Managing dryland wheat for maximum yield potential – Tamarang 2014

Rick Graham, Guy McMullen, Steven Simpfendorfer and Bruce Haigh

NSW DPI, Tamworth

Key findings

Results from this study, clearly demonstrated that sowing timing is important. For example, delayed sowing (30 June vs 9 May) reduced the grain yield potential for EGA Gregory⁽ᵈ⁾ by 1.75 t/ha or ~24%.

Agronomic management factors that affected yield potential from the early sowing time (9 May) included response to nitrogen (N) input (~9% variation), with genotype and crown rot disease pressure both individually accounting for ~8% variations in grain yield.

When the time of sowing was delayed to 30 June, agronomic factors had a larger impact/variation on grain yield potential. With both genotype (variety selection) and crown rot disease pressure responsible for a 13% variation/decline in grain yield.

Delayed sowing also affected yield response to N with no increase in grain yield potential due to N input, whilst targeted plant population affected grain yield, with the low population treatment accounting for ~9%

Introduction

The Liverpool Plains (LPP) with its fertile, high water-holding capacity vertosol soils is regarded as a high yielding environment within the Northern Grains Region. Despite this, average dryland wheat yields achieved on the LPP are still considered to be substantially lower than the maximum attainable or potential yields. Identifying the key agronomic drivers of yield in these water-limited (rain fed) environments is an important step towards closing the so called 'yield gap' – the difference between maximum attainable (potential) yield and the yield that is currently being achieved commercially.

The aim of this co-funded NSW DPI and GRDC research was to determine the maximum attainable grain yield for a given location and year, and to quantify the contributions various agronomic management factors might have on grain yield and quality. Possible yield-limiting agronomic factors or drivers investigated included time of sowing (TOS), variety, plant population, fertiliser inputs (nitrogen and phosphorus rates) and disease pressure (± crown rot infection; CR). Defining the contribution these agronomic factors have on potential grain yield will help growers understand why there are yield gaps and give them some direction as to how they can best bridge these gaps. This is important, as growers are often reluctant to provide the inputs necessary to achieve water-limited yield potential due to the perceived risks associated with the return on investment.

This report outlines findings from a dryland wheat experiment conducted at Tamarang on the LPP of northern NSW in 2014.

Site details

Location:	**"The Point", Tamarang**
Co-operators:	**David Ronald**
Previous crop:	**Long fallow out of cotton**
Soil type:	**Black vertosol**
Starting nutrition:	**Starting soil nutrition is outlined in Table 1.** **Soil nitrate N was calculated as 160 kg/ha (0–120 cm)**
Starting water:	**~210 mm PAW (plant available water) to 1.2 m when cored pre-sowing (TOS 1)**
In-crop rainfall:	**170 mm**

Table 1. *Starting soil nutrition*

Depth (cm)	Nitrate (mg/kg)	Colwell P (mg/kg)	Colwell K (mg/kg)	Sulfur (mg/kg)	Organic carbon (%)	Conductivity (dS/m)	pH level ($CaCl_2$)
0–10	26	77	737	16.2	1.41	0.223	7.6
10–30	19	17	319	26.5	0.86	0.255	7.8
30–60	11	11	244	13.9	0.53	0.245	8.1
60–90	5	24	261	12.9	0.37	0.401	8.0
90–120	3	41	275	10.0	0.42	0.404	8.1

Treatments

A series of 36 treatment combinations (2 TOS × 18 treatments) were investigated in a partially factorial experiment, with three replicates. Treatments were designed similar to an omission trial, with the high input treatment aimed at providing the perceived optimum combination of factors and a low input treatment comprising a base set of agronomic factors. Treatments details are outlined in Table 2.

Table 2. *Treatment details*

Treatment	Details
Two times of sowing (TOS)	TOS 1: 9 May 2014 TOS 2: 30 June 2014
Four varieties	EGA Gregory⚡︎ (TOS 1 & 2) LRPB Spitfire⚡︎ (TOS 2) Sunvale⚡︎ (TOS 1) LRPB Crusader⚡︎ (TOS 1 & 2)
Three plant populations	60, 120 or 180 plants/m^2
Five nitrogen rates	0, 50, 100,150 or 50 + 50 (split application) kg N/ha all applied as urea (46% N). Treatments were side banded at sowing, apart from the split application, which was applied at sowing and stem elongation (GS31).
Four phosphorus (P) rates	0, 10, 20 or 30 kg/ha P applied as triple super at sowing
Four crown rot (CR) inoculum rates	0, 0.5, 1.0 or 2.0 g/m row sterilised durum grain colonised by at least five different isolates of *Fusarium pseudograminearum* (*Fp*) +/– added at sowing i.e.; 0, CR+, CR++ or CR+++

Results

- Timeliness was shown to have a significant effect on grain yield. Delayed sowing reduced yield by 1.75 t/ha or ~24% from 7.33 t/ha TOS 1, down to 5.58 t/ha for TOS 2 for the 'High Input' EGA Gregory treatment targeting 120 plants/m^2, 100 kg N/ha and 20 kg P/ha applied at sowing, with nil additional disease pressure (0 *Fp* applied at sowing; Table 3). Physical grain quality parameters were also impacted with delayed sowing increasing screenings (% grain below the 2.0 mm screen), decreasing seed weight, and reducing test weight (data not shown).

Table 3. *Effect of agronomic factors on grain yield potential, Tamarang 2014*

Variety	Population (plants/m^2)	Applied N (kg N/ha)	Applied P (kg P/ha)	Added ± *Fp* (CR+,++,+++)	Yield (t/ha)	Yield gap (t/ha)
*EGA Gregory	120	100	20	0	7.33	
*EGA Gregory	120	0	20	0	6.70	–0.63
*EGA Gregory	120	100	20	+++	6.75	–0.58
*Sunvale	120	100	20	0	6.77	–0.56
**EGA Gregory	120	100	20	0	5.58	–1.75
*TOS 1, **TOS 2						

- There was a significant (P<0.001) grain yield (GY) and grain protein concentration (GPC) response to applied N for TOS 1, with a 0.63 t/ha GY increase from applying 100 kg N/ha compared with the nil treatment for EGA Gregory (Table 3). There was no difference between the upfront and split applications (Figure 1). There was no additional GY response at the higher 150 kg N/ha rate, while the 50 kg N/ha rate gave no significant yield benefit over the nil N treatment. In contrast to TOS 1, increasing the N rate provided no GY benefit for LRPB Spitfire, in the delayed sowing (TOS 2). This could have been from the effect of cold temperatures (soil and air) on plant growth, affecting both N uptake and efficiency. Conversely, heat and moisture stress during the shortened critical grain-filling period could also have influenced yield potential. Unlike the GY response to N application, there was a GPC response to increasing N rates for both times of sowing (data not shown).

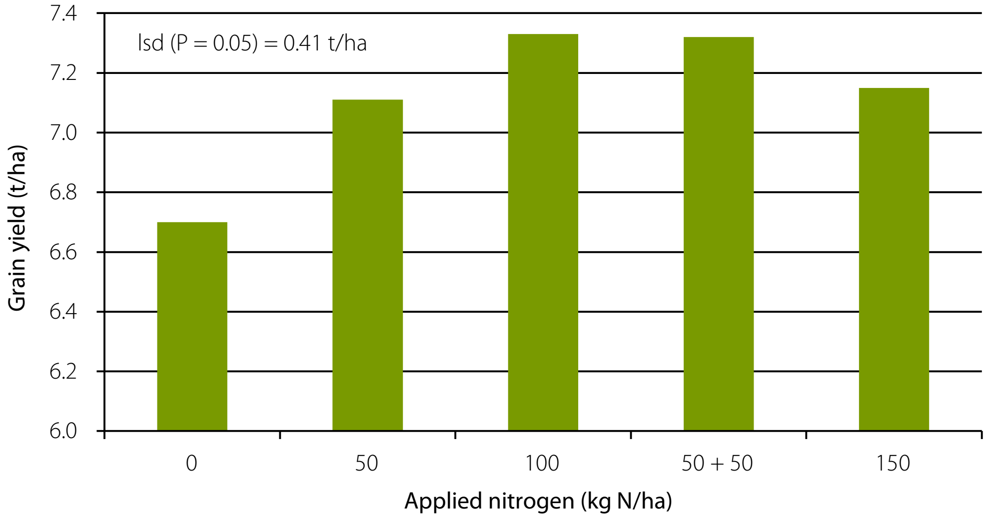

Figure 1. *Grain yield response of wheat to nitrogen rate, Tamarang 2014*
Grain yield based on EGA Gregory sown at 120 plants /m², with 20 kg P/ha and 0 applied CR averaged across the two sowing times

- There was no significant GY or quality response to increasing rates of phosphorus (P) application for either TOS, which probably indicates the high starting Colwell P values of 77 mg/kg at 0–10 cm and 17 mg/kg at 10–30 cm soil depths (Table 1).
- Increasing crown rot (CR) disease pressure (± *Fp* applied at sowing) when all other variables were held constant, resulted in a significant decrease in GY. Yield decreased from 7.33 t/ha with nil added *Fp* down to 6.75 t/ha with the 2.0 g/m *Fp* inoculum rate (CR +++), a 0.58 t/ha (8%) decrease in yield at TOS 1 (Table 3). A similar trend was also observed for TOS 2 for LRPB Spitfire, with a 0.63 t/ha decrease in GY under high crown rot pressure (CR +++) (Table 4). There was also a trend for increased screenings with increasing crown rot disease pressure increasing from 5.1% to 7.0% for TOS 2 (data not shown).
- Variety selection also affected grain yield potential. Changing the variety from EGA Gregory to Sunvale in TOS 1 resulted in a 0.56 t/ha GY decrease (Table 3).
- Plant population targeting 60, 120 or 180 plants/m² had no significant effect on GY for TOS 1. In contrast, plant population did have a significant effect on GY potential for TOS 2 (Table 4). The low targeted population of 60 plants/m² was significantly lower yielding than either the 120 and 180 plants/m² at 4.56 t/ha vs. 4.95t/ha and 4.98 t/ha respectively (Figure 2), supporting the accepted principal of increasing targeted plant populations for delayed sowings.

Table 4. *Impact of agronomic factors on grain yield with delayed sowing (TOS 2), Tamarang 2014*

Variety	Population (plants/m²)	Applied N (kg N/ha)	Applied P (kg P/ha)	Added ± *Fp* (CR+,++,+++)	Yield (t/ha)	Yield gap (t/ha)
LRPB Spitfire	120	100	20	0	4.95	
LRPB Spitfire	60	100	20	0	4.52	−0.43
LRPB Spitfire	120	100	20	+++	4.32	−0.63

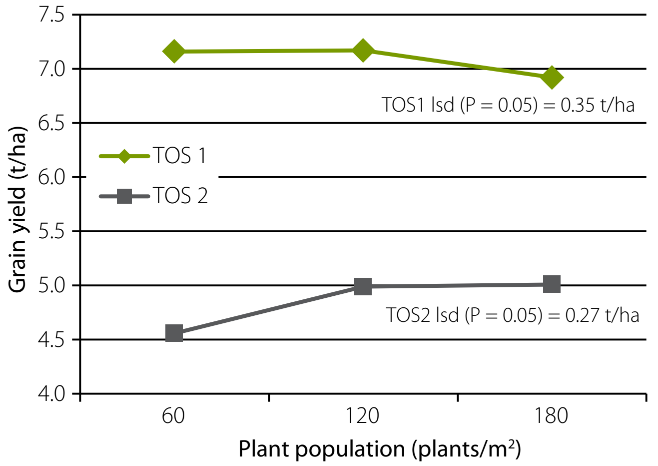

Figure 2. *Grain yield response of wheat to plant population and time of sowing, Tamarang 2014*

Summary

Although PAW and in-crop rainfall are key determinants of yield in water-limited dryland production systems, agronomic management factors can be manipulated to increase GY potential. Of the agronomic factors considered in this study, sowing time was found to be a key driver of GY potential, emphasising the importance of sowing varieties in the earlier part of their optimal sowing window. Delayed sowing of EGA Gregory (30 June vs. 9 May) for example, reduced grain yield potential by 1.75 t/ha or ~24%. Delayed sowing also adversely affected physical grain quality and GY responsiveness to N application. The reduction in GY was most likely the result of increased maximum temperatures and evapotranspiration, and a shortened grain filling period. Nitrogen input was shown to be a limiting factor in TOS 1, with a 0.63 t/ha or ~9% variation in GY attributed to N applied at 100 kg N/ha compared with the nil N treatment for EGA Gregory. Increasing crown rot disease pressure (±*Fp* applied at sowing) resulted in a 0.58 t/ha or 8% decrease in GY potential for TOS 1, and was responsible for a 0.63 t/ha or ~13% yield reduction for TOS 2. Variety selection (genotype) accounted for ~8% or a 0.56 t/ha variation in yield for TOS 1 (EGA Gregory vs. Sunvale) and for ~13% or 0.63 t/ha in TOS 2 (EGA Gregory vs. LRPB Spitfire). Plant population was only a significant factor in TOS 2, with the low target population resulting in ~9% or 0.63 t/ha decrease in GY. In this study, P nutrition was not a limiting factor due primarily to the high starting Colwell P values.

Acknowledgements

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