

TIME OF SOWING

FACT SHEET

WESTERN REGION

When to sow wheat to minimise risk

The optimal sowing date results in wheat flowering after the last frost and with adequate reserves of soil moisture before heat stress begins.

KEY POINTS

- Crops sown early within the sowing window will establish faster and have the potential to maximise water use efficiency.
- Early sowing increases the chance of frost damage and can limit weed control.
- WA wheat varieties flower in response to an accumulation of warm temperatures. Many varieties also have a mild cold temperature requirement to delay flowering and some varieties are affected by day length. Research in WA is teasing out the differences.
- Growers need to be selective with varieties for particular sowing times to ensure a spread of flowering dates. Models such as 'Flower Cal' and 'DM' from DAFWA or Yield Prophet™ can assist.
- Late sowing can increase severity of most root diseases early sowing increases severity of a number of leaf diseases. Rusts are not consistently affected by sowing time.

PHOTO: EMMA LEONARD



Although temperature is the driving force of plant development, day length and vernalisation moderate its effect. Consequently, different varieties with different genetic make-up mature at different rates but the difference is greater when sown early.

The widespread adoption of no-till farming means Western Australia's wheat growers can now sow crops earlier. Yields are usually higher for earlier sowing within the recommended sowing window. Early sowing speeds establishment but crops can also flower earlier.

Sowing too late lowers yields as grain fill occurs during increasingly hot and dry conditions.

Sowing too early will increase the chance of frost damage and can limit weed control options. With late maturity varieties, it can also increase the bulk of crops and lead to stored

soil water being used up before flowering (haying off). In fast maturing varieties, sowing very early can reduce the bulk of the crop as development is hastened and root depth reduced. This can lead to lower yield potential and reduce access to deeper moisture and nutrients.

WA research has shown growers can lose yield by sowing too early or too late in years with an autumn break before mid May. However, with a late break (after mid May), early sowing proved best, with yields dropping with progressively later sowing. Only in seasons with a favourable spring did yields increase with later sowing. In rare cases, yields were not affected by sowing time, usually when poor growing conditions such as severe drought led to low yields.

The availability of soil moisture is a key to crop growth. However, wheat development is controlled by genetic responses to the accumulation of temperature, day length and cold requirement (vernalisation). The influence of each of these factors can vary between varieties.

Drought, nutrition and the sun's radiation can modify the effects of temperature at certain growth stages. It is thought that when temperate plants like wheat are stressed, flowering is accelerated.

Factors controlling wheat development

The rate of development in wheat is controlled by temperature and day length. Development is different from growth. Development refers to the crop moving between stages whereas growth refers to an increase in biomass. In Australia, developmental stages are commonly referred to as 'growth stages'. To ensure the crop flowers at the optimal time, an understanding is required of how sowing time affects flowering time as well as the frequency of frosts and high temperatures.

Sowing time affects different varieties in different ways. Various combinations of genes are present in Australian wheat varieties which provide a wide spectrum of responses to temperature and day length. The products of the vernalisation (cold requirement) and day length genes almost certainly interact with each other to promote or delay flowering.

However, not all differences can be related to vernalisation and day length responses. Another trait is known as the basic vegetative period (BVP) or earliness and describes the minimum time taken by the plant to complete its life cycle. It is strongly affected by temperature and varies between varieties.

Temperature

Temperature is the main factor that controls plant development. Increasing temperature can advance the timing of germination and flowering.

Although temperature is the driving force of plant development, day length and vernalisation moderate its effect.

It takes about 150 'degree-days' from sowing for wheat to emerge. So, when the average daily temperature is 10°C, emergence will take 15 days, that is 10°C x 15 days = 150 'degree-days'. If the average is 15°C, emergence will take only 10 days, or 15°C x 10 days.

Vernalisation

A number of Australian wheat varieties also have a cold requirement, which must be satisfied before the plant will switch from the vegetative to reproductive stages (for example, flowering). This is termed 'vernalisation'. The low temperatures required can vary from 3°C to 10°C. A vernalisation requirement can prevent early sown crops from flowering too early in warm growing conditions.

Most Australian wheat varieties are known as 'spring' varieties. Spring wheats have little or no response to vernalisation. The winter conditions in WA's cropping areas are sufficient to meet the low vernalisation requirements of Australian spring wheats. For example, the varieties Westonia and Yitpi[®] have only a very

small vernalisation response.

'Winter' wheat varieties, like EGA Wedgetail[®], require cold temperatures to trigger flowering. Winter wheats are not well adapted to most regions of WA, generally suited only to April sowings and in the higher rainfall areas.

Day length

Many Australian wheat varieties are sensitive to day length, or photoperiod, to varying degrees. However, to date, most varieties are not well characterised for responses to day length.

Flowering is triggered by days longer than a critical duration. Days become longer after 22 June. The further from the equator, the greater the variation in the length of days. The effect of day length on flowering time is more noticeable in areas of southern WA such as Katanning or Albany where day length changes more as the season progresses than in the Northern Agricultural Region around Geraldton, where day length is less variable (Table 1).

While many pre-1970s varieties responded strongly to day length, current WA varieties are less sensitive to day length. Varieties like Yitpi[®], Magenta[®], Endure[®] and Wyalkatchem[®], all have a 'medium' sensitivity to day length but vary in BVP and vernalisation to produce very different maturity times.

Table 1 Influence of variety and region on wheat development in relation to sowing date.

	Sowing date	15 May	2 June	22 June	15 May	3 June	22 June
Variety		Geraldton			Katanning		
Westonia (short)	Flowering date	8 Aug	24 Aug	13 Sep	28 Sep	8 Oct	18 Oct
	Days to flowering	75	79	85	136	128	118
Yitpi [®] (mid to long)	Flowering date	30 Aug	20 Sep	5 Oct	12 Oct	18 Oct	24 Oct
	Days to flowering	107	110	105	150	138	124

SOURCE: Department of Food and Agriculture, WA

NOTE: Westonia is a variety with very little sensitivity to vernalisation and day length with a short basic vegetative period (BVP). Its development is driven mostly by warm temperatures. Sowing on 22 June 2009 led to Westonia flowering at the optimal time at Geraldton. In contrast, Yitpi[®] will flower at the optimal time if sown in mid May at Geraldton or if sown earlier than 15 May at Katanning. Yitpi[®] has no vernalisation requirement, moderate day length requirement and a very long BVP. Cooler temperatures at Katanning compared with Geraldton retard the development of wheat, particularly for Westonia in this example. The difference in flowering dates between varieties is greatest with early sowing.

PHOTO: PETER MALONEY, DAFWA



Planting too late does not give the crop enough time to produce sufficient biomass or root depth for high yields and increases the chance of grain filling during increasingly hot and dry conditions.

Early sowing

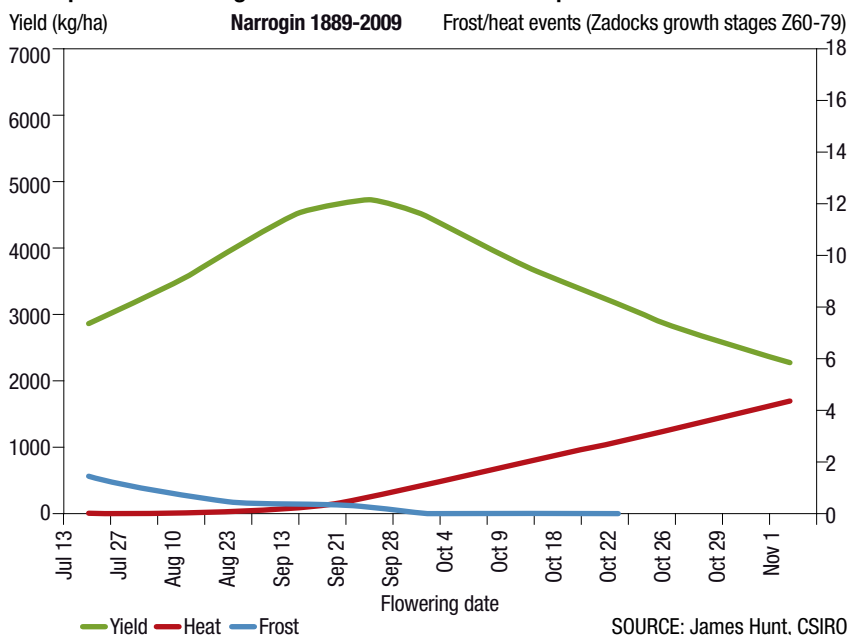
Crop growth

Given adequate rainfall and soil moisture, early sowing can set the potential for higher yields. Warmer days aid fast establishment and better early growth than later sown crops.

Biomass contains carbohydrates, allowing for grains to fill later in the season. Strong early growth provides more heads and more potential grains in each head.

If growth before flowering is excessive due to early sowing and high nitrogen, yields can be reduced by haying-off when moisture is limited during grain fill. This problem is more common on heavy land and in the eastern states. It occurs because the canopy has limited capacity to fill all grains, leading to higher screenings when moisture reserves are used up before flowering. Very early sowing also increases risk of some short maturing varieties developing too quickly with inadequate biomass or root depth for good yields.

FIGURE 1 The optimal sowing date will aim to achieve a flowering date coinciding with minimal risk of frosts, heat shock and dry conditions during flowering and grain fill. In this example developed from APSIM at Narrogin, the optimal flowering time is the third week of September



SOURCE: James Hunt, CSIRO

Similarly, planting too late does not give late-maturing varieties enough time to produce sufficient biomass or root depth for high yields and increases the chance of grain filling during increasingly hot and dry conditions. Even without haying-off or frost, late sown crops may produce higher screenings than earlier sown crops as they mature under hotter and drier conditions.

Frost risk and the recommended flowering window

The main risk of early sowing is frost between flowering and early grain fill. In WA, the optimal flowering window is based on yield data from time of sowing trials rather than long-term climatic data for frost risk.

The recommended flowering window for Geraldton is 25 August to 15 September. At Northam the window is 5 September to 25 September and at Katanning it is 17 September to 7 October. The recommended windows at Northam and Katanning do include an overlap of frost risk of at least one year out of every three for the first half of the estimated window.

The theory is to match the variety and sowing date so that flowering will occur within the window. For example, use a mid to late maturing variety such as Yitpi[®] if sowing early May or a short season variety such as Westonia if sowing in June (Table 1). It is still important to try and get a spread in flowering within the window across the whole cropping program to minimise the impact of frost across the entire cropping program in the years when frost does occur.

If the risk of frost is unacceptable, it is recommended to sow the higher parts of the landscape first, delaying the sowing of the low-lying and more frost-susceptible areas until later in the program. Another option is to sow less susceptible crops.

Early sowing within the recommended sowing window

Delayed sowing has reduced yields in WA in most trials since the late 1980s. The exceptions were severely frosted sites with high leaf disease or where weeds could not be controlled when sowing early.

Trials in the Northern Agricultural Region in 2009 showed delayed sowing to 2 June only reduced yields slightly. Wheat yields fell by between 14 to 31 kilograms for each day's delay in sowing at Mingenew, Coorow and Mullewa. Losses in this case were far

greater when sowing was delayed beyond 2 June, ranging from 28 to 55kg a day. Quairading was the only exception; mid-May sowing into marginal moisture reduced establishment and restricted weed control at this site (Figure 2).

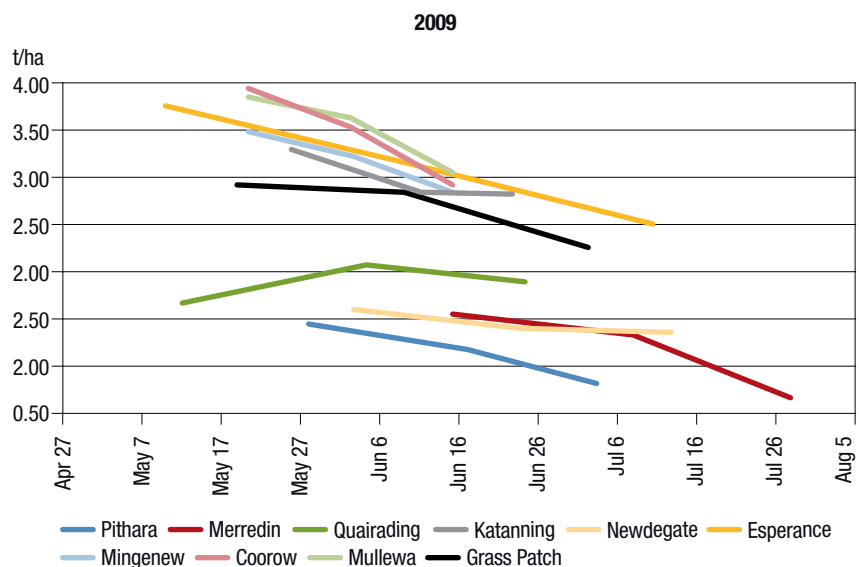
Variety selection for different sowing times

Western Australian trials have found highest yields are generally achieved with mid season varieties

sown in late May, within the sowing window. In WA, short maturing varieties, such as Zippy[®], rarely out yield the well adapted mid-season varieties when sown late, which is in contrast to other parts of Australia (Table 2). Proven varieties have competitive yields; the mid season varieties are generally well-suited to tight finishes in WA.

The Flower Cal model was developed by Tennant and Tennant in 2000 (available though DAFWA). The model uses temperature and day length to predict the flowering of the most common varieties grown in WA over a range of sowing dates and locations.

FIGURE 2 Impact of delayed sowing on wheat yield



SOURCE: Department of Food and Agriculture WA

Table 2 A comparison of the performance of the short season variety Zippy[®], sown after 15 June, to varieties with longer maturity over from multiple locations in WA – 2007 to 2009.

Maturity	Variety	Higher	Similar	Lower
Short-mid	EGA Bonnie Rock [®]	0	11	2
Short-mid	Mace [®]	1	13	8
Short-mid	Wyalkatchem [®]	1	18	3
Long	Calingiri	4	11	5
Mid	Carnamah	3	12	7
Mid-long	Magenta [®]	2	15	5
Mid-long	Yitpi [®]	4	10	3

Note: Figures represent the number of trials where the yield of Zippy[®] was higher, similar or lower than the comparison variety. SOURCE: DAFWA

Some predictions are shown in Farmnote 51/2005 *Time of sowing, varieties and the flowering window*. While work is continuing to update the varieties, a new model is being developed; Flower Cal is far less accurate in the colder southern sites of WA than the warmer and northern locations of WA.

The new model, DM, includes a vernalisation component in addition to day length and temperature components. The online interface for the DM model will be developed by April 2011 and the user will be able to compare the flowering date and spread of different varieties currently released in WA over a range of sowing dates. Both models show the likelihood of frost and or heat stress.

Yield Prophet™ is another online decision support tool for growers and advisers via a paid subscription. It helps growers decide the best variety for a given sowing date or the best sowing date for a variety in their own paddock.

Yield Prophet™ uses information about responses of individual varieties to day length, thermal time and cold requirement in conjunction with information about the paddock and long-term climate data. For some varieties and locations there is more information than others.

Sowing time effect on quality

Late sowing in seasons with a tight finish can lead to higher screenings in some varieties (Figure 3). Researchers find it difficult to tease out the effects of sowing date, as season and variety choice have such a big impact on wheat quality. Difficult seasons tend to damage most varieties and varieties with quality defects tend to display these, even in reasonable seasons.

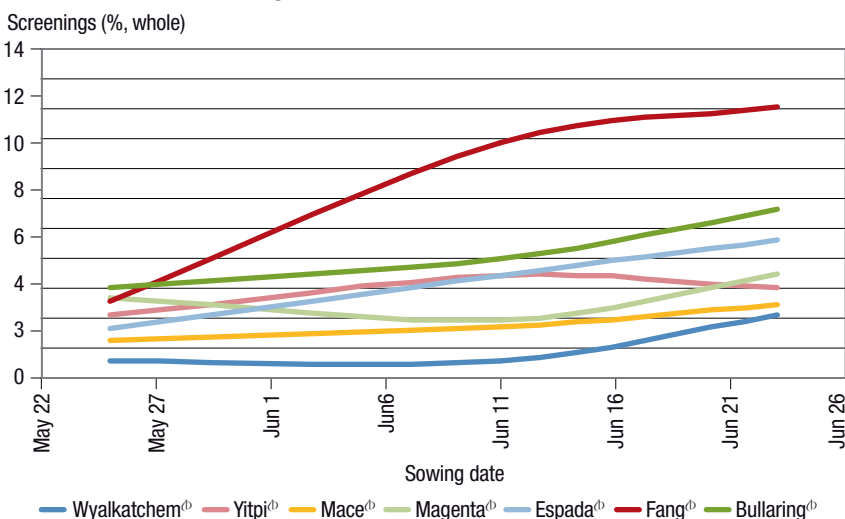
Early sown crops can suffer more sprouting (measured by 'falling number') than later crops due to rain during grain fill. Sprouting can be affected by rainfall any time from mid-dough onwards (growth stage 85+), so the probability of significant rainfall damaging the grain decreases with later sown or longer season and later maturing crops. However, the yield penalty of delayed sowing will negate the quality gains from avoiding late rain. Varieties with improved seed dormancy and sprouting tolerance are being developed as a better alternative management tool than altering sowing time.

PHOTO: DAFWA



Earlier sowing tends to increase the severity of yellow spot, Septoria and barley yellow dwarf virus.

FIGURE 3 A tight finish to the season at Katanning in 2009 meant delayed sowing increased the risk of higher screenings in a number of varieties. Some varieties, like Fang[®], were more affected than others



SOURCE: DAFWA

Sowing time effect on disease

Growers can identify the risk of the different diseases with the help of a state department cereal disease guide and a PreDicta B™ soil test.

Leaf diseases

Earlier sowing tends to increase the severity of fungal diseases yellow spot and Septoria. Barley yellow dwarf virus (BYDV) and wheat streak mosaic virus may also be worse with early sowing. For BYDV, severity depends on the timing of the aphid flight.

Warmer temperatures in early autumn favour wheat curl mite, the vector which transmits wheat streak mosaic virus (WSMV).

Delaying sowing is not a useful tool for stripe rust control as it is not consistently affected by sowing time. Most wheat varieties have some adult plant resistance. Later sowing of these varieties allows this form of resistance to start working earlier. However, early sowing can increase levels of stripe rust at early crop stages due to warmer temperatures in early autumn favouring rust cycling. If the rust arrives in a district in late winter or spring, early sowing can also mean fewer fungicide sprays are required if crops are more advanced.

Root diseases

Delayed sowing increases the severity of Rhizoctonia, cereal cyst nematode, *Pratylenchus* and crown rot. This is due to slower root growth in colder soils.

Crown rot exacerbates yield loss and high screenings from late sowing, particularly in seasons with a hot and dry finish.

Delayed sowing increases the number of whiteheads and brown bases from crown rot, which is worsened

by moisture and heat stress during grain fill. The effects are more severe in seasons with a hot and dry finish. Increased screenings from late sowing are also exacerbated by crown rot.

Take-all is less severe in later sown crops but only if weeds are controlled and inoculum has decomposed before sowing.

Why sow early?

Advantages of early sowing include:

- yield benefits in season with hot and dry finishes, particularly where frost is not a major problem;
- better establishment from early sowing provides competitive crops for weed control;
- varieties which flower earlier will have a longer grain filling period;
- increased biomass for increased yield potential in a wet season;
- less yield loss from crown rot than in later sown crops;
- logistical benefits; and
- reduced risk of a number of root diseases.

Disadvantages of early sowing include:

- dry sowing is at more risk of a false break, especially on heavier soil types;
- varieties which flower earlier are more at risk of frost damage in frost-prone areas;
- varieties sown before their recommended time can develop too quickly, leading to low biomass and shallow rooting depth at flowering and relatively poor yields.
- increased biomass increases haying-off risk. The drier the spring, the worse the effect;
- more risk of a number of leaf diseases and take-all;
- tall crops are more at risk of lodging;
- no opportunity for knockdown or mechanical weed control for herbicide resistance management; and
- complete reliance on in-crop weed control, increasing the chance of weed problems and poor establishment.

Useful resources:

- Ben Curtis, DAWFA, Esperance 08 9083 1105 Email ben.curtis@agric.wa.gov.au
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- Sarah Ellis, DAFWA, Esperance 08 9083 1151 Email sarah.ellis@agric.wa.gov.au
- Brenda Shackley, DAFWA, Katanning 08 9821 3333 Email brenda.shackley@agric.wa.gov.au
- Christine Zaicou-Kunesch, DAFWA, Geraldton 08 9956 8549 Email christine.zaicou@agric.wa.gov.au
- Wheat variety guide 2010 Western Australia, Department of Agriculture and Food
www.agric.wa.gov.au/objtwr/imported_assets/content/fcp/cer/wh/bn_wheat_variety_guide_2010.pdf
- New wheat varieties – exploit the benefits and avoid the pitfalls (Crop Updates 2010)
www.grainindustryassociationwa.com/pastevents-cropupdates2010.php
- Yield Prophet® www.yieldprophet.com.au
- Farm Note 51/2005: *Time of sowing, varieties and the flowering window*
http://www.agric.wa.gov.au/objtwr/imported_assets/content/fcp/cer/fn2005_timeofsowing.pdf
- Flower Cal, DAFWA www.agric.wa.gov.au

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Acknowledgements: Ben Biddulph, Ben Curtis, Sara Ellis and Brenda Shackley, DAFWA; Howard Eagles, University of Adelaide; Russell Eastwood, AGT; Grant Hollaway, Victorian DPI; James Hunt, CSIRO; Peter Martin and Steven Simpfendorfer, NSW I&I; Tim McClelland, BCG; and Nick Poole, Foundation for Arable Research.