SOWING EARLY TO MAXIMISE WHEAT YIELD ON LONG FALLOW

Early sowing is essential in order to maximise yield of wheat crops grown on long (18 month) fallow. Long fallowing and early sowing are complementary practices, as the fallow reduces weeds and diseases which can be difficult to control in early sown crops, and early sowing with slow developing cultivars allows the crop to better use soil water that is stored during the fallow. Stored soil water also helps to establish early sown crops when there is minimal autumn rainfall. This fact sheet outlines how farmers can maximise wheat yield on long fallow by sowing early with slow developing cultivars, and is based on two years of GRDC funded research conducted by AgGrow Agronomy, CWFS and CSIRO in western NSW.

Aim for the optimal flowering window

In environments such as western NSW that have a cool winter and hot summer, one of the main drivers of wheat yield and quality is flowering time. When selecting a cultivar and sowing time combination, the intention is to match plant development with seasonal pattern and most importantly get the crop to flower during the optimal period for yield. In southern NSW the optimal flowering period varies from late August in the west to early October in the east (Table 1). This period is a trade-off between increasing drought and heat, and declining frost risk. There is no 'perfect' time to flower where these risks are nil, only an optimal time where they are minimised and yield on the balance of probabilities is maximised. Optimal flowering time tends to be earlier on heavy clay soil types more prone to drought than on sands (Table 1).

Table 1: Optimal flowering periods, peak of the mean of frost-heat adjusted APSIM yield and corresponding flowering date and sowing date range for a mid-fast cultivar for 51 years (1963-2013) for locations in southern NSW (taken from Flohr BM, Hunt JR, Kirkegaard JA, Evans JR 2016 Drought, radiation, frost and heat define the optimal flowering period for wheat in south-eastern Australia. Journal of Experimental Botany. *In review*).

	Optimal flowering period		**Peak mean yield (t/ha) and corresponding flowering date**		**Median sowing date for corresponding peak mean yield (mid-fast cultivar e.g. Suntop)**
Location	**Open**	**Close**			
Nyngan	26-Aug	29-Aug	2.2	27-Aug	2-May
Merriwagga	27-Aug	10-Sep	2.6	31-Aug	27-Apr
Swan Hill (clay)	1-Sep	10-Sep	2.8	5-Sep	27-Apr
Swan Hill (sand)	1-Sep	20-Sep	3.7	15-Sep	6-May
Condobolin	11-Sep	19-Sep	2.4	15-Sep	7-May
Mathoura	15-Sep	22-Sep	2.3	18-Sep	3-May
Bogan Gate	18-Sep	1-Oct	3.7	21-Sep	13-May
Urana	18-Sep	29-Sep	3.3	23-Sep	8-May
Yarrawonga	25-Sep	2-Oct	3.6	28-Sep	8-May
Temora	25-Sep	10-Oct	3.0	3-Oct	13-May
Cootamundra	6-Oct	20-Oct	4.3	12-Oct	20-May

Sowing time and cultivar combinations to maximise yield

In the majority of seasons, yield will be maximised when wheat cultivars are sown so that they flower during the optimal period. The sowing dates required for cultivars commonly grown in south western NSW to achieve the optimal flowering date for the region are given in Table 2. In very dry seasons, yield is maximised when crops flower earlier than the optimal time and the opposite is true in very wet seasons.

Table 2. Recommended sowing times for south western NSW of different development classes to flower during the desired period. On long fallows, yield of winter and slow developing cultivars sown early is higher than faster cultivars sown later.

	March	April	May
Winter cultivars (e.g. Wedgetail, Wylah)	Dual purpose	Grain only	
Slow spring cultivars (e.g. Bolac, Lancer, Sunvale, Kiora)			
Mid spring cultivars (e.g. Gregory, Flanker)			
Mid-fast spring cultivars (e.g. Suntop, Trojan, Beckom)			
Fast spring cultivars (e.g. Spitfire, Condo, Corack, Scepter)			

In the presence of stored soil water such as is found following long fallow, winter and slow developing spring cultivars sown early yield more than faster cultivars sown later (Tables 3 & 4). This is because the longer growing season available to early sown crops allows them to grow deeper roots and extract more water, reduce evaporation and produce more biomass. However, if there is no stored soil water for growth around anthesis and grain filling, early sown crops can hay off and will yield the same or in some cases less than faster developing cultivars sown later.

Table 3. Grain yield for a range of cultivars of different development rates sown on two dates on long fallow at Rankins Springs in 2015.

Cultivar	Development speed	Grain yield (t/ha)	
		15-Apr	14-May
Wedgetail	Winter	6.2	4.9
Kiora	Slow spring	6.1	5.1
LPB11-0140	Winter	6.0	5.2
Wylah	Winter	6.0	5.0
Bolac	Slow spring	5.9	4.3
V07041-39	Very slow spring	5.9	5.1
Lancer	Slow spring	5.8	4.9
Gregory	Mid spring	5.3	4.0
Sunvale	Slow spring	5.3	4.8
Eaglehawk	Very slow spring	5.1	4.5
Condo	Fast spring	3.0	4.7
P-value		<0.001	
LSD (p=0.05)		0.5	

Table 4. Grain yield (t/ha) and stem frost damage (% tillers frosted) for a range of cultivars of different development rates sown on two dates on long fallow at Rankins Springs in 2014. This trial suffered severe damage from stem frosts in July and August which reduced yield in slow developing spring cultivars sown early.

	Grain yield (t/ha)		**Stem frost damage (% sterile tillers)**	
Variety	**17 April**	**22 May**	**17 April**	**22 May**
Wedgetail	5.8	4.6	1	0
Osprey	5.3	4.8	1	-1
Lancer	4.5	4.5	27	0
Eaglehawk	4.4	4.4	8	1
Sunvale	4.2	4.7	44	-1
Suntop	4.0	4.4	18	0
Gregory	4.0	4.9	29	0
Bolac	3.8	4.6	30	0
Dart	3.5	3.9	43	0
Spitfire	3.4	4.1	42	0
P-value	**<0.001**		**<0.001**	
LSD (P=0.005)	**0.4**		**7**	

Growers with long fallows should keep either a winter or slow spring cultivar in order to maximise yield in seasons with a sowing opportunity in April. They also need to keep either a mid-fast or fast cultivar to use on non-fallow paddocks, and in seasons where there is no establishment opportunity until May. Winter, slow and mid-developing cultivars should not be sown dry, even on long fallows. If these cultivars are not established at their optimal time they will flower too late and suffer yield loss due to drought and heat stress. In seasons with a late break where an establishment opportunity has not arrived by the start of May, yield will be maximised by dry sowing as much wheat area as possible to a mid-fast or fast developing cultivar.

Keeping a winter cultivar (e.g. Wedgetail) gives the greatest range of potential establishment dates, but is of more value to mixed farmers who can graze these crops in the vegetative phase (typically for ~1000 DSE/ha grazing days). Because they take longer to reach stem elongation, winter cultivars are also less susceptible to stem frost than slow spring cultivars (Table 4). There is unlikely to be a yield advantage of sowing winter cultivars intended only for grain production before early April as the extra vegetative biomass production will not contribute to grain yield. Winter cultivars will be more attractive once cultivars better adapted to western NSW become available in 2018.

Other agronomy

Fallow management, root and foliar diseases

The yield benefits of summer and winter fallow weed control in western NSW are beyond doubt, but controlling fallow weeds is particularly important for early sown crops for several reasons. Firstly, having as much stored soil water as possible helps establishment of early sown crops when breaking rains are marginal. Secondly, spraying summer weeds conserves N which is necessary to support the higher yields of crops growing on long fallows. Thirdly, early sown wheat crops are more vulnerable to a range of diseases that can be hosted by weeds and volunteers growing during the fallow e.g. barley yellow dwarf virus (BYDV), take-all, *Rhizoctonia*, wheat streak mosaic virus (WSMV). Making sure fallows are kept weed free from at least August in the fallow year up until sowing reduces the risk of these pathogens attacking early sown crops. BYDV in particular can be very damaging to early sown crops. This virus is spread by aphids in autumn, and crops need to be protected from infection with insecticides. An effective insecticide program should start with a seed dressing product registered for aphid control (e.g. imidacloprid), and needs to be backed up with a foliar insecticide (e.g. lambda-cyhalothrin) at GS13 (3 leaves emerged) if aphids persist past this time. If planning on grazing, check stock withholding periods on any insecticides used.

Some slow developing cultivars also have low levels of resistance to foliar fungal pathogens such as stripe rust, and appropriate monitoring and protection with fungicides is required.

Grass weeds

Sowing wheat early requires clean paddocks free of grass weeds. It is rarely possible to achieve a good knockdown of grass weeds if sowing in April, as most grass weed populations have evolved a greater degree of dormancy and will not emerge until later in May. This also means that many pre-emergent herbicides used when sowing early will have lost residual activity by the time grass weeds begin to emerge. If sowing early into paddocks with grass weed pressure, it is worth using pre-emergent herbicides with a higher level of residual control (e.g. Sakura).

Given the yield penalties associated with delayed sowing in western NSW, it is worthwhile keeping grass weed seed banks low so crops can be sown on time without relying on knockdown and pre-emergent herbicides for grass weed control. One year of long fallow alone is not sufficient to drive down high grass weed seed banks. Crop (including hay), pasture and herbicide rotation in conjunction with long fallows and harvest weed seed control (chaff carts, narrow windrow burning, seed destructors etc.) are the most effective way of reducing seed bank numbers and keeping them low.

Seeding rates

Two years of trials at Rankins Springs have shown no significant yield benefit from reducing seeding rates below 90-100 plants/m² in early sown crops. Trials conducted by BCG in the Victoria Mallee as part of the Early Sowing project showed that even in extremely dry years there was no yield benefit from reducing seeding below 90 plants/m² (Table 5). However, previous trials by NSW DPI at Condobolin have shown a yield benefit from reducing plant densities to ~30 plants/m² in early sown wheat (Table 6).

The BCG trials also showed that in the presence of weeds, lower crop densities do not yield any less but they are less competitive with weeds and allow greater weed biomass production and seed set (Table 5). If paddocks are free of grass weeds, plant density can be reduced to 30-60 plants/m² which reduces establishment costs and increases sowing work rate and may provide a yield benefit in some seasons. If planting into paddocks with any level of grass weed pressure or intending to graze, seeding rates should be maintained at 90-100 plants/m² in order to provide even establishment, greater crop competition and early dry matter for livestock. Check seed size and viability in order calculate and appropriate sowing rate in kg/ha.

Table 5. Plant density of early sown Wedgetail grown in the presence of a model weed (commercial oats) with corresponding weed biomass and grain yield. At each site wheat density and weed biomass means are significantly different from each other (P<0.05), but wheat yield means are not.

	Quambatook 2014 (sown 1 April)		**Berriwillock 2015 (sown 9 April)**	
Target wheat plant density (plants/m²)	**50**	**150**	**50**	**150**
Actual wheat plant density (plants/m²)	38	88	56	109
Weed biomass (t/ha)	5.4	1.3	0.7	0.4
Grain yield (t/ha)	2.0	2.0	1.3	1.3

Table 6. Grain yield (t/ha) of wheat cultivars of different development speed sown at appropriate times to flower on the same date (~18 September) at two plant densities at Condobolin in 2011 and 2012.

Grain yield (t/ha)	**2011**		**2012**	
Variety & sow date	**30 plants/m²**	**90 plants/m²**	**35 plants/m²**	**80 plants/m²**
Eaglehawk⌽ (mid-April)	3.4	3.1	3.2	2.6
Bolac⌽ (late-April)	3.3	2.9	3.4	3.5
Gregory⌽ (early-May)	3.6	3.2	3.4	3.0
Lincoln⌽ (mid-May)	2.8	3.0	3.0	2.6
Axe⌽ (late-May)	2.1	2.6	-	-
P-value	0.029		<.001	
LSD (p=0.05)	0.4		0.4	

Nitrogen management

The higher yield potential of early sown crops on long fallows needs to be supported with nitrogen (N). Dryland wheat crops need to see ~40 kg/ha mineral N per tonne of grain yield at 11% protein. A 6 t/ha crop at 11% protein needs a total N supply of 240 kg/ha N. Some N is available in the soil at the start of the season, some will mineralise during the growing season, and the remainder needs to be supplied as fertiliser. The amount available can be determined from soil cores (deep N) prior to sowing. N can leach in long fallows so it is important to sample as deeply as possible (>1 m) and segment cores into depths to get a more accurate estimate of available N (e.g. 0-10, 10-30, 30-60, 60-90, 90-120 cm).

Mineralisation is dependent on a lot of variables (organic carbon content of soil, moisture, temperature, surface residue) and is very hard to predict. It can range from >80 kg N/ha following a legume pasture in years with good spring rainfall, to <0 kg/ha following a cereal crop with a large stubble load in a dry spring.

In early sown crops that aren't to be grazed, most N should be top-dressed to avoid excessive early growth. On acid soils in S NSW urea can be top-dressed 'by the calendar' in July when soil is cold, crops are generally at Z30 and have covered the soil surface. N losses under these circumstances are minimal.

Acknowledgements

This factsheet has been prepared as part of GRDC Project CSP00178. The local project team includes Neil Fettell (CWFS), Barry Haskins, Rachael Whitworth (AgGrow Agronomy) James Hunt, Bonnie Flohr, Tony Swan, Brad Rheinheimer and Laura Goward (CSIRO Agriculture). The project team gratefully acknowledges the guidance of local farmers, particularly Michael Pfitzner who hosted Rankins Springs trials in 2014 and 2015.