Moving summer crop sowing early or late - risks and rewards on the Liverpool Plains

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Take home message

- Planting early in August/September has less risk than delaying planting later until February for both sorghum and maize. There is little information to support moving sunflower sowing time earlier than currently established sowing windows
- Risks associated with earlier sowing include variable and low soil temperatures resulting in poor establishment and frost risk for all crops. Also, the risk of winter weed competition with young establishing crops. However, the flowering, grain fill and harvest periods are all brought considerably forward
- Late planting (i.e. early February) was not successful for sorghum or sunflower in the 2019/20 season due to damage from birds in sunflower and a combination of ergot, midge and slow grain ripening being affected by frost in sorghum. Maize had few agronomic issues apart from a longer grain filling period and dry down delaying harvest
- Additional research, particularly in maize and sunflower is required to support the conclusions in this paper before adoption by growers.

Introduction

The Liverpool Plains is the land of opportunity when it comes to selecting a summer crop. It is considered a very reliable region with the ability to grow a wide range of summer crop species namely, sorghum, sunflower, maize, mungbean and cotton.

Climate variability seems to be increasing and over the last decade, fluctuations in rainfall and temperature have brought new challenges to this dynamic cropping system. These include questions over the most reliable and productive way to ensure summer crops remain in the system.

The concept of varying sowing windows to either much earlier or later than “normal” in response to weather patterns expected in individual seasons brings with it risks and opportunities which each need to be evaluated.

The largest influence in all decisions though is water, primarily how much has been stored in the soil profile. Deciding to plant with less than a full profile immediately increases the risk of reduced crop yields or failure and ultimately profitability unless you can be “under the right cloud” during the season.

This paper merges the results from a range of NSW DPI experiments over the last 5 years which relate to optimising the performance of sorghum, sunflower and maize.

Sowing windows - a moving target?

Identifying the recommended sowing window for all summer crops is easy if you stick with traditional guides. Where it becomes more interesting is when you want or need to push the boundaries by planting significantly earlier or later to respond to changing seasonal conditions.

NSW DPI produces the summer crop production guide which has indicative planting times for summer crops on the Liverpool Plains (Table 1). These tables are based largely on the need to meet three criteria:

1. Adequate soil temperatures to enable rapid crop emergence; 12°C for maize and sunflowers and 16-18°C for sorghum
2. To minimise the risk of damaging frosts on young establishing crops in the spring
3. To minimise the risk of frost damage to crops during grain fill if late sown.

Ideal timing for the early plant starts in mid-September for sunflower and maize and the second week of October for sorghum (Table 1). It is recommended to cease sowing maize at the end of October. Sorghum and sunflower have the advantage of a late planting opportunity which starts in early December and ends in mid-January for sorghum and late January for sunflowers.

Table 1. Recommended sowing times for summer crops on the Liverpool Plains (source: an extract from the NSW DPI Summer crop production Guide, 2019)

Liverpool Plains	Early plant										Late plant													
	Aug		Sept				Oct				Nov				Dec				Jan				Feb	
	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Sorghum							<	★	★	★	★	★	>		<	★	★	★	★	>				
Sunflower			<	<	★	★	★	★	★	>	>				<	<	★	★	★	★	★	>	>	
Maize			<	<	★	★	★	★	★	★	>	>												

< earlier than ideal but acceptable

★ optimum planting time

> Later than ideal but acceptable

In the last 5 years we have experienced hotter and drier summer conditions which have highlighted the need to avoid crops flowering during peak heat stress conditions, most likely to occur in late December/ early January.

Using CliMate, we can see that in 45% of years (1990 to present) we have received temperatures over 35°C during a 7-day period at Breeza. In the last 5 years this has occurred between 6 and 23 times in the period between 15 December and 31 January which is the traditional flowering period for all three summer crops. These conditions have resulted in reduced seed set, grain yield and quality.

These issues have led us to conduct research on two alternative options for planting:

1. moving the sowing window forward by around 4 weeks from the “ideal” sowing time
2. extending the sowing window later to include the end of January and early February.

This past season, many parts of the Liverpool Plains did not receive enough rain to enable planting prior to mid-January when the sorghum window closes. Following a dry winter, many producers

were faced with the prospect of no summer crop or planting outside of the normal sowing window in mid to late January.

Sorghum

Early sowing – risks and rewards

The largest 'early sowing' research effort has been on sorghum in recent years. A series of early sown sorghum trials have been conducted across the northern grain's region stretching from Emerald in central Queensland to the Liverpool Plains, including a site at Breeza.

This research has been evaluating the potential for sowing sorghum into soil temperatures as low as 12°C, which in local terms means planting at the beginning of September on the Liverpool Plains.

Trials which were sown in August or early September; produced better yields than a late October plant in the first two seasons (2017-18 and 2018-19). In this season, the October 29 plant out yielded the September 11 planting, but was not different to planting on October 8. This is probably not surprising considering that late season rainfall amounted to an additional 100mm of in-crop moisture for the late October sown crop.

The primary risks with early planting relate to ensuring crops are sown when soil temperatures are at a minimum of 12°C and rising to allow uniform emergence within 14 days of planting. This relies on good quality seed (germination and vigour) and accurate weather forecasting to predict a warming front for at least 7 days following planting.

The risk of a severe frost in September, which could cause significant early plant death, remains. However, we have not experienced this in the last three seasons. At most we have lost 10% of emerged plants in our earliest sowing time. This equates to 5 dead plants in 10m of plant row. At a population of 50,000 plants/ha, this loss seems acceptable. It is also possible to lose the main stem only from frost and have tillers recover.

Planting early at soil temps of 12°C will result in slower emergence and a longer vegetative period. It will also generally move the flowering period forward towards early December, reducing the risk of heat stress at flowering.

Early planting should also move grain fill, and crop maturity forward allowing an earlier harvest and increased time for fallow refill and consideration of a double crop option in the following winter.

On the downside, there is potential for winter weeds to still germinate and compete with early sown sorghum crops. The main species of concern are grass weeds such as black/wild oats.

Late sowing in 2019-20 - risks and rewards

With little research data to support our decisions to stop planting after mid-January, a late summer species trial was planted at Breeza. The trial was watered up on the 5 February and has since remained dryland. The trial included three hybrids each of sorghum, sunflower and maize.

The main risks associated with planting sorghum in late January into early February is predicting when temperatures fall to a point where pollination will be affected or when a frost will occur. The date of the first frost has often been suggested as Anzac Day based on local memories, or the middle of May based on crop modelling. This season the first frost occurred on the 6 June at Breeza and visible leaf damage was observed in the following days although plant death did not occur.

Other challenges for late planted sorghum include ergot and midge, with both present this season. Even though the midge resistance of hybrids has greatly improved, there was still a requirement to spray this season. However, more damage has resulted from ergot this season caused by fungal infection (*Claviceps africana*) which can produce toxins in the grain. No control options are available for this disease in sorghum.

In the middle of June, the sorghum was looking dismal due to the heavy ergot infection. A combination of poor seed set, ergot infection and honeydew coated seed with a low percentage of coloured grain present, gave little hope of a harvest prior to our next early sowing opportunity.

Our conclusion from this season has been that delaying sorghum planting until early February at Breeza is likely to result in crop failure. There is a slim chance that a successful crop can be produced from sowing this late, the period for grain fill, physiological maturity and crop dry down for harvest would be extremely prolonged.

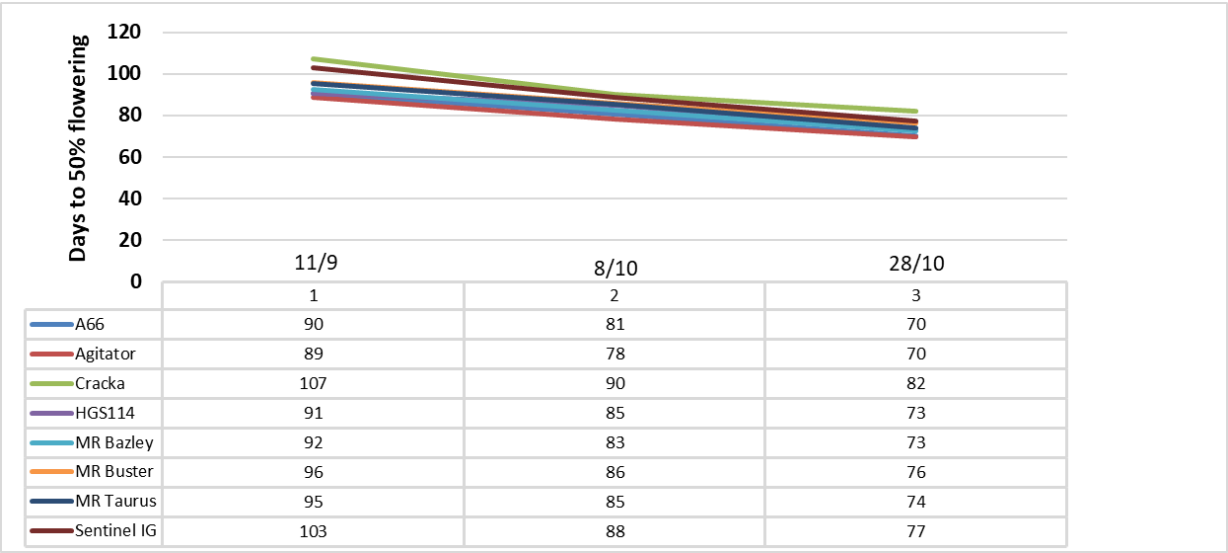
If planting very late, as per our trial this season, the recommendation would be to increase the plant population to reduce tillering and force the hybrids into earlier flowering as well as carefully selecting your hybrid for maturity and midge resistance.

What is the impact on days to flowering in sorghum from varying sowing time?

Early sowing (e.g. 11 September) results in a longer vegetative period compared with a 'normal' sowing time of the 28 October (Figure 1). For example, a mid-maturity hybrid such as MR Buster, when sown on the 11 September took 95 days to reach 50% flowering but only 76 days when sown 7 weeks later, on the 28 October.

When sowing on a late plant, it is generally expected that the days to reach flowering will continue to decrease but this can depend on the day degrees and photoperiod response of individual hybrids. In this season, MR Bazley (73 vs 67 days) shortened its days to flowering whilst A66 (70 vs 71 days) was stable when comparing the late October planting date to our 5 February planting date (Figure 1).

The general rule in sorghum is that warmer temperatures during the vegetative stages cause the crop to be quicker to flower. This however is somewhat dependent on the day degrees and photo period requirement of individual hybrids.



	1	2	3
A66	90	81	70
Agitator	89	78	70
Cracka	107	90	82
HGS114	91	85	73
MR Bazley	92	83	73
MR Buster	96	86	76
MR Taurus	95	85	74
Sentinel IG	103	88	77

Figure 1. Days to 50% flowering for eight sorghum hybrids at Breeza in 2019-20

Maize

Early sowing – risks and rewards

Little research has been conducted in maize in northern NSW since the 2017-18 season. Only one season of trials which compared the effects of planting maize earlier than normal was conducted at Breeza.

In 2017-18 early planting in the second week of August into a soil temperature of less than 10°C, lower than the recommended 12°C, did not affect plant establishment at this site in this season. Further research is needed to validate these results and allow for variations in climate in different seasons. In August it is typical to experience frosts at Breeza. The cold soil temperatures slowed emergence in this trial but did not impact establishment. Frosts at the early vegetative stages could burn leaves or kill plants. Similar to sunflower there is no compensatory mechanism of tillering and dryland populations are quite low, around 30,000 plants/ha. Under irrigation, plant populations are much higher, but cold soil temperatures will also be compounded by cold water temperatures if irrigation is required.

The 2017-18 trial included three times of sowing, each with different soil temperatures:

- TOS 1: 9 August 2017 at 9.7 °C soil temperature
- TOS 2: 28 August 2017 at 10.8 °C soil temperature
- TOS 3: 20 September 2017 at 15.8 °C soil temperature

The main effect of sowing in August was that the flowering period was moved considerably earlier, into late November and as a result both maximum and minimum temperatures experienced by the crop were lower compared with the September planting date (Figure 2).

This trial was provided with supplementary irrigation to prevent water stress. Under dryland conditions, the impact of these higher temperatures are likely to be larger, especially if combined with a water deficit.

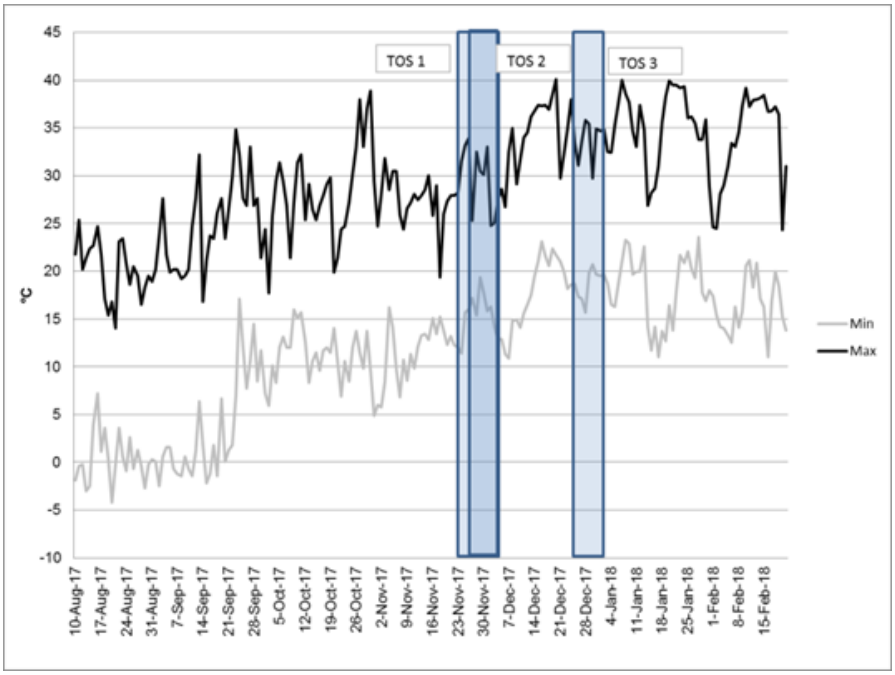


Figure 2. Maximum and minimum temperatures at Breeza 2017-18
Blue rectangles indicate flowering periods associated with the three sowing times

There was no impact on grain yield (site averaged 7.5 t/ha) of varying the sowing time from early August, late August or mid-September (data not shown). There was also no significant difference in grain yield between the three maize hybrids (P1467, P1756 and PAC606IT) included in this experiment (data not shown).

There was a significant impact of sowing time on grain protein, with the protein content declining as the sowing date became earlier. Sowing in September produced significantly higher protein at 11.3% than sowing in early or late August, which produced grain protein levels of 10.7 and 11.0% protein, respectively.

Late sowing in 2019-20 - risks and rewards

Sowing maize late is rarely discussed as an option by growers. This season we included maize in our late sowing trial which was watered up on the 5th February. The maize hybrid Pac606IT was the quickest of all hybrids across species to reach flowering, at just over 60 days (Figure 3). The slow progress towards harvest ripeness is the main concern with maize.

The maize did not have any agronomic issues and only suffered some moderate leaf burn from the first frost of the season on the 6 June. The cobs were well into grain fill and the quickest hybrid was approaching physiological maturity in mid-June. A small amount of leaf rust was noted but not at levels to cause concern.

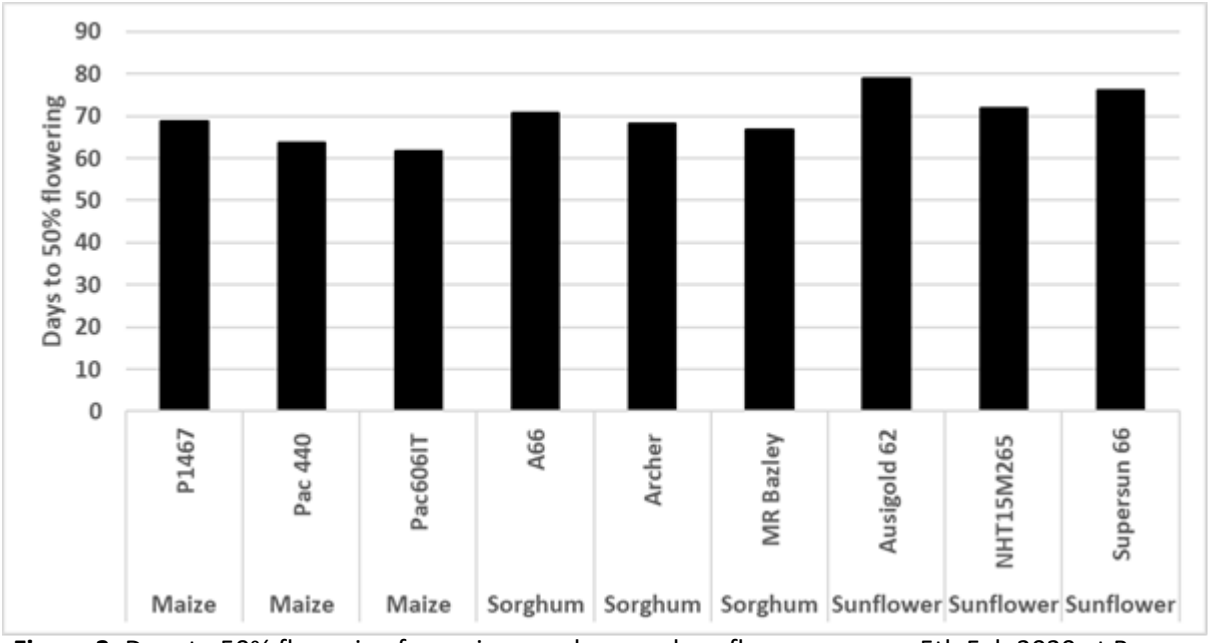


Figure 3. Days to 50% flowering for maize, sorghum and sunflower sown on 5th Feb 2020 at Breeza

What is the impact on days to flowering in maize from varying sowing time?

The 2017-18 maize trial collected data on the impact of sowing time on days to flowering. The number of days taken to reach 50% flowering was recorded for each of the treatments (Table 2). There was a significant reduction in the time taken to reach flowering between TOS 1 and TOS 3 from 117 days to 105 days for P1467 which was the slowest maize hybrid in the trial.

In the late species trial sown on the 5 Feb 2020, the maize hybrids were much quicker, taking only 60-70 days to each flowering with PAC606IT remaining the quickest and P1467 being the slowest (Figure 3).

Like sorghum and sunflower, the super late planting caused a reduction in the days to flower in maize.

Table 2. Days to 50% flowering of maize treatments in 2017-18 at Breeza

TOS	Hybrid	Days to 50% flowering
1 - 9th August	P1467	117
	PAC1756	112
	PAC606IT	109
2 - 28th August	P1467	98
	PAC1756	97
	PAC606IT	95
3 - 20th September	P1467	105
	PAC1756	103
	PAC606IT	99

Sunflower

Early sowing – risks and rewards

The least research has been conducted in sunflower. Spring sown sunflower crops are comfortably planted from the middle of September on the Liverpool Plains. These spring sown crops take longer to move through vegetative growth stages and take longer to reach flowering compared with a summer planted crop. In general, it takes 80-85 days for a spring sunflower crop to reach flowering, whilst a December planted crop takes only 65 days (Table 3).

The longer vegetative period with spring planting typically leads to a larger biomass crop with higher yield potential. They are also generally taller than a summer planted crop. However, the high yields will only occur if the water supply is adequate to realise this increased yield potential.

Sunflowers are reasonably tolerant of frost at certain growth stages. Newly emerged seedlings are frost tolerant up until between the 6–8 leaf stage but are frost sensitive from the 6-leaf stage until the seed ripening stage. For early plant sunflower the largest risk is from plant death as a result of frost, as there is no compensatory mechanism such as with tillering in sorghum and the established plant populations are lower, meaning increased impact of any plant loss on yield.

Unfortunately, to date not trials have been conducted to evaluate early sowing in sunflower.

Late sowing in 2019-20 - risks and rewards

Late plant sunflower is at risk of similar issues to sorghum and maize. Late season flowering and grain fill hold the risk of poor seed set, slow crop maturity and failure to adequately dry down for harvest. This season late season powdery mildew was present due to conducive humid conditions, but infection did not develop to a point that required fungicide application.

Bird damage and the lack of effective control options has been challenging for our trials and commercial crops. Our research plots were decimated by cockatoos even though they were covered with nets.

As temperatures cool in autumn the risk of frost increases. Sunflower buds are susceptible to frost damage but a significant drop in air temperature can also be detrimental to pollen viability at flowering. Frosting during the bud development stage can result in distortion of the bud, failure to set seed and even a complete lack of flower production. Mild frost damage is seen as blackening or purpling around the edges of the head. Temperatures of 2°C can prevent flowers from opening and subsequently reduce seed set, while frosts (0°C) during grain fill can substantially reduce yield.

What is the impact on days to flowering in sunflower from varying sowing time?

Like sorghum, the days taken to reach flowering are longer with a spring planted crop compared with a summer planted crop. Moving planting from mid-September to early December results in a change of around 20 days (Table 3). There was also an impact on the days to flowering associated with plant population, moisture and hybrid (data not shown).

Table 3. Days to flowering in sunflower at Gunnedah

Hybrid	Region	Days to mid flower
Ausigold 62	Gunnedah – spring – early plant	90
	Gunnedah – summer - Dec plant	70
Ausigold 4	Gunnedah – spring – early plant	90
	Gunnedah – summer - Dec plant	67

Source: An extract from the Big Yellow Sunflower Pack

Conclusions

Early or late sowing of summer crops have both associated risks and rewards. The greatest risk of early sowing is the soil and air temperatures which the establishing crop are exposed to. Slow, patchy and reduced establishment can occur if the crop is sown too early, or colder than expected conditions or frosts prevail. There is a greater emphasis on selecting paddocks which do not have a history of winter weeds which may be difficult to control. Early planting can allow the flowering, grain fill and harvest to occur earlier than normal, reducing the risk of high temperatures and heat stress during flowering. An earlier harvest also provides a longer period to refill the soil water profile, increasing the likelihood of a double crop option.

Late sowing seems to bring more theoretical risks than sowing early. Planting is occurring in the heat of summer, so seedbed temperatures will be hotter, possibly impacting establishment, and seedbed moisture will decline faster. Later sown summer crops will grow more rapidly through the vegetative stages and reach flowering in fewer days. There was no risk of heat stress at flowering though.

The late species trial suffered with issues of ergot and midge in the sorghum, bird damage and powdery mildew in the sunflower, with slow grain filling and dry down in all three summer crops, pushing harvest into July. Frosts only commenced in early June in this season, much later than normal. The use of harvest aids, i.e. desiccants may also be needed to assist in bringing the crop into harvest. This is an additional expense rarely needed with an early planted crop. Furthermore, following a late harvest there is minimal opportunity to double crop back into a winter crop.

Frost remains the largest risk for both early and late planting of summer crops.

In addition, waiting for a late plant may mean watching several sowing opportunities pass by over the summer. As such, late planting is most likely to hold merit only in seasons when insufficient summer rain has fallen to allow earlier planting.

The challenge is selecting the right crop to plant at the right time. In all seasons, this decision will be based on gross margins, crop rotation, stored soil moisture over the fallow and of course personal preference. In summary the risks from an earlier planting of summer crops appears much smaller than the potential rewards.

In contrast, late planting is most likely to be the last resort, when cash flow is needed, and other options have past, as the risks are numerous including frost terminating the crop before maturity, slow dry down and delayed harvest as well as clashes with winter crop planting. While crop

modelling has suggested the autumn grain fill period as being more favourable due to lower temperatures and an increased likelihood of rain, the logistics often outweigh the risk.

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