Yardstick trial: A grower group's solution to reducing wheat and barley variety selection risk for their low rainfall farming system

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Key messages

- Variety ranking remained reasonably consistent across the different fertiliser treatments within each season, years 2015-17. Wheat variety ranking was reasonably consistent with NVT variety ranking in 2016 and 2017.
- The overall season/site had a greater impact on yield and grain protein than individual variety or nutrition choice. The optimum nutrition package differed between seasons.
- Any fertiliser is more profitable than no fertiliser across all seasons; low inputs upfront are the lowest risk, but still allow for playing of the season.

Aims

Designed to provide data on the genetic potential of varieties across environments, the NVT program is often scrutinised for not being managed under district practice where perhaps growers could gain more understanding on the variety performance variability under their own management system. Merredin and Districts Farm Improvement Group (MADFIG) initiated the yardstick project to reduce the risk in selecting new varieties by evaluating them under nutrition strategies lower than provided in the NVTs. The group also targeted a heavy soil type for these trials instead of light to medium land that had been preferred for NVTs for many years.

Under high background levels of nitrogen on fertile red clay-loams the addition of a higher than district average nitrogen application (usually reserved for decile 9-10 years) coupled with low rainfall can quite easily overshoot the yield curve and even result in a yield penalty. These trials were designed by the grower group

- To provide local growers with a better understanding of how recently released wheat and barley varieties perform under four 'district practice' nutrient packages, each depicting a different strategy of decision making depending on budget and season.
- To investigate whether there was validity in concerns about varieties that perform well in NVT may not yield as well relative to others under local nutrition practices.
- To ensure that locally generated variety data would be available should no other local variety data be released or available.

Method

Randomised complete block design plot trials with three replications were established for wheat and barley adjacent to the Merredin wheat and barley NVTs in 2015, 2016 and 2017. The paddocks and host farmer changed every year within the Merredin district (~260 km east of Perth) but a similar red-brown clay loam was targeted as the soil type each year. Trials were managed the same as the NVT trials apart from the selected fertiliser treatments.

Trials were sown with an experimental plot cone seeder with knife points and press wheels at a seed rate of 60 kg/ha and 65 kg/ha for wheat and barley respectively. Plots were harvested with a small plot header and sampled for grain quality.

Treatments

In 2015 there were 10 wheat and 5 barley varieties, 12 wheat and 5 barley in 2016 and 14 wheat and 6 barley varieties in 2017. Wheat varieties evaluated were **AH:** Mace, Emu Rock, LRPB Cobra, and Scepter (2016 & 2017) **APW:** Magenta, Hydra, LRPB Trojan, Corack (2015) and Cutlass (2017); **imi-tolerant APW:** Impress CL Plus and Chief CL Plus (2017); **ANW:** Calingiri, Zen, Supreme (2016 & 2017) and Ninja (2016 & 2017). Barley varieties tested

were La Trobe (malt), Scope CL (malt), Compass (under accreditation), Fathom (feed), Spartacus CL (2017 & 2017, under accreditation), Hindmarsh (2015, food), and Rosalind (2017, feed).

Four nutrition scenarios were implemented across the wheat and barley trials to represent various district fertiliser strategies. Three of the treatments remained the same for the three seasons; the 'Play the season' treatment differed from 2015 to 2017 depending on rainfall conditions:

Decile 1: 0 P, 0 N
Decile 4-5: 10 N, 5 P at seeding
Decile 7-8: 30 N, 5 P at seeding
Play the season: 10 N, 5 P at seeding + 10 N post emergent in 2015
30 N, 5 P at seeding + 20 N post emergent in 2016, 2017

The trial was analysed by a 2-way ANOVA with a focus on the significance of the interaction between variety and fertiliser treatments. Correlation of variety mean yields were calculated between the Yardstick and NVT results.

Site and seasonal details

Table 1. Site 0-10 cm soil properties and sowing details.

Season	Total N mg/kg	P mg/kg	OC %	EC ds/m	pH $CaCl_2$	Previous crop	Sowing date	Soil moisture at seeding	Next rain > 5 mm
2015	72	49	1.0	0.180	5.2	Wheat	16 May	Dry	17 May (9 mm)
2016	16	42	0.7	0.052	5.2	Wheat	27 May	Good	7 June (5 mm)
2017	17	33	0.7	0.100	5.9	Canola	6 May	Good at 2-3 cm	11th May (11 mm)

Table 2. Annual Merredin rainfall GSR = growing season rainfall (May-Oct). Source: BOM, Merredin Station.

	Total monthly rainfall (mm)												GSR (mm)	Annual (mm)
	J	F	M	A	M	J	J	A	S	O	N	D		
2015	4	5	85	16	15	42	63	80	7	6	31	6	213	360
No. rainy days	*2*	*2*	*5*	*5*	*4*	*6*	*9*	*11*	*2*	*3*	*6*	*3*		
2016	41	12	76	55	42	43	39	42	21	11	2	22	198	406
No. rainy days	*7*	*2*	*5*	*10*	*9*	*12*	*10*	*16*	*6*	*3*	*1*	*4*		
2017	32	53	21	5	28	5	36	48	48	26	11	4	191	317
No. rainy days	*3*	*6*	*4*	*2*	*5*	*3*	*15*	*14*	*11*	*4*	*5*	*2*		
Av. 2000-2017	34	16	23	22	33	30	44	37	28	19	18	16	191	320

Results and discussion

Yield

Variety ranking remained reasonably consistent across the different fertiliser treatments within each season, years 2015-17. These trials do not provide evidence that relative variety performance changes within the various fertiliser treatments (variety by fertilizer interaction was not significant $P>0.05$ for wheat and barley all years except barley 2015 $P<0.05$).

There were significant yield differences between varieties ($P<0.001$) and significant yield differences between the fertiliser treatments both wheat and barley in all years.

The grain yield results for wheat and barley are shown in Figures 1A and 1B. The site mean yield for wheat was 2.2 t/ha in 2015, 2.4 t/ha in 2016 and 1.9 t/ha in 2017. The site mean yield for barley was 2.4 t/ha, 3.1 t/ha and 1.9 t/ha in 2015, 2016 and 2017 respectively.

Generally, the varietal yields had reasonable correlation to Merredin NVT data; correlation was poor in 2015 (0.38, wheat and barley) but improved for 2016 and 2017 (2016: 0.92 wheat, 0.64 barley; 2017: 0.78 wheat, barley NVT not yet released).

The effect of fertiliser on grain yield for wheat and barley is shown in Figures 2A and 2B. The 10N 5P treatment (Decile 4-5) at seeding was sufficient for an equal or better yield than no fertiliser in all seasons on both wheat and barley. 2016 was the only year where yields improved with each higher fertiliser rate above 10N 5P (Decile 4-5) at seeding. The higher fertiliser treatments received a yield penalty relative to the nil and 10N 5P (Decile 4-5) fertiliser treatments in 2017.

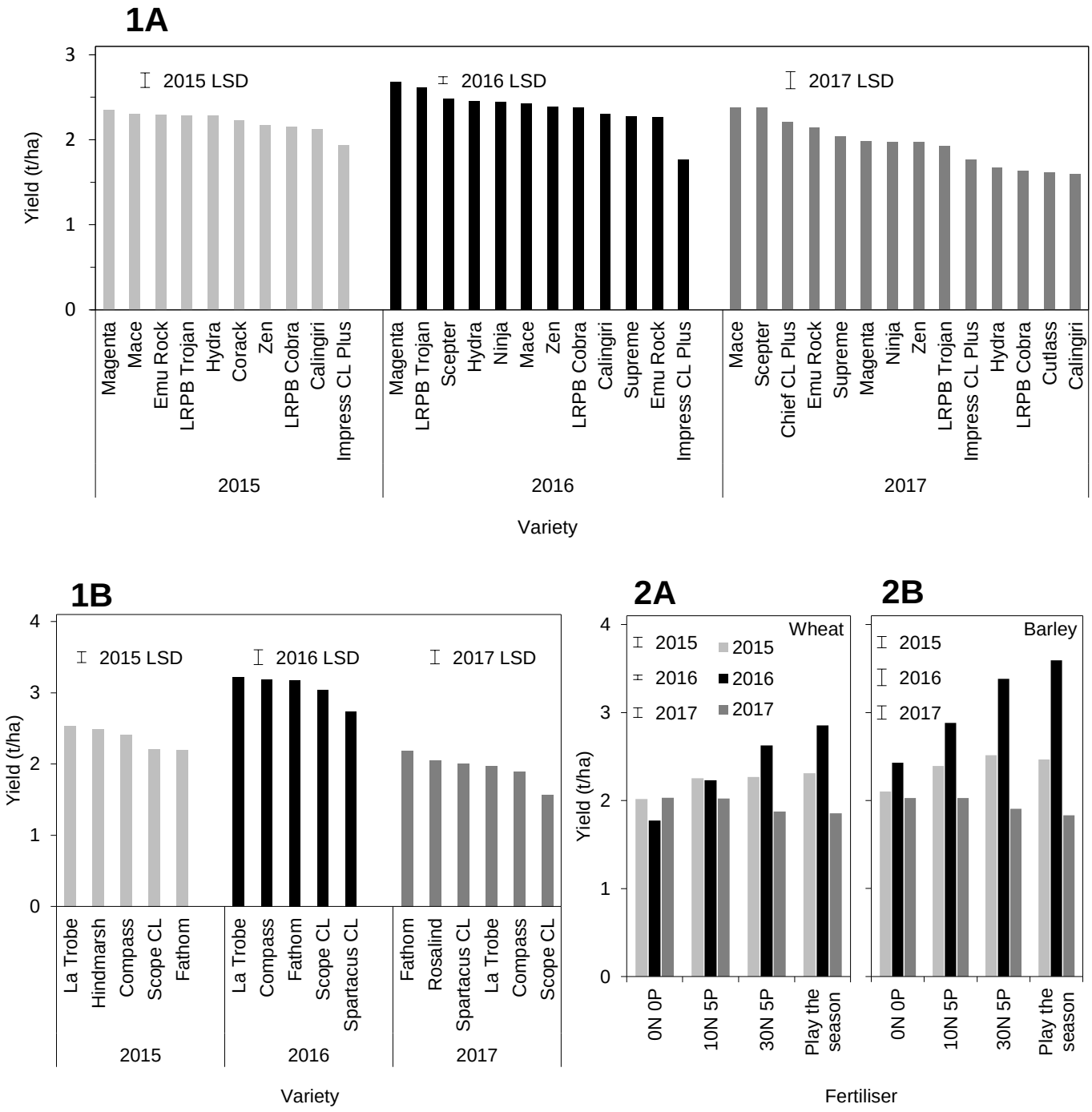

Figure 1A & 1B. Wheat (1A) and barley (1B) yield at Merredin over three seasons. P<0.001 all years for yield main effects.

Figure 2A & 2B. Yield of wheat (2A) and barley (2B) under different fertiliser treatments at Merredin over three seasons. Error bars show LSD 5%. P<0.001 all years for fertiliser main effects. Note: The 'Play the season' treatment in 2015 was 10 N, 5 P at seeding + 10 N post emergent and 30 N, 5 P at seeding + 20 N post emergent in 2016, 2017.

Quality

Table 3 outlines wheat and barley quality differences due to variety or nutrition selection. Wheat varieties did not differ in their sensitivity to fertiliser in quality attributes except in 2015 with screenings. Barley varieties did have an interaction with fertiliser on screenings in 2016, but not in any other season or for any other

quality attribute. Hydra had the highest wheat screenings in all years. Compass had low barley screenings in all years. Scope had high screenings 2017, reflecting the lower yield. The higher fertiliser treatments had higher screenings in 2015 and 2017, but lower in 2016 in both wheat and barley.

Hectolitre weights were over 76 kg/hl for wheat and 64 kg/hl for barley in all years. Fathom had lower hectolitre weights than other varieties in all seasons.

Table 3. Wheat and barley yield and quality for variety and fertiliser main effects. *** = P<0.001, ** = P<0.01, * = P<0.05, n.s. = not significant. Note: The 'Play the season' treatment in 2015 was 10 N, 5 P at seeding + 10 N post emergent and 30 N, 5 P at seeding + 20 N post emergent in 2016 and 2017.

	Yield (t/ha)			Protein %			Screenings %			Hectolitre (kg/hl)		
Wheat												
Variety	2015	2016	2017	2015	2016	2017	2015	2016	2017	2015	2016	2017
Calingiri	2.12	2.30	1.60	8.8	7.9	11.5	2.8	1.6	5.7	77.4	80.1	77.8
Chief			2.21			10.8			5.6			79.5
Cobra	2.15	2.38	1.63	8.9	7.8	11.1	4.0	1.5	6.3	76.4	81.8	77.9
Corack	2.23			8.8			2.5			79.0		
Cutlass			1.61			12.5			5.0			78.3
Emu Rock	2.29	2.26	2.14	9.0	8.6	11.1	3.9	2.1	4.8	77.7	82.5	80.7
Hydra	2.28	2.45	1.67	8.5	7.5	11.6	5.2	2.4	11.5	78.9	82.1	79.4
Impress	1.94	1.76	1.77	9.4	9.5	11.0	2.8	2.1	5.9	76.7	80.0	79.2
Mace	2.31	2.42	2.38	8.3	7.5	10.5	3.9	1.4	4.0	78.5	80.5	81.3
Magenta	2.35	2.68	1.98	8.7	7.4	12.3	3.8	1.5	5.8	78.9	82.0	80.6
Ninja		2.44	1.98		7.4	10.7		1.5	4.4		81.1	80.4
Scepter		2.48	2.37		7.0	10.2		2.3	6.1		81.5	81.5
Supreme		2.27	2.04		7.5	10.8		1.5	4.1		83.5	81.1
Trojan	2.29	2.61	1.93	8.6	7.3	11.3	3.3	1.4	4.4	79.7	84.1	80.9
Zen	2.17	2.39	1.97	8.8	7.8	10.8	2.7	1.0	4.0	77.3	80.4	79.8
Variety sig.	***	***	***	***	***	***	***	***	***	***	***	***
Variety LSD	*0.171*	*0.078*	*0.201*	*0.36*	*0.22*	*0.45*	*1.12*	*0.23*	*0.79*	*0.75*	*1.85*	*0.94*
Fertiliser												
0P 0N	2.02	1.77	2.03	8.4	7.9	10.6	3.3	1.9	5.2	78.7	81.7	80.4
10N 5P	2.26	2.23	2.02	8.5	7.7	10.9	3.3	1.7	5.4	77.7	81.7	80.0
30N 5P	2.27	2.63	1.88	9.2	7.7	11.5	3.7	1.6	5.7	77.4	81.7	79.7
Play the season	2.31	2.85	1.86	8.9	7.7	11.7	3.6	1.6	5.8	78.3	81.5	79.4
Fert sig.	***	***	***	***	***	***	*n.s.*	***	***	***	*n.s.*	***
Fert LSD	*0.108*	*0.045*	*0.107*	*0.23*	*0.13*	*0.24*	*n.s.*	*0.13*	*0.42*	*0.47*	*n.s.*	*0.50*
Variety x Fert	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*
Barley												
Variety												
Compass	2.41	3.19	1.90	9.7	7.1	13.8	0.4	1.6	8.2	66.4	69.0	68.3
Fathom	2.20	3.18	2.19	10.6	7.8	13.8	1.5	2.4	7.9	64.6	69.5	63.4
Hindmarsh	2.49			9.8			2.0			68.1		
La Trobe	2.54	3.22	2.97	9.5	7.8	14.0	1.7	2.4	14.9	68.3	72.1	67.1
Rosalind			2.03			13.5			13.1			66.6
Scope	2.21	3.04	1.57	10.7	8.0	14.4	1.5	1.9	21.1	67.9	71.0	64.9
Spartacus		2.74	2.00		8.1	13.7		2.8	15.2		72.2	67.2
Variety sig.	***	***	***	***	***	*n.s.*	*	***	***	***	***	***
LSD	*0.147*	*0.208*	*0.186*	*0.49*	*0.26*	*n.s.*	*1.06*	*0.27*	*3.61*	*0.73*	*0.93*	*1.62*
Fertiliser												
0P 0N	2.10	2.43	2.03	9.5	7.8	13.0	0.5	2.4	11.1	67.2	70.8	66.8
10N 5P	2.39	2.88	2.03	9.6	7.7	13.7	0.7	2.4	12.9	67.3	70.6	66.8
30N 5P	2.51	3.38	1.90	10.6	7.7	14.2	2.6	2.1	15.0	66.7	70.5	66.5
Play the season	2.47	3.59	1.82	10.4	7.7	14.6	1.8	1.9	14.6	67.2	71.0	65.0
Fert sig.	***	***	*	***	*n.s.*	***	***	***	*	*n.s.*	*n.s.*	*
LSD	*0.131*	*0.186*	*0.152*	*0.44*	*n.s.*	*0.53*	*0.95*	*0.24*	*2.95*	*n.s.*	*n.s.*	*1.32*
Variety x Fert	*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*n.s.*	*	*n.s.*	*n.s.*	*n.s.*	*n.s.*

Figure 3A and 3B shows the relationship between grain yield and protein for the three seasons between 2015 and 2017. Generally, fertiliser treatments were insufficient to improve the received grade in any season.

Season/site was the larger influencer of yield and protein than fertiliser. Protein remained stable in 2016 whilst yields improved with higher fertiliser. Conversely, protein concentrations were higher in lower yielding high fertiliser treatments in 2017. There were slight improvements in protein in the higher fertiliser treatments in 2015 at the same yield.

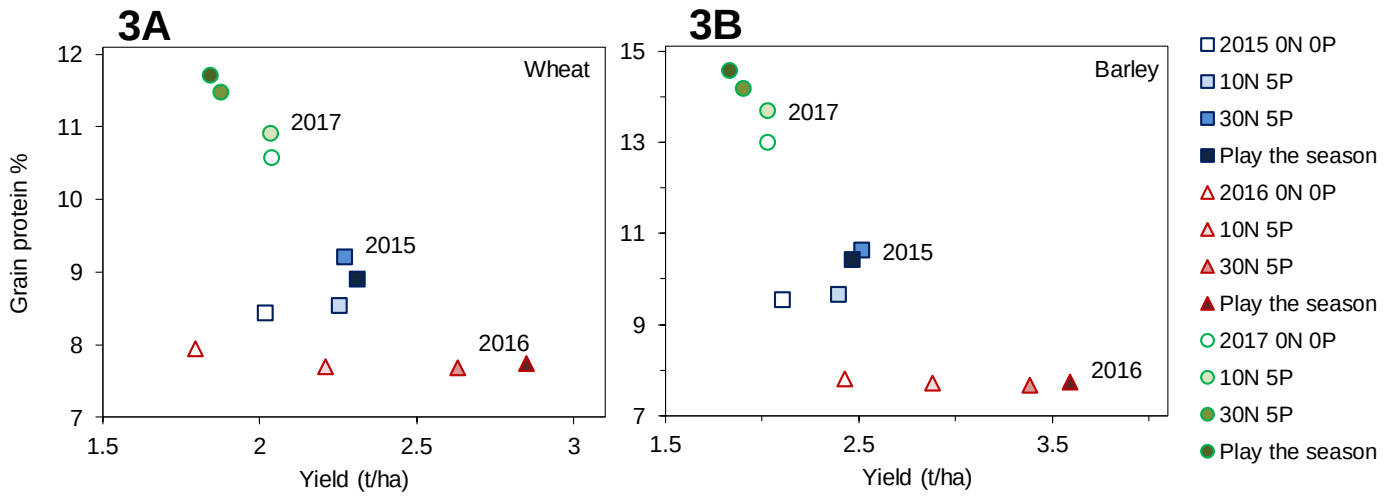

Figure 3A & 3B. Relationship between yield and grain protein % for wheat (3A) and barley (3B). Values are means of all varieties at each fertiliser level. Note: The 'Play the season' treatment in 2015 was 10 N, 5 P at seeding + 10 N post emergent and 30 N, 5 P at seeding + 20 N post emergent in 2016, 2017.

Return

Each individual season from 2015 to 2017 resulted in a different fertiliser strategy delivering the optimum yield and return. Table 4 shows the consecutive decision of a specific scenario resulted in any fertiliser being more profitable than no fertiliser, but none more profitable than each other. To truly 'Play the season', growers need to consider soil type, rotation, summer rain and forecasted rain, but this trial series indicates that a small amount of upfront fertiliser is a low risk option, while allowing for top up fertiliser if the season becomes favourable. These results indicate that in a constrained budget scenario return on these heavier, more fertile soils can be equivalent to higher fertiliser regimes.

Assumptions for Table 4: $250/t wheat, $240/t barley, $420/t urea, $700/t MAP, $10 spreading cost for top-up N application.

Table 4. Return on investment and total farm gate margins ($Net return/ha) for 4 fertiliser treatments wheat and barley over 3 seasons. Averages of all varieties were used. Note: The 'Play the season' treatment in 2015 was 10 N, 5 P at seeding + 10 N post emergent and 30 N, 5 P at seeding + 20 N post emergent in 2016, 2017.

Wheat	t/ha	2015 $Net return/ha	t/ha	2016 $Net return/ha	t/ha	2017 $Net return/ha	$Return/ha Accum. 3 yr
0N 0P	2.0	504	1.8	443	2.0	508	1456
10N 5P	2.2	541	2.2	536	2.0	484	1561
30N 5P	2.3	527	2.6	616	1.9	428	1572
Play the season	2.3	536	2.8	645	1.9	395	1576
Barley							
0N 0P	2.1	505	2.4	583	2.0	487	1574
10N 5P	2.4	552	2.9	669	2.0	464	1686
30N 5P	2.5	552	3.4	771	1.9	417	1740
Play the season	2.5	562	3.6	793	1.8	371	1726

Conclusion

These trials have provided valuable variety performance data for the Merredin region. The findings largely align with the recent work of the DPIRD wheat and barley agronomy research and NVT analysis (Anderson et al., 2011; Paynter et al., 2017; Dion Nicol, pers. comm.). The lack of strong evidence of a variety x fertiliser interaction in this environment should give growers more confidence in the results being generated from the NVT program being relevant for their farm and variety selection. There are challenges in interpreting trial

results from a single site per season due to the fact that variation between seasons or sites can be quite large and therefore results may not necessarily be repeatable. It would be recommended that results from similar activities be viewed together with the wider NVT and agronomy research outcomes to provide greater awareness of the risks and strengths each variety may have in your system.

Key words

MADFIG, wheat, barley, NVT, nutrition, nitrogen, phosphorus

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References

Anderson, W.K., van Burgel, A.J., Sharma, D.L., Shackley, B.J., Zaicou-Kunesch, C.M., Miyan, M.S., Amjad, M. 2011. Assessing specific agronomic responses of wheat cultivars in a winter rainfall environment. *Crop & Pasture Science*. **62:** 115-124.

Paynter, B., Graham, N., Graham, R., Burch, D., Walters, L., Malik, R., Curry, J., Chong, P., Porker, K., Menz, I. 2017. Do barley varieties differ in their response to increasing nitrogen and increasing seed rate? *18th Australian Barley Technical Symposium Proceedings*.