Faba bean time of sowing – Wagga Wagga 2014

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Key findings

- Sowing time has far greater consequences on growth, development, dry matter and grain yield of faba bean than variety choice.
- The dry spring, combined with temperature constraints, imposed a common ceiling to yield despite large differences measured in dry matter (DM), height and reproductive node number across all treatments.
- Early-sown faba bean was primarily affected by severe frosts, while later sown was limited by flower-node production and heat stress.
- Under these conditions, early April sowings resulted in greater biomass, taller plants, more flowering nodes, additional lodging, more disease and greater frost damage. Given a more favourable spring, disease and lodging could have been further exacerbated, inflicting even greater yield penalties to the first time of sowing (TOS).
- Findings from this and previous experiments show the optimum sowing window for faba bean on acidic, red-brown soils of southern NSW to be from 20 April to 15 May. The later sown crops within this window could still be disadvantaged under early unfavourable finishing conditions.

Introduction

This experiment compared the growth, development and yield of current commercial faba bean varieties and promising advanced breeding lines at three sowing dates on a hard-setting, acidic, red-brown soil at Wagga Wagga. This information will be used to confirm and update current agronomic recommendations for faba bean production in this region.

Site details

Site	Paddock 20A, Wagga Wagga Agricultural Institute
Soil type	Red-brown earth, pH_{Ca} 5.2 (0–10 cm) (Table 1). The site was limed in 2010
Paddock history	Sown to pasture in autumn 2013 but poor establishment led to chemical fallowing of the paddock in the spring. Therefore, stubble was absent for the 2014 season
Fertiliser	80 kg/ha SuPerfect® grain legume fertiliser (NPKS 0:13.8:0:6.1) placed 2 cm below seed.
Plant population	Targeted 35 plants/m² adjusted for seed size and germination
Sowing	Direct-drilled using a six-row cone seeder with 300 mm row spacing, press wheels and GPS auto-steer
Inoculation	Group F peat inoculant was mixed directly into an on-board 200 L water tank then pumped through micro-tubes into each sowing furrow
Weed management	Commercial practices aimed at weed-free conditions to eliminate weed competition and prevent weed seed set. Fallow weed control: 2 L/ha glyphosate (450 g/L) and 1 L/ha 2,4-D LV ester (680 g/L) Incorporated by sowing: 2 L/ha glyphosate (450 g/L), 2 L/ha Stomp® (440 g/L pendimethalin), 2 L/ha Avadex® (400 g/L tri-allate) and 1 kg/ha Terbyne® (750 g/kg terbuthylazine) Post sow pre-emergent: 250 g/ha Terbyne® (750 g/kg terbuthylazine) Post emergent: 330 mL/ha Select® (240 g/L clethodim), 100 mL/ha Verdict® (520 g/L haloxyfop) and 500 mL/100 L Uptake® spraying oil
Disease management	Penncozeb® 750 (mancozeb) – 2 kg/ha on 23 June for chocolate spot Howzat® (carbendazim) – 500 mL/ha on 8 August and 1 September for chocolate spot
Insect management	Targeting *Helicoverpa* sp.: 400 mL/ha Fastac® Duo (100 g/L alpha-cypermethrin) – 20 September and 24 October

Treatments

Varieties (8)	Farah[(l)]	PBA Samira[(l)]
	PBA Nasma[(l)]	PBA Zahra[(l)]
	Nura[(l)]	AFO7125
	PBA Rana[(l)]	AFO6125
Time of sowing (3)	TOS 1: 2 April	
	TOS 2: 24 April	
	TOS 3 12 May	

Soil

Pulse growth and rhizobia survival can be affected when soil pH falls below five. This can lead to problems on the acidic, red-brown soils that dominate the cropping zones of southern NSW. Growers need to consider this and routinely monitor soil acidity to maintain a base pH of approximately five using strategic lime applications.

The 2014 Wagga Wagga site was limed in 2010, and its topsoil (0–10 cm) pH_{Ca} is now 5.2. Soil nitrogen levels were low and phosphorus levels medium (Table 1).

Table 1. Site soil chemical characteristics for 0–10 cm and 10–20 cm depths at Wagga Wagga, 2014.

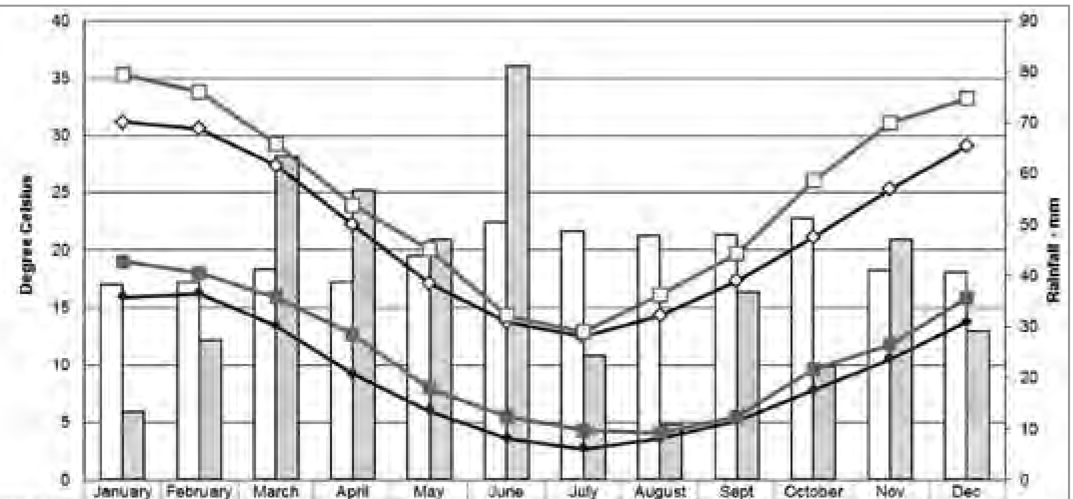
Characteristic	Depth	
	0–10 cm	10–20 cm
pH (1:5 $CaCl_2$)	5.2	5.0
Al Sat (%)	1.7	2.5
Nitrate N (NO_3) (mg/kg)	8.5	15.0
Ammonium N (mg/kg)	0.8	1.1
P (Colwell) (mg/kg)	34.0	13.0
CEC (cmol(+)kg)	7.0	6.5

Season

The 2014 season at Wagga Wagga was warmer, drier and shorter than normal (Figure 1). Early season rainfall (March–June) was 40% above the long-term average and, in combination with the mild temperatures during this period, the conditions were ideal for plant establishment and early growth. This rainfall also replenished sub-soil moisture, benefiting grain fill at the end of the season when July to October rainfall was only half (93 mm) the long-term average. Crops finished 2–3 weeks earlier under these low rainfall and warm temperatures (1–2 °C above average) conditions.

There were 43 frost events in 2014 where temperatures fell below 2 °C. More severe frosts occurred in July and August (18 events where temperatures dropped below 0 °C) causing isolated stem-splitting with some flower and pod loss. A further three significant frosts occurred in September (temperatures fell below –1°C on 4, 19 and 20 September). Further flower and pod loss resulted from these events; however, moisture and high temperature stresses ultimately became the overriding limitations to grain fill and yield.

These conditions were not conducive to disease and incidence was low.



	January	February	March	April	May	June	July	August	Sept	October	Nov	Dec
Long term rainfall	38.1	38.6	41.1	38.6	43.8	50.4	48.5	47.6	47.8	51.0	40.9	40.6
2014 rain	13.2	27.2	63.4	56.6	47.0	81.0	24.2	10.6	36.6	22.0	47.0	29.0
Long term Max temps	31.2	30.6	27.4	22.2	17.1	13.7	12.5	14.3	17.3	21.1	25.3	29.1
2014 mean max	35.3	33.8	29.3	23.8	20.1	14.3	12.9	16.1	19.7	26.0	31.1	33.2
Long term Min temps	15.9	16.2	13.4	9.2	6.0	3.6	2.7	3.6	5.1	7.8	10.5	13.7
2014 mean min temp	19.0	18.0	15.9	12.7	8.0	5.5	4.3	4.1	5.5	9.6	11.8	15.8

Figure 1. Monthly rainfall in 2014, monthly temperature in 2014, and long-term average rainfall (1898–2014) at Wagga Wagga.

Results

Seasonal effects

Chocolate spot (*Botrytis* sp.) developed, especially in TOS 1 (2 April), but was held in check with strategic preventative fungicide applications, the dry spring weather and associated lower humidity. Overall, 2014 was a very favourable year for pulses at Wagga Wagga despite the frosts and late moisture stresses. It was characterised by minimal disease, above average yields; and an early, dry harvest producing good quality, unblemished seed.

Grain yield, dry matter production and harvest index (HI%)

The unusual outcome of this experiment was that grain yield across all three sowing times and eight varieties was statistically the same, averaging 2.87 t/ha. This is well above the expected long-term average of 1.8–2.0 t/ha for faba bean in this region, despite the dry, tight finish to the season.

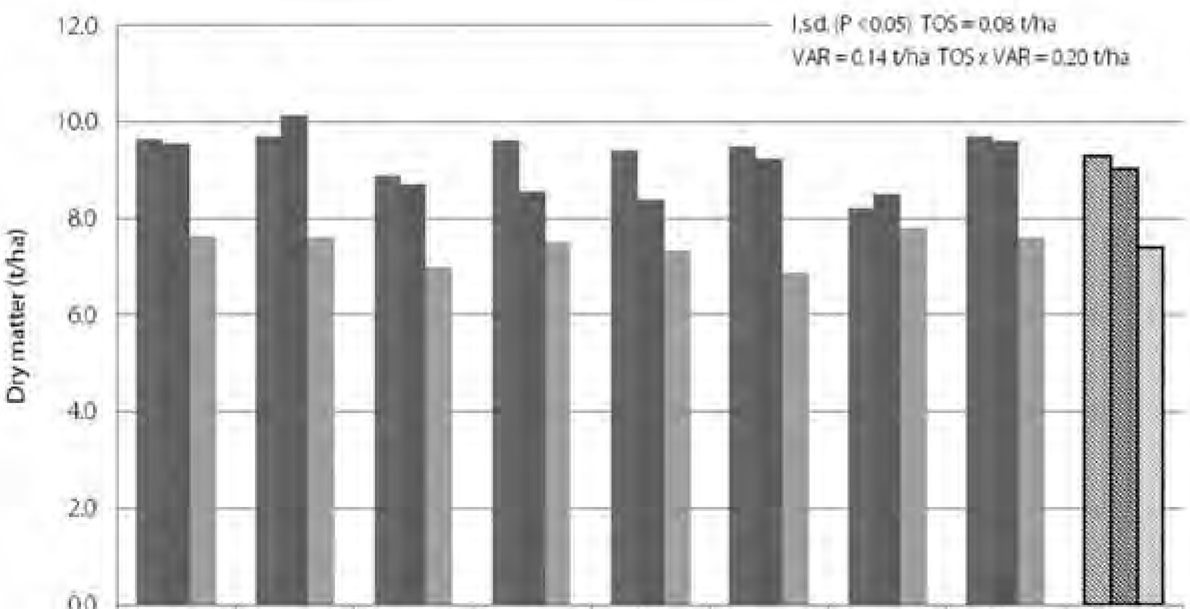
This absence of any yield differences across all treatments was unexpected given the very large variation in dry matter production, height, lodging and flowering across the three sowing times and eight varieties (figures 2, 3, 4 and 5). Despite these large variations it seems likely that the moisture and temperature constraints of spring set a ceiling on pod set, seed fill and yield. No doubt, varying sowing dates (and to a lesser degree the different varieties) reached this ceiling via different means: the early sowings produced taller stems with a greater number of flowering nodes but high abortion rates; the later sowings produced fewer flowering nodes but with better pod retention.

To put these results in perspective, the average commercial yield of faba beans across southern NSW is 1.83 t/ha compared with 1.46 t/ha, 1.35 t/ha and 1.28 t/ha for lupin, field pea and chickpea respectively (Scott, 2013). However, commercial faba bean yields have reached 4.0 t/ha, and in some instances up to 6.0 t/ha (Matthews & Marcellos 2003). To achieve these yield levels, seasonal conditions (moisture and temperature in particular) have to be ideal to reduce the high rates of flower abortion observed here along the stems.

Nevertheless, these results are consistent with maximum faba bean yield resulting from mid-April to mid-May sowing in this region. Growers still need to consider the consequences of:

- sowing too early (before 15 April) – excessive height, lodging and disease
- sowing too late (after the middle of May) – short plants and restricted dry matter and grain yield.

Growers also need to consider that in cool, moist and extended springs, even late April sowings can be subject to greater disease pressure and require careful monitoring and appropriate foliar fungicide responses.



	PBA Rana	PBA Zahra	AF06125	AF07125	PBA Nasma	Farah	PBA Nura	PBA Samira	MEAN
2 Apr	9.67	9.72	8.88	9.62	9.42	9.50	8.23	9.71	9.30
24 Apr	9.56	10.15	8.73	8.56	8.39	9.24	8.49	9.61	9.02
12 May	7.66	7.63	7.00	7.51	7.36	6.88	7.81	7.63	7.40

Figure 2. Dry matter production of eight varieties of faba bean sown at three times at Wagga Wagga, 2014.

Dry matter production was statistically the same at TOS 1 and TOS 2 (mean of 9.1–9.3 t/ha) but decreased significantly (by 20%) when sowing was delayed to 12 May (TOS 3 average 7.4 t/ha). The more vigorous growth of PBA Rana, PBA Zahra, PBA Samira and Farah was reflected in higher DM at TOS 1 and TOS 2 and higher normalised difference vegetation index (NDVI) readings at the early vegetative stage, especially PBA Rana (data not shown). (Note: NDVI was measured on 19 June and 25 July using a hand-held GreenSeeker®, which gives an index of plant 'greenness' or photosynthetic activity).

Harvest index (HI) averaged 33.8% across the experiment with no significant differences between sowing time and variety, although mean HI did increase to 38% for TOS 3. This reflected lower DM and plant heights in TOS 3 combined with a more efficient conversion of DM into grain. The implication here is that a higher proportion of fixed nitrogen is exported in the grain resulting in less residual nitrogen for subsequent crops.

Plant height, lodging and podding

Late varieties, such as PBA Rana, flower and pod later; and flower and set pods at nodes higher up the stem compared with early varieties such as PBA Nasma (Figure 3). As sowing was delayed from early April to mid-May, plant height and bottom-pod height reduced significantly. This places physical restrictions on reaching the lowest pods during harvest. Conversely, sowing too early extends growing periods and produces excessively tall plants leading to lodging and further problems at harvest, as seen with PBA Rana and Farah at TOS 1 (Figure 4). All varieties at TOS 2 and TOS 3 were shorter and remained erect, simplifying management and harvest.

Growth and development phases

The development phases of all faba bean varieties contracted as sowing was progressively delayed (Figure 5). As an example, a 40-day delay of sowing (TOS 1 to TOS 3) was reduced to a 12-day difference by the end flowering (17 September to 29 September), then to only a 4-day difference by maturity (27 October to 31 October).

This significant reduction in growing periods at later sowing times translates into shorter flowering periods (73 days down to 37 days), shorter grain-filling periods, shorter plants, reduced number of flowering nodes, more erect growth, less disease and reduced DM. Yet, as previously stated, yield remained unaffected but harvest index increased. This reflects greater environmental stresses imposed on earlier sowings in this experiment, particularly frost and the extra moisture and nutrient demand plants require when producing greater biomass.

Varieties differed in their growth patterns. For example, PBA Nasma was the first to flower and Nura the last at all sowing dates. PBA Nasma is a very early, northern NSW variety and was included in this trial to compare phenology and performance with southern lines. It flowered 60, 37 and 18 days earlier than PBA Rana at the TOS 1, TOS 2 and TOS 3 respectively, but finished flowering only 6–8 days earlier, most likely due to high temperatures. The longer flowering window of PBA Nasma enables it to produce a large number of flowering nodes, greater DM and yield plasticity, and provides better insurance against environmental stresses during flowering and pod-fill. While its yield was similar to other varieties this season, it was the top yielding variety in experiments at Wagga Wagga in 2013.

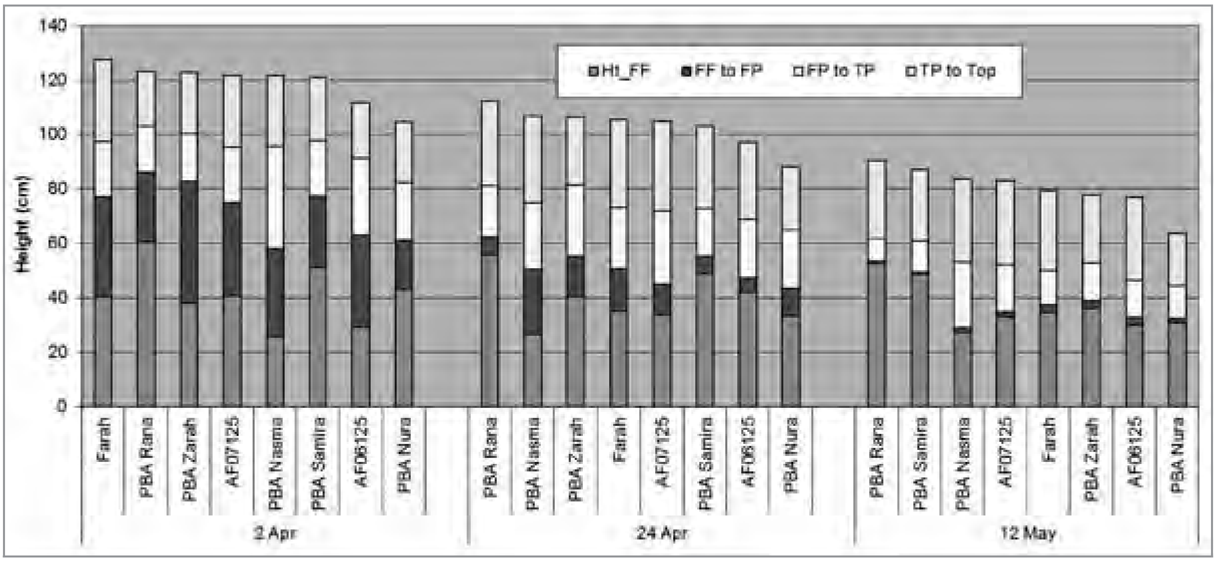


Figure 3. Stem height to first flower (Ht_FF), first pod (FF to FP), last pod (FP to TP) and to the top (TP to Top) of eight varieties of faba bean sown on three dates at Wagga Wagga, 2014.

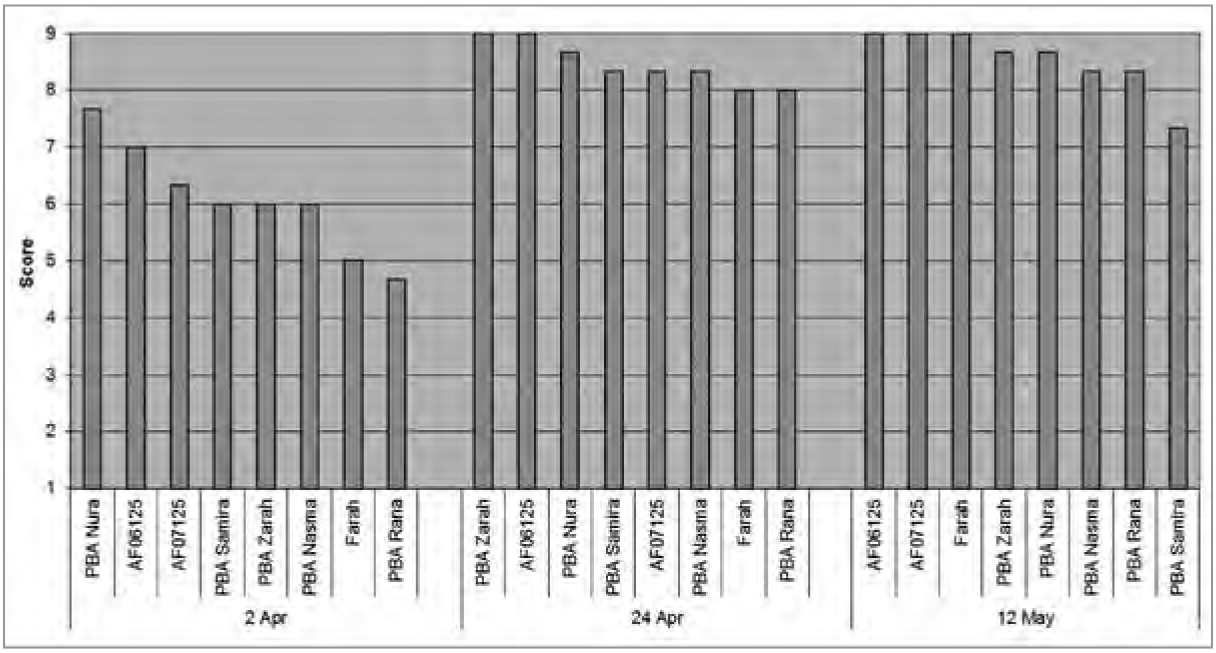


Figure 4. Erect scores at maturity of eight varieties of faba bean sown at three dates at Wagga Wagga in 2014. These scores subjectively estimate how well each variety stands at maturity on a 1 to 9 scale, where 1 is flat on the ground and 9 is completely erect.

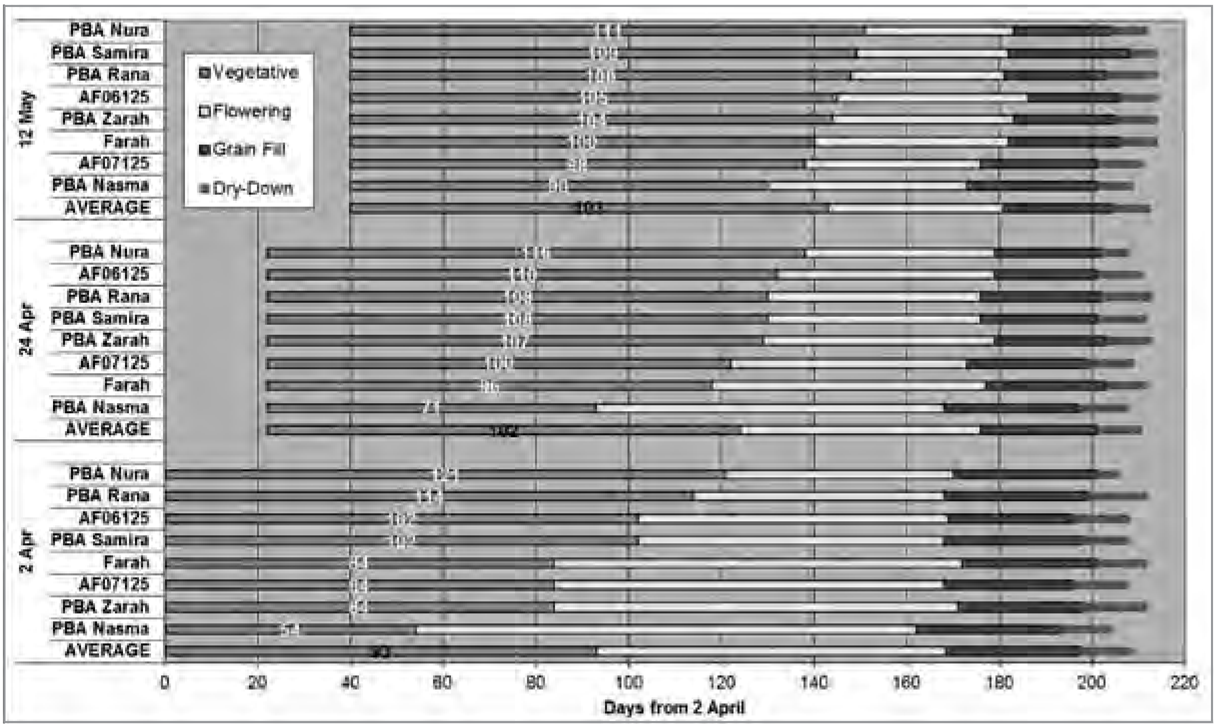


Figure 5. Phases of development of eight varieties of faba bean sown at three dates at Wagga Wagga 2014.

Summary

» Growth and development of faba bean appeared normal on these hard-setting, acidic, red-brown soils and excellent yields were achieved, indicating considerable potential for faba bean production across southern NSW.

» Faba bean yield was unaffected by sowing time and variety during the 2014 season at Wagga Wagga, yielding 2.87 t/ha.

» The dry spring combined with temperature constraints imposed a common ceiling to yield despite large differences measured in dry matter (DM), height and reproductive node number across all treatments.

» Early-sown faba bean was primarily affected by severe frosts, while later sown was limited by flower-node production and heat stress.

» Under these conditions, early April sowings resulted in greater biomass, taller plants, more flowering nodes, additional lodging, more disease and greater frost damage. Given a more favourable spring, disease and lodging could have been further exacerbated, inflicting even greater yield penalties to (time of sowing) TOS 1.
» Later sowing (mid-May onwards) is projected to produce fewer podding nodes, shorter plants, lower bottom pods and lower yield.
» Sowing time has far greater consequences on growth, development, DM and grain yield of faba bean than choice of variety.
» Findings from this and previous experiments shows the optimum sowing window for faba bean on acidic, red-brown soils of southern NSW to be from 20 April to 15 May. The later sown crops within this window might still be disadvantaged under early unfavourable finishing conditions.

References

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