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Field benchmarking of the critical external phosphorus requirements of pasture legumes for southern Australia

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Supplementary Materials

Supplementary Table 1. Pasture cultivars sown at each site and year; s indicates sown, h indicates harvested at peak spring and nh indicates sown but not harvested

Species	Cultivar(s)	Yass			Burrinjuck		Belfrayden	Beckom
		2012	2013	2014	2013	2014	2014	2014
<i>Trifolium glanduliferum</i>	Prima	-	-	-	-	s, nh	s, h	s, h
<i>T. hirtum</i>	Hykon	s, h	s, h	s, nh	s, nh	s, nh	s, h	s, h
<i>T. incarnatum</i>	Dixie	-	-	-	s, h	s, h	s, h	s, h
<i>T. michelianum</i>	Bolta	-	-	-	-	s, nh	-	-
<i>T. purpureum</i>	Electra	-	s, h	s, h	s, h	-	-	-
<i>T. spumosum</i>	Bartolo	s, nh	s, h	s, nh	s, nh	s, nh	s, h	s, h
<i>T. subterraneum</i>	Leura	s, h	s, h	s, h	s, h	s, h	-	-
<i>T. subterraneum</i>	Narrikup	-	-	-	-	s, nh	s, h	s, h
<i>T. subterraneum</i>	Izmir	-	-	-	-	-	s, h	s, h
<i>T. vesiculosum</i>	Zulu II	-	-	-	-	s, h	s, h	s, h
<i>Ornithopus compressus</i>	Avila	-	-	s, h	-	-	-	-
<i>O. compressus</i>	Santorini	s, h	s, h	s, h	s, h	s, nh	s, h	s, h
<i>O. sativus</i>	Margurita	-	-	s, h	s, h	s, h	s, h	s, h
<i>Biserrula pelecinus</i>	Casbah	-	-	s, nh	-	s, nh	s, h	s, h
<i>B. pelecinus</i>	Mauro	s	s, h	-	s, nh	-	-	-
<i>Medicago truncatula</i>	Sultan-SU	-	-	-	-	-	s, h	s, h
<i>M. sativua</i>	SARDI 10	s, h	h	nh	s, h	h	s, h	s, h
<i>T. ambiguum</i>	Kuratas	s, nh	h	-	-	-	-	-
<i>T. tumens</i>	Permatas	s, nh	-	-	-	-	-	-
<i>Lotus corniculatus</i>	LC07AUYP	s, h	h	-	s, nh	-	-	-
<i>Bituminaria bituminosa</i>	Tedera27	s, nh	s, h	-	-	-	-	-
<i>Dactylis glomerata</i>	Porto	-	s, h	h	s, nh	-	-	-
<i>Dactylis glomerata</i>	Uplands	s, nh	-	-	-	-	-	-
<i>Phalaris aquatica</i>	Advanced AT	s, nh	s, h	h	s, nh	-	-	-
<i>Lupinus albus</i> and <i>T. subterraneum</i> mixture	Luxor and Leura	-	-	s,h	-	-	-	-

1 **Supplementary Table 2. Monthly rainfall¹ (mm) recorded for Yass (2012, 2013 and 2014), Burrinjuck (2013 and 2014), Belfrayden and Beckom (2014),**
 2 **and long-term average (1889 to 2015) rainfall for each location**

Yass	January	February	March	April	May	June	July	August	September	October	November	December
2012	51.1	120.0	204.7	29.3	42.3	51.7	44.5	51.5	44.3	41.7	46.8	53.9
2013	61.8	55.1	38.3	11.7	14.6	95.4	69.6	46.4	68.0	22.1	77.7	22.8
2014	14.5	54.0	103.3	88.7	30.9	78.6	41.2	53.6	47.4	43.8	29.4	119.1
<i>Long term average</i>	54.8	45.0	50.6	48.5	52.7	62.7	63.5	61.6	61.8	66.6	59.5	53.9
Burrinjuck	January	February	March	April	May	June	July	August	September	October	November	December
2013	18.7	52.2	42.4	14.0	26.9	124.8	77.8	70.9	70.5	28.3	74.5	24.1
2014	19.3	79.9	131.5	110.6	45.9	131.9	76.9	56.6	49.4	40.7	31.1	102.2
<i>Long term average</i>	57.5	47.3	54.3	58.4	66.2	81.5	85.2	78.5	76.8	76.6	62.2	57.0
Beckom	January	February	March	April	May	June	July	August	September	October	November	December
2014	13.7	26.7	45.8	58.3	39.2	61.5	17.6	8.3	30.0	17.2	35.9	15.3
<i>Long term average</i>	35.5	32.6	34.8	36.2	41.7	47.8	44.3	42.6	40.8	45.9	34.8	34.1
Belfrayden	January	February	March	April	May	June	July	August	September	October	November	December
2014	27.0	22.0	72.6	45.7	27.3	66.2	23.7	18.6	30.9	11.1	18.2	52.6
<i>Long term average</i>	45.0	36.5	39.4	37.7	39.8	47.2	44.8	43.6	40.0	45.7	39.4	39.1

3 ¹Rainfall data for the sites were sourced from the Australian Bureau of Meteorology (<http://www.bom.gov.au/>) and were supplemented for Belfrayden and
 4 Beckon using rainfall data collected near these sites during the experiments.

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Supplementary Table 3. Parameters (and standard error) derived by fitting a Mitscherlich response ($y = A+B*R^c$, where y is herbage yield (kg dry matter/ha) and c is the Colwell soil test phosphorus (P) concentration (0-10 cm, mg/kg soil)) to data for each pasture variety grown at each site in each year)

Maximum yield is predicted by A, the asymptote; responsiveness to P is reflected in R, the curvature parameter; and the intercept at a theoretical Colwell P value of zero is A+B. The Mitscherlich function was fitted using Genstat (Version 16)

Site-Year	Species	Cultivar	Parameter					
			R		B		A	
			estimate	se	estimate	se	estimate	se
Yass 2012								
	<i>Trifolium hirtum</i>	Hykon	0.9032	0.0179	-6757	1427	3723	121
	<i>Lotus corniculatus</i>	LC07AUYF	0.8398	0.0552	-4546	2554	1397	104
	<i>Trifolium subterraneum</i>	Leura	0.9436	0.017	-4653	529	3949	344
	<i>Ornithopus compressus</i>	Santorini	0.856	0.0473	-5523	3360	2118	92
	<i>Medicago sativa</i>	SARDI 10	0.9793	0.0455	-1003	1048	1083	1251
Yass 2013								
	<i>Phalaris aquatica</i>	Advanced AT	0.8802	0.0242	-11387	2913	4818	222
	<i>Trifolium spumosum</i>	Bartolo	0.896	0.0442	-6489	3796	2972	238
	<i>Trifolium purpureum</i>	Electra	0.592	0.184	-1874632	8072413	2175	120
	<i>Trifolium hirtum</i>	Hykon	0.8938	0.0248	-6019	1123	3871	226
	<i>Trifolium ambiguum</i>	Kuratas	0.8981	0.0943	-3494	5239	945	212
	<i>Lotus corniculatus</i>	LC07AUYF	0.915	0.137	-995	1119	1530	278
	<i>Trifolium subterraneum</i>	Leura	0.9011	0.0188	-13545	2905	5576	300
	<i>Biserrula pelecinus</i>	Mauro	0.9042	0.0221	-9380	2142	4709	260
	<i>Dactylis glomerata</i>	Porto	0.8901	0.0807	-4383	4699	2498	254
	<i>Onithopus compressus</i>	Santorini	0.7939	0.0526	-27908	20759	3979	142
	<i>Medicago sativa</i>	SARDI 10	0.9972	0.0331	-15581	167533	16510	168026

Supplementary Table 3 continued

			R		B		A	
			estimate	se	estimate	se	estimate	se
Yass 2014								
<i>Phalaris aquatica</i>	Advanced AT		0.8909	0.0396	-5455	1375	5493	354
<i>Ornithopus compressus</i>	Avila		0.8801	0.0597	-5289	2164	3984	406
<i>Trifolium purpureum</i>	Electra		0.9015	0.0375	-7550	2690	5652	424
<i>Trifolium subterraneum</i>	Leura		0.92	0.0197	-8810	1331	6715	428
<i>Ornithopus sativus</i>	Margurita		0.8572	0.0541	-9448	5398	6987	254
<i>Dactylis glomerata</i>	Porto		0.8918	0.0787	-4223	2714	4054	414
<i>Ornithopus compressus</i>	Santorini		0.8784	0.0418	-6953	2148	5976	377
<i>T. subterraneum</i> and <i>Lupinus albus</i> mixture	Leura and Luxor		0.8663	0.0539	-8811	4827	5518	274
Burrinjuck 2013								
<i>Trifolium incarnatum</i>	Dixie		0.8596	0.0494	-21805	14785	8062	291
<i>Trifolium purpureum</i>	Electra		0.8339	0.0606	-30043	27507	5964	401
<i>Trifolium subterraneum</i>	Leura		0.9354	0.0495	-7080	3859	6070	868
<i>Ornithopus sativus</i>	Margurita		0.942	0.143	-2585	1739	6188	1778
<i>Ornithopus compressus</i>	Santorini		0.9199	0.0795	-3815	3920	4281	490
<i>Medicago sativa</i>	SARDI 10		0.9804	0.063	-2871	3773	3052	4824
Burrinjuck 2014								
<i>Trifolium michelianum</i>	Bolta		0.8836	0.0297	-17377	5380	11903	453
<i>Trifolium incarnatum</i>	Dixie		0.8502	0.0436	-28641	16207	10726	346
<i>Trifolium subterraneum</i>	Leura		0.9037	0.0216	-14961	3019	9489	524
<i>Ornithopus sativus</i>	Margurita		0.8067	0.097	-39107	58636	9267	302
<i>Medicago sativa</i>	SARDI 10		0.9361	0.0265	-7534	1920	6855	616
<i>Trifolium vesiculosum</i>	Zulu II		0.769	0.117	-46015	73869	7179	243

Supplementary Table 3 continued

			R		B		A	
			estimate	se	estimate	se	estimate	se
Beckom 2014								
<i>Trifolium spumosum</i>	Bartolo		0.902	0.0426	-3030	505	3542	307
<i>Biserrula pelecinus</i>	Casbah		0.8524	0.0753	-4313	2111	2549	279
<i>Trifolium incarnatum</i>	Dixie		0.9127	0.0463	-2066	430	3618	284
<i>Trifolium hirtum</i>	Hykon		0.8804	0.0426	-3401	802	3117	219
<i>Trifolium subterraneum</i>	Izmir		0.9323	0.067	-1539	495	2591	374
<i>Ornithopus sativus</i>	Margurita		0.758	0.118	-3912	2896	2576	163
<i>Trifolium subterraneum</i>	Narrikup		0.9234	0.0337	-2742	496	3488	336
<i>Trifolium glanduliferum</i>	Prima		0.9356	0.0385	-2171	504	2467	322
<i>Ornithopus compressus</i>	Santorini		0.385	0.272	-104972	356294	2009	107
<i>Medicago sativa</i>	SARDI 10		0.9648	0.0418	-1721	739	1825	961
<i>Medicago truncatula</i>	Sultan-SU		0.9303	0.0238	-3221	410	3631	279
<i>Trifolium vesiculosum</i>	Zulu II		0.7792	0.0861	-5783	3576	2945	166
Belfrayden 2014								
<i>Trifolium spumosum</i>	Bartolo		0.9455	0.0166	-6652	785	7838	506
<i>Biserrula pelecinus</i>	Casbah		0.9502	0.0169	-5287	648	7108	554
<i>Trifolium incarnatum</i>	Dixie		0.9413	0.022	-6580	1171	9093	682
<i>Trifolium hirtum</i>	Hykon		0.8939	0.0268	-10357	3010	7370	315
<i>Trifolium subterraneum</i>	Izmir		0.9496	0.0201	-5779	1098	6094	541
<i>Ornithopus sativus</i>	Margurita		0.9535	0.0329	-2691	608	5396	625
<i>Trifolium subterraneum</i>	Narrikup		0.9222	0.028	-8124	2891	7053	385
<i>Trifolium glanduliferum</i>	Prima		0.9508	0.0438	-5101	1267	5821	1374
<i>Ornithopus compressus</i>	Santorini		0.9125	0.0491	-3797	1589	4331	286
<i>Medicago sativa</i>	SARDI 10		0.9619	0.0337	-3303	696	3844	805
<i>Medicago truncatula</i>	Sultan-SU		0.9563	0.0309	-3973	749	6633	940
<i>Trifolium vesiculosum</i>	Zulu II		0.9057	0.0385	-6153	2110	5694	329