	4	20	8
Yagan	2	26	19	12	9	22	15
YU6472	25	34	33	8	23	12	29
Zhepi4	27	33	30	1	21	23	22



Supplementary Fig. 1. The variation in rhizosheath size among the varieties of barley used in the experiments. The error bar is the lsd ($P = 0.05$).