Optimising wheat variety choice across the sowing window – Grass Patch 2021

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Key Messages

- The highest yielding treatment was Calibre (RAC2721) sown on 28 April, achieving just over 4.6t/ha.
- Yields of over 4t/ha were consistently achieved by mid-slow to slow maturing spring wheats sown on 14 April and quick to mid maturing spring wheats sown 28 April. This coincided with flowering occurring during August.
- Despite being sown onto field pea stubble with 75kg N/ha applied, high yielding (4+ t/ha) treatments rarely met APW1 protein specifications, indicating that at these high yields greater nitrogen applications are required to achieve premium milling grades.

Aim

To determine the optimum sowing date and variety combinations to maximise yield and quality of wheat in WA.

Background

In recent years there has been an increase in the appetite of growers to take advantage of early breaks to the season to establish early cereal crops. It is understood that delayed seeding past a critical date in Western Australia will substantially reduce the yield of a wheat crop due to exposure to heat events, as well as warmer and drier grain filling conditions. On the other hand, sowing wheat too early can equally reduce production if the rate of development results in reduced biomass accumulation or an exposure to greater frost risk. Previous time of sowing trials at a relatively mild and frost-free Esperance sandplain environment (Gibson 2015-2018) indicated that (i) there is a relatively flat response to flowering date in most seasons, (ii) yield was maximised through sowing quick-mid (e.g. Mace) to mid-slow (e.g. Cutlass) spring wheats in May, and that (iii) yield of April sown crops was maximised by sowing mid-slow spring wheats. It is important to see whether these findings differ in the Esperance mallee environment which is characterised by fewer seeding opportunities, increased frost and heat prevalence, and lower annual rainfall.

Trial Details

Property	Sanderson's, Grass Patch WA 6446. GPS 33.228769°S, 121.477243°E
Plot size & replication	1.85 m centres x 10 m sown x 3 reps
Soil type	Alkaline grey shallow sandy duplex
Sowing dates	TOS1 – 14 April 2021 TOS2 – 28 April 2021 TOS3 – 13 May 2021 TOS4 – 9 June 2021
Seeding rate	Packed according to grain weight, germination (%) and estimated field establishment to target 150plants/m^2.
Fertiliser	Seeding - 100kg/ha Vigour Rich banded plus 54kg/ha urea top-dressed to supply a total of 35N, 14P, 10K and 5S. Post-seeding – 95L/ha UAN at 7-9 weeks after sowing to supply 40N. 1L/ha ZnSO4 + 4L/ha MnSO4 at 8-12 weeks after sowing to supply 0.35Zn and 1.2Mn.
Herbicides and insecticides	IBS – 2 L/ha SpraySeed (135g/L paraquat + 115g/L diquat) + 2 LHa TriflurX (480g/L trifluralin) + 118g/ha Sakura (850g/kg Pyroxasulfone) Post-emergent: TOS1 – 70g/ha Lontrel (750g/kg clopyralid) TOS2 – 70g/ha Lontrel (750g/kg clopyralid) + 600ml/ha MCPA (750g/L MCPA) TOS3 – 1L/ha Velocity (210g/L bromoxynil + 37.5g/L pyrasulfotole) + 2.5L/ha Boxer Gold (800g/L prosulfocarb + 120g/L S-metolachlor) TOS4 – 1L/ha Velocity (210g/L bromoxynil + 37.5g/L pyrasulfotole)
Fungicides	300ml/ha Prosaro (210g/L prothioconazole + 210g/L tebuconazole) at 12-14 weeks after sowing.
Harvested	TOS1 & TOS2 – 15 November 2021 TOS3 & TOS4 – 13 December 2021
April to October rainfall	266 mm (on-farm weather station)

Trial design
24 wheat varieties were sown in each of four sowing dates: 14 April, 28 April, 13 May and 9 June. Plots (10m x 6 rows [25.7cm spacing]) were sown in six banks with three replicates per time of sowing and sowing date blocks were fully randomised.

Varieties
The trial consisted of 24 wheat varieties; these were composed of a number of commercially relevant, recently released, and elite breeding lines (nominated by breeding companies). The varieties chosen represented the range of maturity types that are grown in Western Australia. Spring wheats, those that have a minimal requirement for cold temperatures (vernalisation) to stimulate reproductive development, comprised 21 of the varieties tested. These represented all maturity classes within spring wheats; quick (e.g. Vixen, Sting), quick-mid (e.g. Scepter, Devil), mid (e.g. Chief CL Plus, Ninja), mid-long (e.g. Cutlass, Kinsei) and long (e.g. Denison [*provisionally rated*]). There were three winter wheats, those that require a period of prolonged cold temperatures to stimulate reproductive development, in the trial. Illabo and the breeding line, LPB19-14343, are considered fast winters due to their comparatively faster development compared to other winter wheats such as DS Bennett, a mid-slow winter wheat that was included in the trial.

Seasonal conditions
Rainfall was recorded at the Sanderson's weather station approximately 2km from the trial site at west Grass Patch. Data from the DPIRD weather station at Salmon Gums Research Station was used to baseline 2021 against the average conditions of the last 20 years.

Summer rainfall (Jan-Mar) was slightly above average, with 71mm recorded across 16 rainy days. The first time of sowing (TOS1, 14 April) was seeded into moisture on the back of 18mm of rainfall on 12 April. Five days with temperatures near to or exceeding 30C in late April resulted in some surface crusting and although the second time of sowing (TOS2, 28 April) germinated immediately, emergence was not assured until significant (20+mm) rainfall fell in early May. May to July all recorded average to above average rainfall in a period of prolonged wet conditions. The third time of sowing (TOS3) was sown into very good moisture on 13 May, while the fourth time of sowing (TOS4) was delayed from its planned 01 June sowing to 09 June due to paddock trafficability issues.

Generally dry but cool August and September conditions dried out much of the profile, although notably there were few frost events recorded at the site during this period where many of the varieties were flowering. Canopy temperatures below -2C were recorded on 14 August, 23-24 August, and 10 October, with temperatures below -1C also recorded 16 August, 4-5 September and 18 September. In addition to cold temperatures, there were notable hot days (near to or exceeding 30C) on 7-8 September, 22 September and 30 September. October and November had average and below-average rainfall, respectively, albeit with cooler than average temperatures.

Results
Establishment and in-season growth
Plant establishment was variable across the four sowing times. The first time of sowing had staggered germination in some plots as a result of surface crusting following warm weather post-seeding, although all varieties reached at least 130pl/m^2 on average by four weeks post-seeding. The second and fourth sowing dates had particularly even establishment.

Crop growth through the first 14 weeks was assessed visually and with NDVI. In general, the second sowing date had the highest NDVI and the fourth sowing date the lowest. There were major differences between varieties, although these were driven by growth habit and phenological development as much as by rate of biomass production.

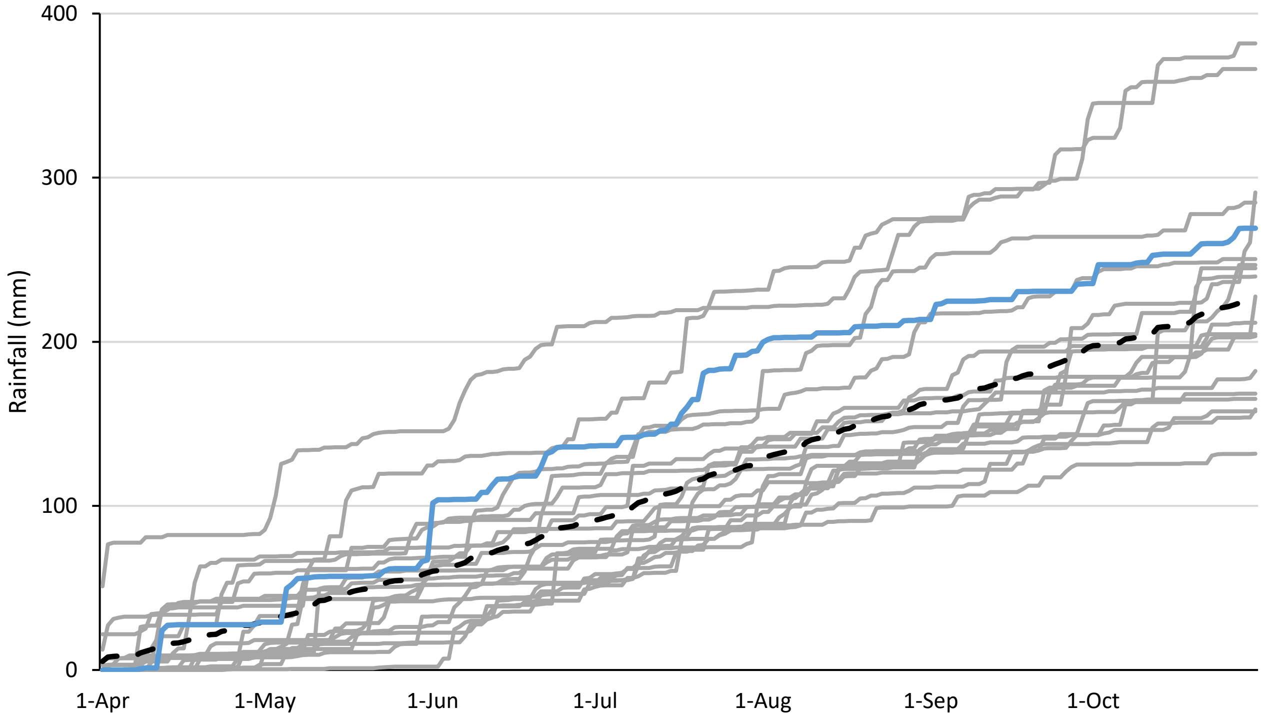

Figure 1: Cumulative growing season (Apr-Oct) rainfall from 2001-2021 at Salmon Gums Research Station (DPIRD weather station). Blue line = 2021, dotted line = average, grey lines = all other years. NB// Data from Sanderson's weather station aligned very closely with that of Salmon Gums Research Station in 2021.

Phenological development

The development of varieties was assessed opportunistically throughout the vegetative and early reproductive growth stages with particular interest in the date of the start of stem elongation. From booting onwards, plots were assessed for growth stage (Zadok's) twice weekly and the date of full head emergence (Z59) and mid-anthesis (Z65) were recorded.

As was to be expected, spring wheats recorded a shorter duration to stem elongation and flowering than winter wheats. From the mid-April sowing date, the start of stem elongation was reached by late May in quick spring wheats (e.g. Vixen) through to mid-June in slow spring wheats (e.g. Denison). For winter wheats, the start of stem elongation was not reached until mid-July (e.g. Illabo) or late July (DS Bennett). From the mid-May sowing date, stem elongation was reached by late June in the quick spring wheats, mid-July in the slow spring wheats, and mid-late August in the winter wheats.

The flowering date response of varieties varied with their development habit (Figure 2). Quick to mid maturity spring wheats generally had the longest duration to flowering when sown in mid-May and their duration to flowering significantly reduced as they were sown earlier. Mid to slow maturing spring wheats had a similar duration to flowering whether sown in late April or mid-May and generally did not have significantly reduced duration to flowering even when sown in mid-April. The June sowing had the smallest variation in flowering date between varieties with slower maturing varieties (spring and winter) having their shortest duration to flowering and quicker maturing spring wheats having a moderate duration to flowering.

Grain yield

Grain yield between varieties and sowing dates varied from 2.1t/ha to a peak of 4.6t/ha. The lowest yields for all varieties were achieved at the June sowing date, while the sowing date with the highest yields differed between maturity types. In general, mid to slow maturity spring wheats and winter wheats achieved their highest yields at the mid-April sowing date and quick to mid maturity spring wheats achieved their highest yields at the late April sowing date. This was due to the impact of development timing on yield, with the highest yields achieved from varieties sown at times that had them flowering in the August period (Figure 3).

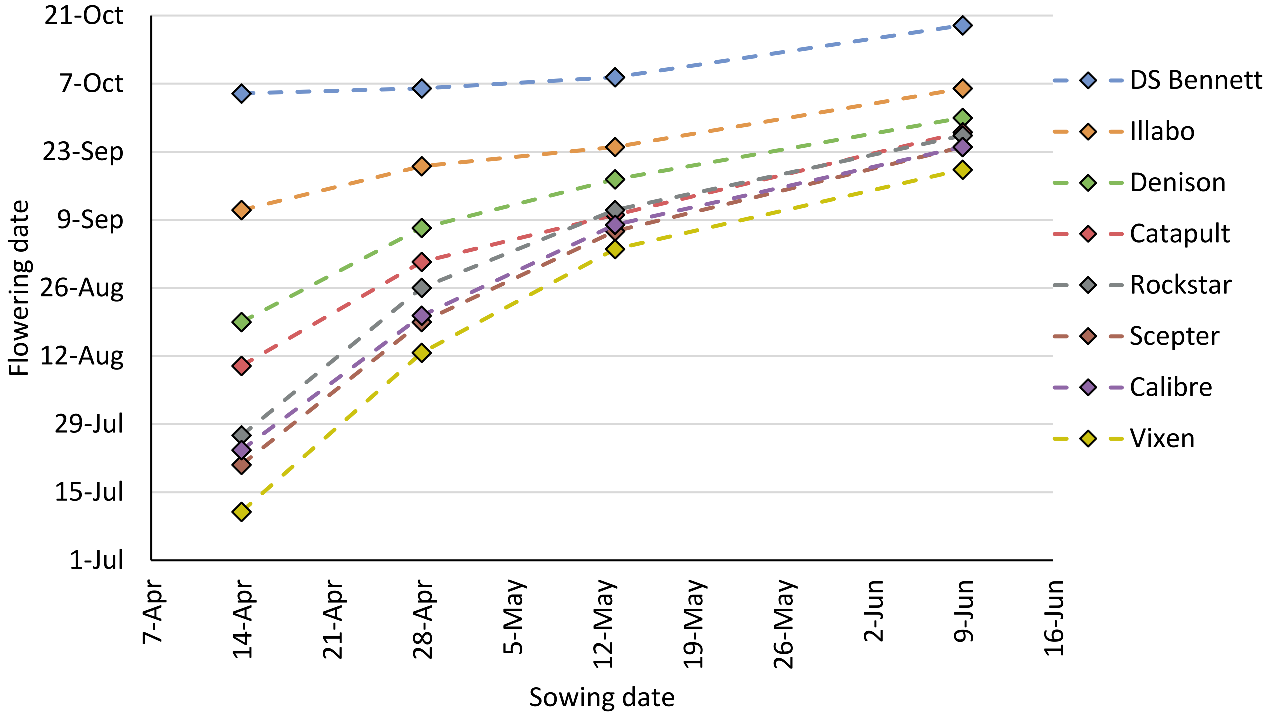

Figure 2: Flowering date of eight wheat varieties from four sowing dates at Grass Patch in 2021.

Despite both frost and heat events occurring during the flowering period, grain yield was influenced to a greater degree by biomass accumulation than harvest index (Figure 4). Overall, there was limited evidence of frost damage to varieties at the site, although heat events during booting of many varieties sown in June were attributed to increased sterility and lower grain number at this time of sowing.

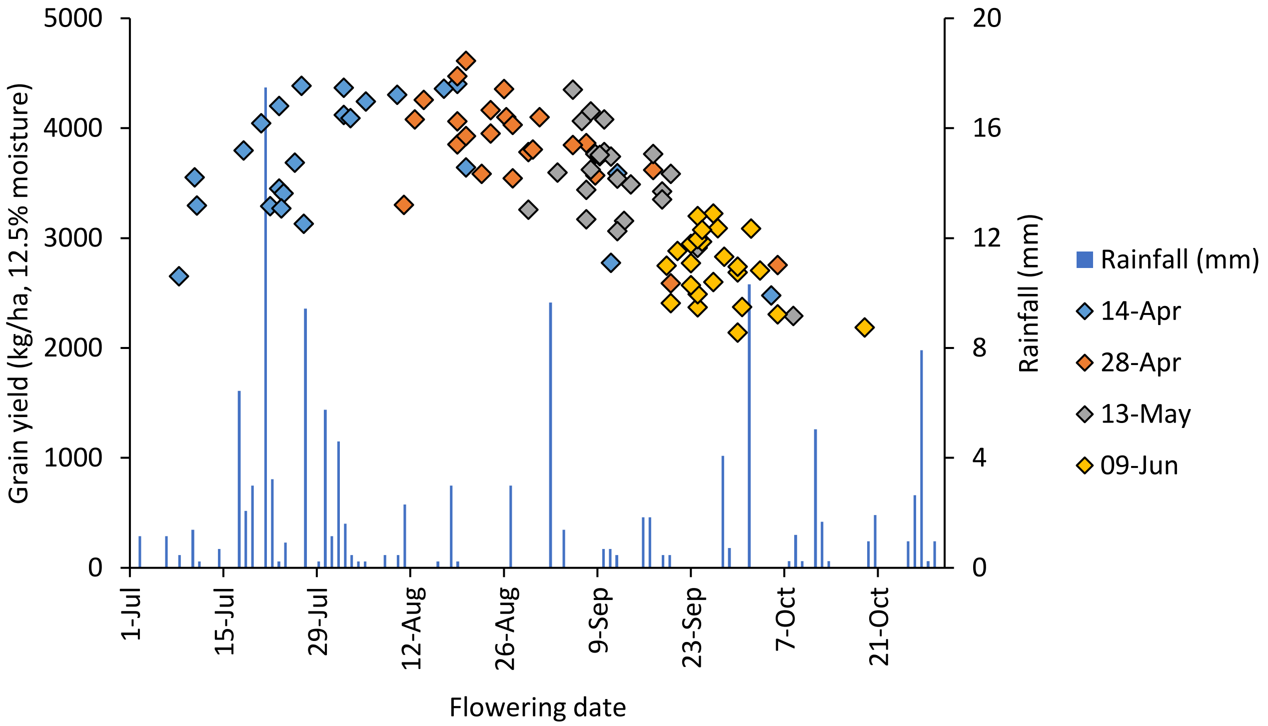

Figure 3: Relationship between flowering date and grain yield (corrected to 12.5% moisture) of 24 wheat varieties sown at four sowing dates at Grass Patch in 2021.

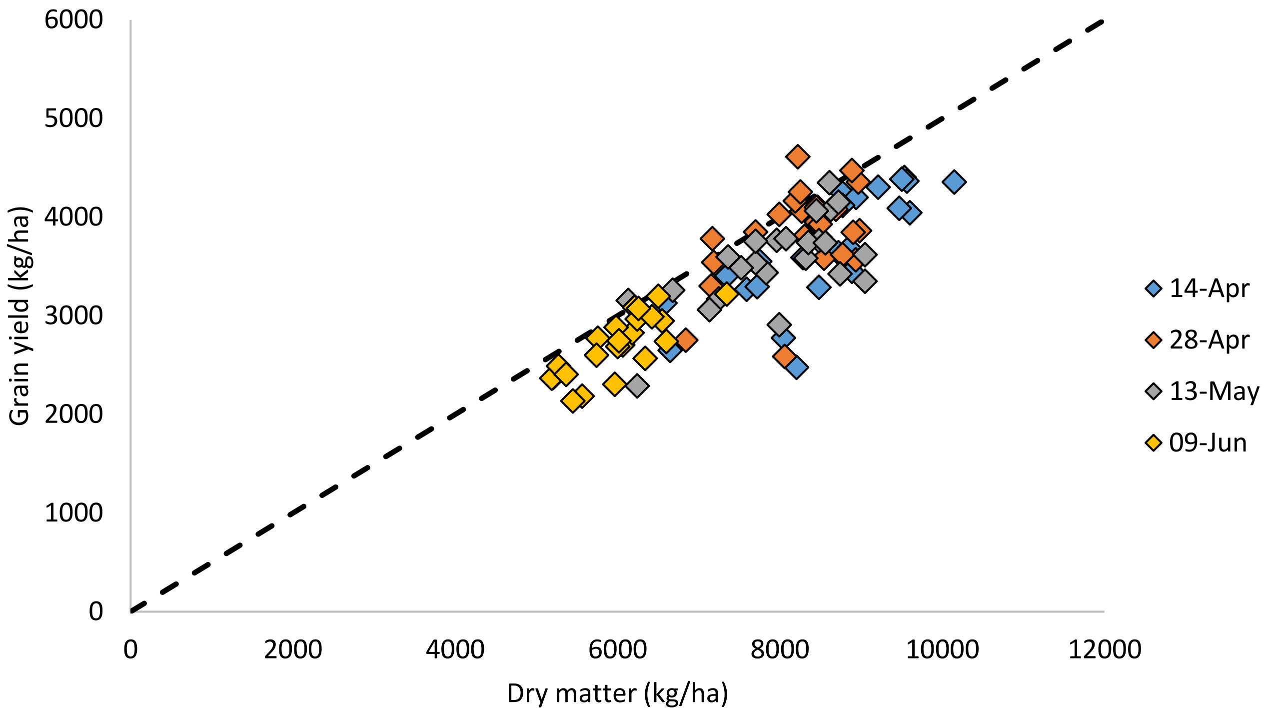

Figure 4: Relationship between total dry matter (kg/ha) at maturity and grain yield (12.5% moisture) for 24 wheat varieties sown at four sowing dates at Grass Patch in 2021.

Grain quality
Despite a large variation in grain weight (less than 30mg in DS Bennett through to over 50mg in Calibre), all varieties were within receival limits for grain screenings and grain screenings did not correlate well with grain weight (data not shown). Hectolitre weight was generally above 80kg/hL in all varieties and sowing times.

Grain protein averaged 10.9% (range 9.1% to 13.4%), with grain protein reducing by approximately 1% for every 1t/ha extra grain yield achieved (Figure 5). Grain protein yield (total protein produced per hectare) reduced with later development timing, indicating that later developing crops do not have a proportional increase in protein to compensate for their reduced yield and that protein yield is driven by yield more so than protein (Figure 5).

Conclusion
The generally wet start to the year created the opportune scenario to test whether growers in the low to medium rainfall zone of Esperance should consider planting wheat from mid-April, or whether traditional sowing times (May to June) are more appropriate for the varieties available.

In this relatively frost-free season with a mild finish, yields were maximised through variety and sowing date combinations that resulted in flowering occurring in August. This was generally achieved by sowing mid-slow maturing spring wheats (e.g. Catapult, Denison, RockStar) from the middle of April and quick-mid to mid-slow maturing spring wheats from the end of April. Crops that flowered too early (July) or too late (past mid-September) generally had reduced biomass and reduced overall yield.

Even when sown 14 April, the winter wheats tested (including Illabo) flowered mid-September or later. While this may be useful in a grain and graze scenario or as part of a frost avoidance strategy, their yields were reduced relative to many of the spring wheats sown at the same date.

Grain protein varied from 9.1% to 13.4% across the trial, with an approximate 1% reduction in grain protein for each extra ton of yield achieved. Despite this being the first wheat following field peas and 75kg/ha of N applied, only one quarter of the samples that achieved a grain yield of over 4t/ha met APW1 protein limits, indicating that in-season applications of over 70kg N/ha may be required to meet higher protein specifications in better yielding seasons.

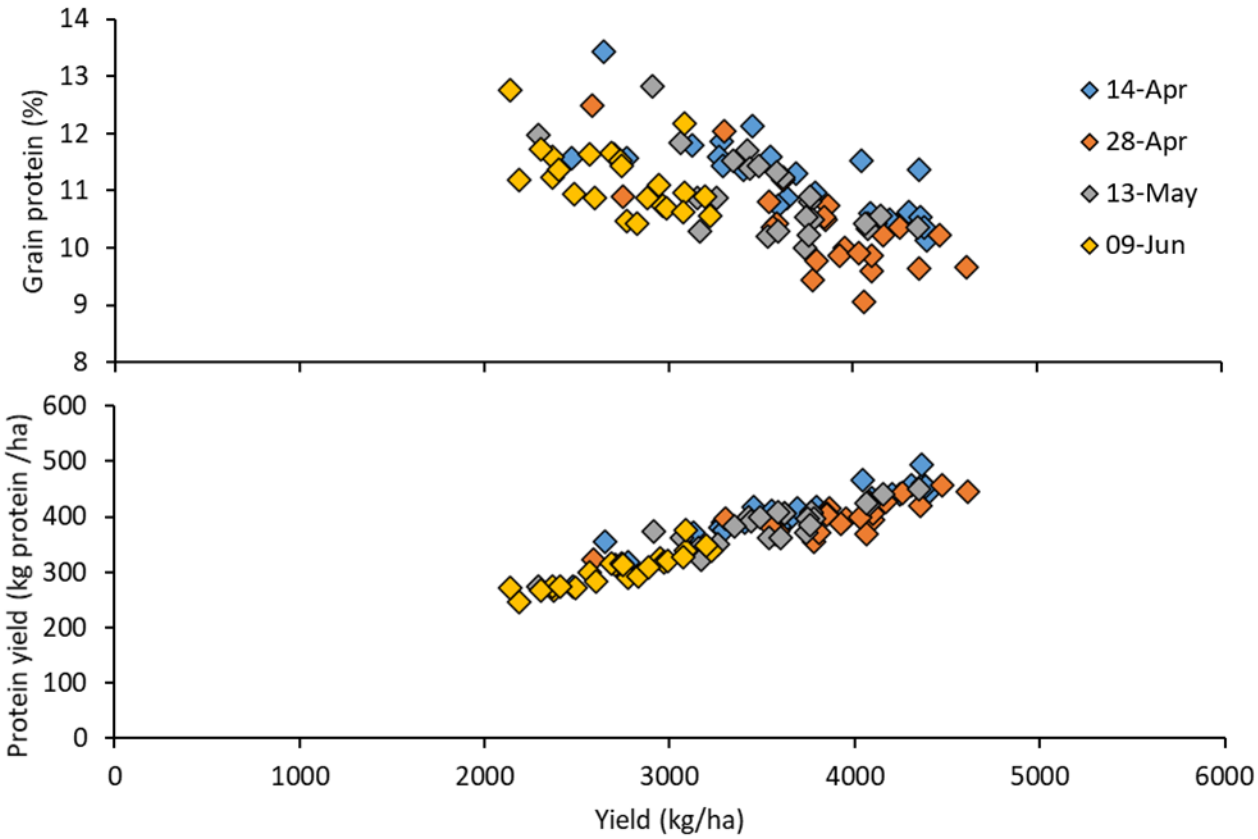

Figure 5: Relationship between grain yield (kg/ha, 12.5% moisture) and (top) grain protein concentration (%) and (bottom) total protein yield (kg protein/ha) for 24 wheat varieties sown at four sowing dates at Grass Patch in 2021.

Appendix 1 – soil test results

Table 2: Soil test results taken at seeding at 10cm incremental depths (0-10cm – composite of 40 samples, 10-60cm - composite of six samples per 10cm).

Soil group: Alkaline grey shallow sandy duplex

Depth	0-10cm	10-20cm	20-30cm	30-40cm	40-50cm	50-60cm
pH (CaCl2)	7.6	8.0	8.7	8.9	8.8	8.8
pH (water)	8.4	9.3	10.0	10.1	10.2	10.3
P (HCO3) (µg/g)	22	9	8	4	3	2
K (HCO3) (µg/g)	305	656	770	631	572	572
N (NH4) (µg/g)	2	2	2	2	1	1
N (NO3) (µg/g)	15	29	12	8	5	4
S (µg/g)	6.8	42.4	109.8	157.1	137.9	118.4
Organic carbon (%)	0.61	0.34	0.26	0.26	0.22	0.18
PBI	35.4	101.4	173.9	185.4	169.6	162
Conductivity (dS/m)	0.228	0.684	0.645	0.621	0.643	0.572
Soil colour	GRBR	GRYW	GRYW	WH	WH	WH
Hand texture	1.5	2.5	2.5	2.5	2.5	2.5
Gravel (% by weight)	0%	0%	0%	0%	0%	0%
Boron CaCl2	3.42	16.98	34.34	30.92	29.39	28.24

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