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Supplementary Material

Time of sowing influences wheat responses to applied phosphorus in alkaline calcareous soils in a temperate climate

Sean Mason[A,B] *and Glenn McDonald*[A,*]

[A]School of Agriculture, Food and Wine, The University of Adelaide, Urrbrae, SA 5064, Australia.

[B]Agronomy Solutions Pty Ltd, Unit 3/11, Ridley Street, Hindmarsh, SA 5007, Australia.

[*]Correspondence to: Glenn McDonald School of Agriculture, Food and Wine, The University of Adelaide, Urrbrae, SA 5064, Australia Email: glenn.mcdonald@adelaide.edu.au

Supplementary tables

Supplementary table 1. The PUE (%) based on responses in NDVI and grain yield for three sowing dates in 2017 and 2018 and are derived from the P response curves. The times of sowing are given in Table 1

Year and Site	NDVI			Grain yield		
	TOS 1	TOS 2	TOS 3	TOS 1	TOS 2	TOS 3
2017						
Arthurton	86.7	86.6	78.5	93.0	83.3	85.5
Snowtown	84.9	55.9	71.9	90.0	71.5	75.8
Urania				76.2	80.8	75.8
2018						
Arthurton	80.4	86.8	96.0	90.3	90.6	88.8
Brinkworth	71.1	61.9	69.0	74.7	69.9	74.9
Urania	62.2	74.9	76.4	76.5	86.0	80.4

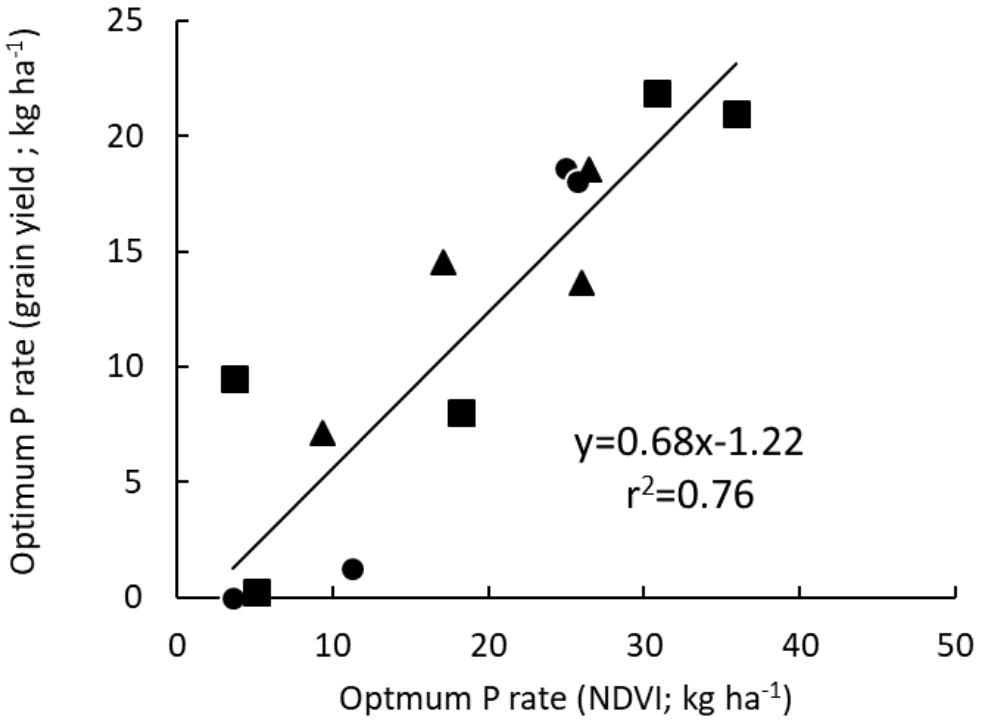
Supplementary table 2. The effect of sowing time on the critical P rate for maximum NDVI or grain yield (kg P ha^{-1}), the critical P rate for P response in NDVI and grain yield (kg P ha^{-1}) and the PUE (%) for NDVI and grain yield. Values are shown as the mean ± standard error of the mean

Sowing date	P_{crit} (maximum yield)		P_{crit} (P response)		PUE (%)	
	NDVI	Grain yield	NDVI	Grain yield	NDVI	Grain yield
Late April-early May	15.5 ± 4.27	7.6 ± 4.30	42.3 ± 4.68	35.0 ± 8.35	77 ± 4.6	85 ± 3.8
Mid late May	18.8 ± 6.54	12.1 ± 4.12	42.3 ± 4.68	43.4 ± 1.12	73 ± 6.3	80 ± 4.1
Mid-late June	20.6 ± 5.62	12.5 ± 3.26	42.0 ± 6.04	42.3 ± 2.54	79 ± 6.1	80 ± 2.9
Mid-late July	17.1	17.1 ± 2.06	43.1	48.0 ± 1.36	76	79 ± 1.6

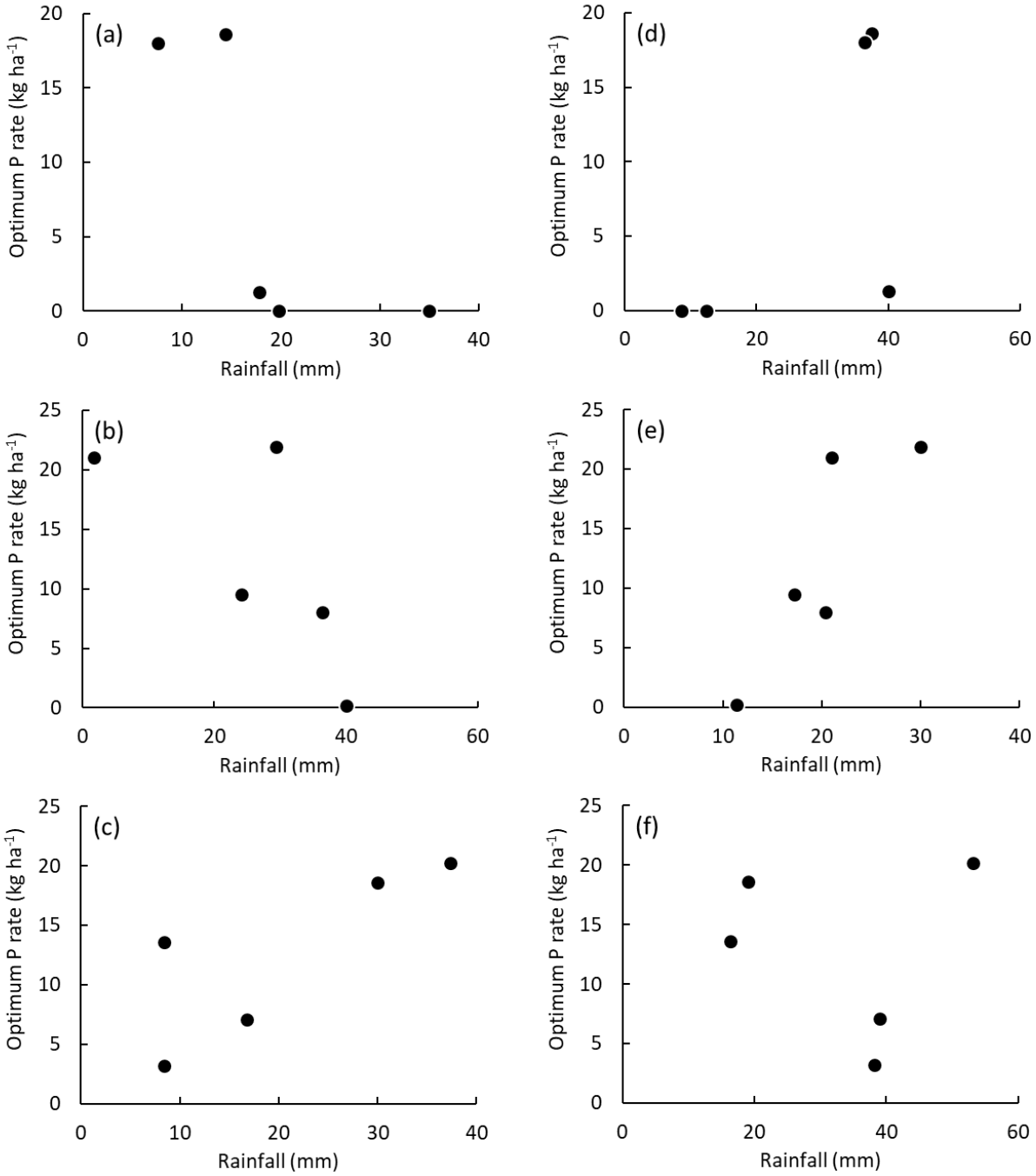
Supplementary table 3. The eigenvalues form the principal component analysis of the data from each sowing period.

Principal component	Late April – early May			Mid-late May			Mid-late June		
	Eigen value	Percent	Cumulative percentage	Eigen value	Percent	Cumulative percentage	Eigen value	Percent	Cumulative percentage
PC1	3.733	46.7	46.7	5.344	66.8	66.8	4.280	53.5	53.5
PC2	2.666	33.3	80.0	1.892	23.7	90.5	2.213	27.7	81.2
PC3	1.364	17.1	97.1	0.592	7.4	97.9	1.349	16.9	98.1
PC4	0.237	3.0	100.0	0.172	2.2	100.0	0.158	2.0	100.0

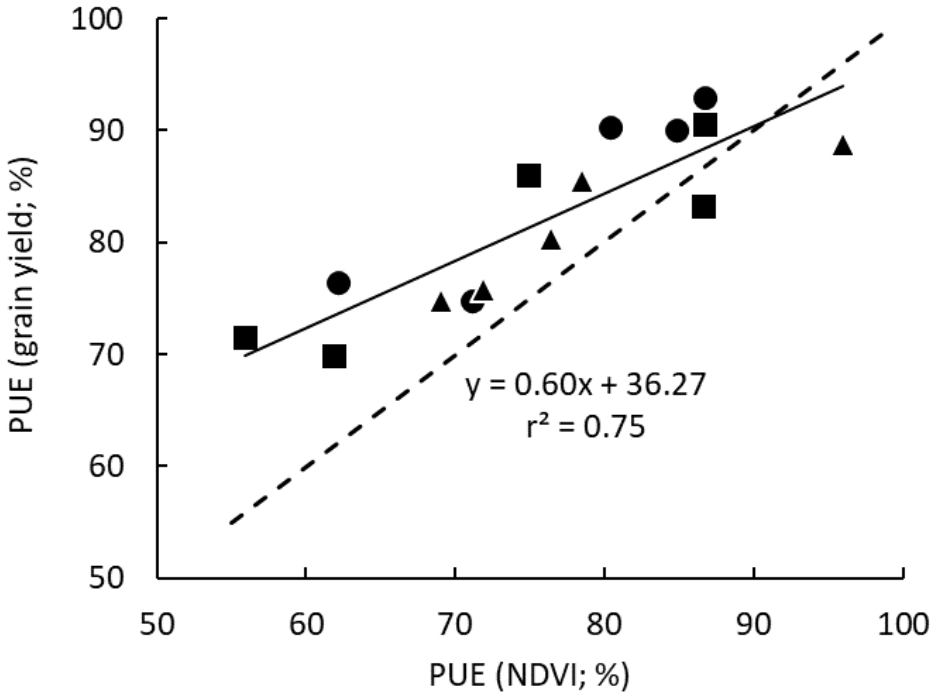
Supplementary Figures



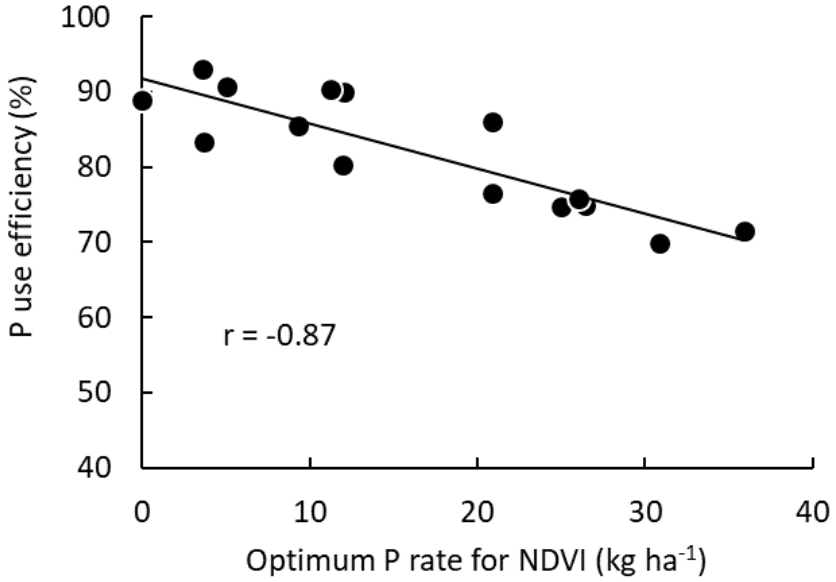
Supplementary Figure 1. The relationship between the optimum P rate for grain yield and the optimum P rate for NDVI in trails conducted in 2017 and 2018. The sowing dates are shown as TOS1 (●), TOS2 (■) and TOS 3(▲)



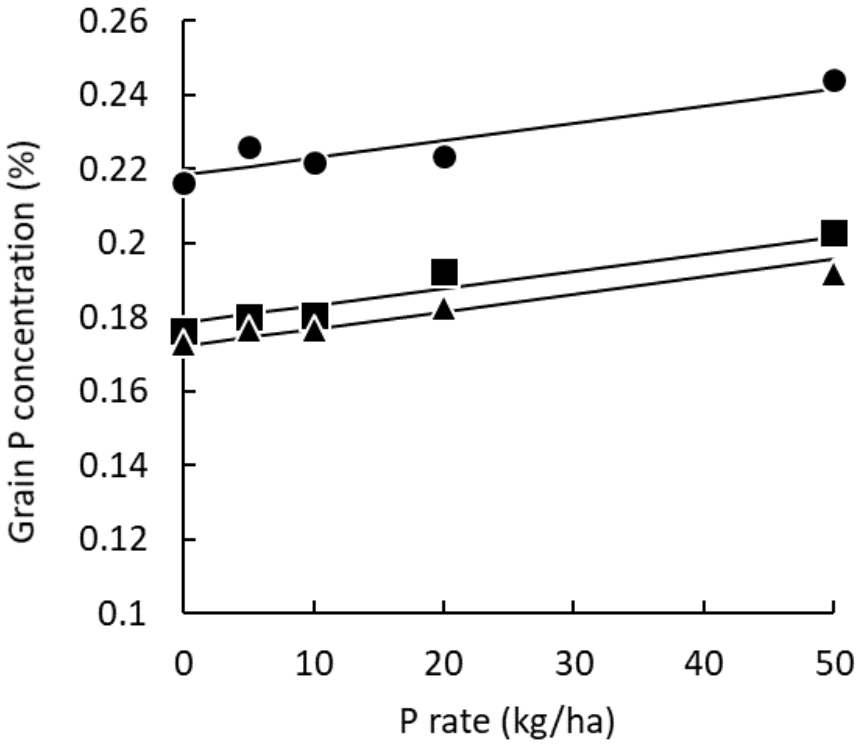
Supplementary Figure 2. The relationship between the optimum P rate for yield and rainfall in the 21 days prior to sowing (a-c) and the 21 days after sowing (d-f) fr wheat sown in later April-early May (a, d), mid to late May (b, e) and mid to late June (c, f). Values are the means of Mace and Trojan.



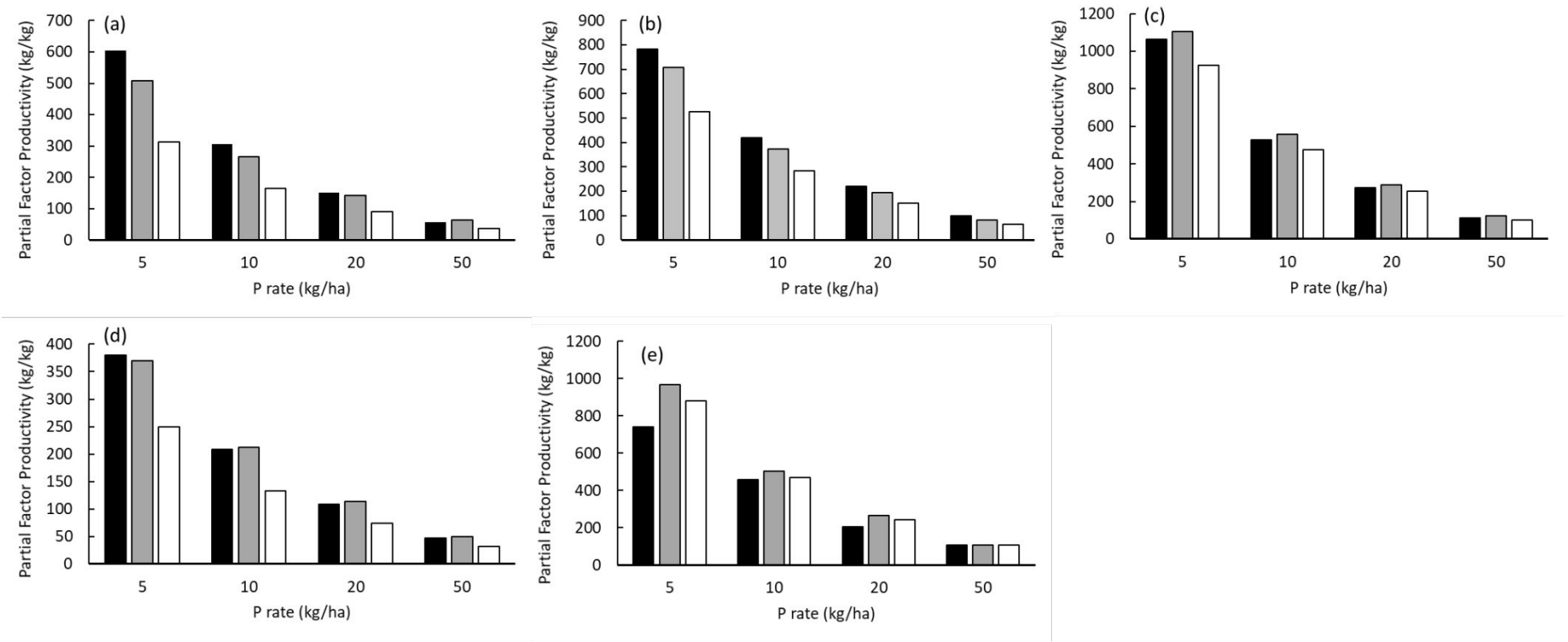
Supplementary Figure 3. The relationship between the PUE (NDVI) NDVI and PUE (grain) in trails conducted in 2017 and 2018. The sowing dates are shown as TOS1 (●), TOS2 (■) and TOS 3(▲) and the values are the averages of Mace and Trojan. The dashed line is the 1:1 line



Supplementary Figure 4. The relationship between the optimum P rate for NDVI and the PUE (grain) in trails conducted in 2017 and 2018.



Supplementary Figure 5. The increase in grain P concertation with P fertiliser rate at Arthurton (●) Brinkworth (■) and Urania (▲) in 2018. The values are the average over the three sowing dates because there was no significant Sowing date × P rate interaction. Comparison of regressions shows no significant different in the slope of the lines with a value of 4.67 x 10^{-4} % per kg ha^{-1}.



Supplementary Figure 6. The effects of time of sowing and P rate on the PFP of wheat at five sites. The LSD (P=0.05) for comparison within a time of sowing and for other comparisons are shown in parentheses for each site: (a) Snowtown 2017 (19.7, 23.0), (b) Urania 2017 (16.2, 24.9), (c) Arthurton 2018 (46.6, 62.9), (d) Brinkworth 2018 (11.3, 12.7) and (e) Urania 2018 (125.4, 114.6) .