TIME OF SOWING

FACT SHEET

Grains Research & Development Corporation

MARCH 2011

SOUTHERN REGION

Impact on yield and quality of wheat

The optimal sowing time for wheat is a compromise. Sowing too early increases the risk of frost damage and haying-off, while sowing too late increases the chance of grain filling during increasingly hot and dry conditions. By understanding the factors that influence time of flowering, better decisions on what to sow and when can be made.

KEY POINTS

- Early sowing can accelerate establishment and make full use of the growing season but can increase the risk of frost during critical growth stages and haying-off in a dry finish.
- Flowering time of wheat is controlled by the interaction of several factors that can include temperature, day length and cold requirement.
- Most Australian wheat varieties flower in response to the accumulation of warm temperatures. Many varieties also have a cold temperature requirement and some varieties flower in response to longer days.
- Winter wheats can be sown earlier than spring wheats in suitable regions as the cold requirement delays flowering.
- To minimise risk, varieties with a range of flowering dates and maturities should be sown, providing other criteria such as disease resistance are also met.
- The relationship between sowing date and crop development can interact with disease development and nutrition management.

PHOTO: EMMA LEONARD

The optimal sowing date results in flowering and grain filling occurring when frost and heat risk is minimised.

Crops are being sown earlier than in the past – even before the opening rains – due to increased adoption of no-till. While early sowing can help crops establish better, they also flower earlier, making them at greater risk of frost or haying-off due to early bulky growth consuming too much soil moisture. Yields can improve, especially in dry seasons but on long-term average, the effects are not always significant. Sowing too late will reduce yields as crops flower and ripen during increasingly hot and dry conditions.

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.

Sowing time affects different varieties in different ways and the effect on development depends on the genetic make-up of the variety (Figure 1). Genes control the plant's development responses to the accumulation of temperature, day length and cold requirement (vernalisation). Various combinations of genes are present in Australian wheat varieties, which result in a wide spectrum of responses to temperature and day length. The products of the vernalisation genes and photoperiod genes almost certainly interact with each other to promote or delay flowering. Australian wheat breeders now have tools to better identify the vernalisation and photoperiod genes in wheat varieties.

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 (Figures 1 and 2).

Controls of wheat development

The rate of development in wheat is controlled by vernalisation, 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'.

Vernalisation

To trigger flowering, 'winter' wheat varieties need to experience low average temperatures – between around 3°C and 17°C above a base temperature after emergence; however as temperatures become warmer within that range, the vernalisation rate is slower.

The minimum duration and temperature will depend on the variety. For this reason, winter varieties should not be sown in spring. Winter wheats vary in their need for cold temperatures. Most grower guides will state if a variety is a winter wheat. Winter wheats are often dual purpose varieties, and in Victoria and South Australia are recommended only for high rainfall regions with a long growing season, such as southern Victoria and the lower south-east of SA. In New South Wales, winter wheats are suited to early sowing in the eastern part of the NSW wheatbelt.

Most Australian wheat varieties are known as 'spring' varieties. Spring wheats have little or no need for vernalisation and the mild winter conditions in southern Australia's cropping areas are sufficient to meet the low vernalisation requirements of Australian spring wheats. The varieties H45⊕, Axe⊕, Janz, Young⊕ and Silverstar have only a very small vernalisation response.

Most spring wheats tolerate a shorter growing season than winter wheats.

Thermal time

Australian wheat crops will develop faster in warmer conditions providing the vernalisation requirement has been met. The accumulation of average daily temperatures largely dictates development for most Australian wheat varieties.

The time and temperature relationship governing growth and development is called 'thermal time' and measured in 'growing degree-days' and this requirement varies between varieties (Figure 3). For barley, it is sometimes referred to as the 'basic vegetative phase'.

Thermal time is simply the average daily temperature, above a base temperature multiplied by the number of days. Plants will stop developing once temperatures are below the base temperature. The base temperature is often assumed to be zero degrees for calculations, although this actually differs between varieties. For the calculation, the average daily temperature needs to be above a base temperature for the crop.

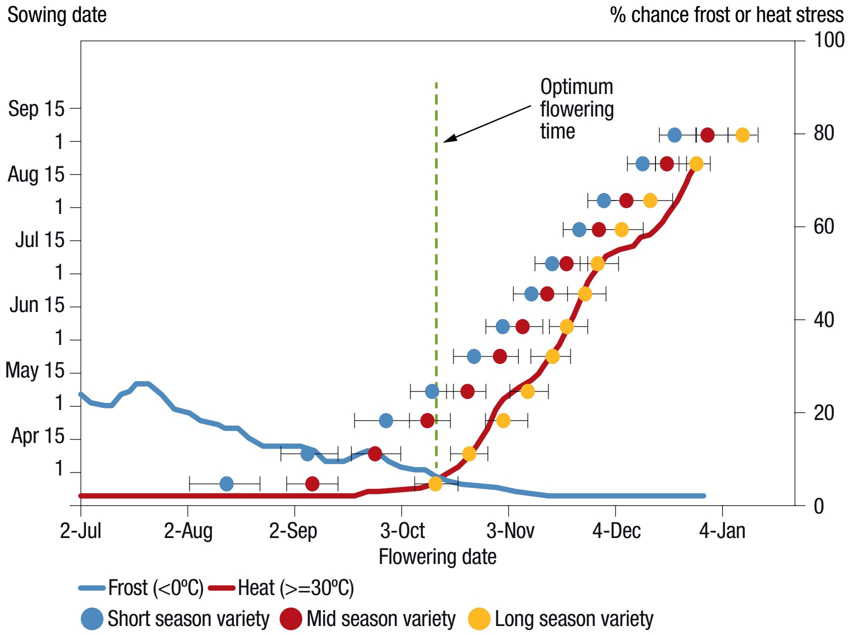
For spring wheats, thermal time is the main driver of development. It usually takes 150 'degree-days' from sowing for wheat to emerge: when average daily temperature is 10°C, emergence will take 15 days, or 10°C x 15 days = 150 'degree-days'. If the average is 15°C, emergence will take only 10 days. Trials in 2007 found wheat sown on 10 May at Cowra emerged twice as fast (11 days) as wheat sown on 15 June (22 days).

Day length

In some Australian wheat varieties, mainly grown in northern Australia, day length (photoperiod) can also impact the length of time required to reach growth stages. Genetic studies and observations of wheat varieties grown in different latitudes suggest many Australian wheat varieties are day length-sensitive to varying degrees; however, most varieties are not well characterised for responses to day length.

The closer to the equator, the less

FIGURE 1 The relationship between variety maturity and sowing date to optimise time of flowering



SOURCE: Penny Riffkin, Victorian DPI

Note: The best sowing time results in wheat flowering when the risks of frost, heat stress and dry conditions are lowest. In this example, at Dunkeld in south-west Victoria, the optimal flowering time is, on average, 10 October. To achieve timely flowering at this site, the winter variety needs an early April sowing, the mid needs early May sowing while the early variety is best sown in mid-May.

variation in day length. Day length increases after 22 June.

The longer the days, the shorter the thermal time needed to initiate flowering in photoperiod-sensitive wheat varieties.

Varieties released before 1973 generally carried a photoperiod-sensitive gene, making them more sensitive to day length. They tended to flower later for a given sowing date when sown before 22 June – on average a week later in the Mallee, compared with current varieties. A photoperiod-sensitive variety will flower four to 12 days later than an insensitive variety when sown early in southern Australia, depending on its need for vernalisation.

Balancing the risks

Early sowing within a variety's recommended window generally maximises yields with dry springs, and no frosts, favouring early flowering. Later sowings can require a different variety. In trials at Cowra, NSW, between 2007 and 2009, delayed sowing within the appropriate sowing window generally reduced wheat yields. All three years had dry springs and in 2007 and 2008, no frosts favoured early sowing.

Crop growth and haying-off risks with early sowing

Given adequate rainfall and soil moisture, early sowing can set the potential for high yields. It aids fast establishment and good early growth due to warmer days.

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.

Very early sowing of an early maturing variety with little or no vernalisation requirement and relatively insensitive to day length (for example, Axe⁽ᴾ⁾) will cause rapid development. The lack of biomass at flowering will reduce the numbers and size of heads and the number of grains. The lack of root depth will also limit the crop's ability to access moisture later in the season, leading to lower yields.

The yield loss from delayed sowing within the window is not large on average but can be high in dry years. Modelling over 30 years showed delaying sowing in the Victorian Mallee from 1 May to 1 June caused an average two per cent yield loss. In two of these years the yield loss was 0.5 tonnes per hectare. Similar results have been seen in trials across the southern region (Figure 3).

In seasons with a dry finish, early sowing (within the sowing window) has generally resulted in lower screenings and higher yields as crops mature during milder conditions. In those years, the benefit from early sowing in reducing moisture and heat stress has outweighed the effects of frost damage.

However, if high rates of nitrogen are applied upfront in early-sown crops, growth before flowering can be excessive. If moisture is limited during grain fill, the canopy will have limited capacity to fill all grains, leading to higher screenings and lower yields – even in the absence of frosts.

Frost risk of early sowing

The main risk of early sowing is frost between flowering and early grain fill. The optimal flowering window is based on long-term climatic data. However, frosts can still occur during the flowering window.

Winter wheats can be sown early where frost risk is a concern – as their cold requirement delays flowering.

Sowing time effect on disease

Foliar diseases

Earlier sowing tends to increase the severity of yellow leaf spot, Septoria tritici blotch and barley yellow dwarf virus (BYDV). Wheat streak mosaic virus (WSMV) and BYDV can also be worse with early sowing however, for BYDV it depends on timing of the aphid flight. Warmer temperatures in early autumn favour wheat curl mite that transmit WSMV.

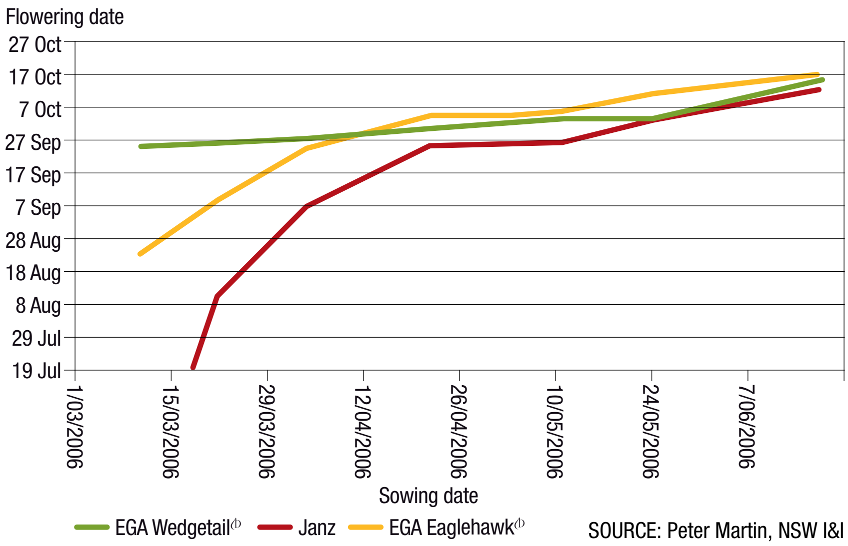
Delaying sowing is not a useful tool to aid stripe rust control as it is not consistently affected by sowing time. Early sowing can provide the benefit of the crop being more advanced when the disease arrives in a district. Conversely, early sowing can also increase levels of stripe rust at early crop stages due to warmer temperatures in early autumn favouring rust cycling, and allow adult plant resistance to start working at a later growth stage.

Root diseases

Growers can identify the risk of significant soil-borne and crown diseases with a PreDicta B™ soil test.

Delayed sowing increases the severity of Rhizoctonia, cereal cyst nematode, Pratylenchus and crown rot. This is due to slower root growth with late sowing.

FIGURE 2 When sowing very early, big differences in flowering time can be identified. In the southern region, when sowing from late April onwards, flowering dates become closer. EGA Wedgetail⁽ᴾ⁾ is a winter variety and can be sown early as flowering is delayed until the strong cold requirement is met. In contrast, Janz has low vernalisation requirement so very early sowing will cause very early flowering. EGA Eaglehawk⁽ᴾ⁾ is intermediate for cold requirement



SOURCE: Peter Martin, NSW I&I

PHOTO: EMMA LEONARD

For spring wheats, thermal time is the main driver of development.

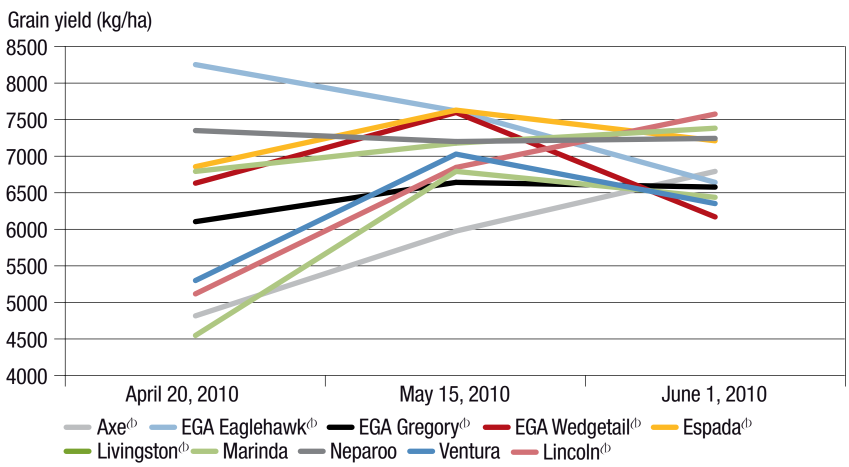
Delayed sowing can increase yield loss and screenings from crown rot, which is worsened by moisture and heat stress during grain fill. The effects are more severe in seasons with a hot and dry finish.

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

Variety and sowing time options

Growers need to select wheat to match their specific growing season and agronomic requirements; selecting varieties with a spread of flowering dates can help minimise risk if sowing starts early and is across at least a month. The later and shorter the sowing window, the less difference

FIGURE 3 Example of variety response to sowing time in a single trial at Cowra in 2010



SOURCE: Jan Edwards, NSW I&I

These responses vary between trials. Across-sites analysis of variety response to sowing time in NSW is available in *Yield response of wheat varieties to sowing time in NSW*, 2009. For more information visit www.dpi.nsw.gov.au/primefacts that will occur in flowering time, even between varieties with different maturities (Figure 2).

Recommended sowing times for individual varieties and regions are provided in Victorian and NSW government department crop guides, while details of flower dates are reported in the SA wheat sowing guide. The commercial program Yield Prophet® can assist with variety selection.

Yield Prophet®

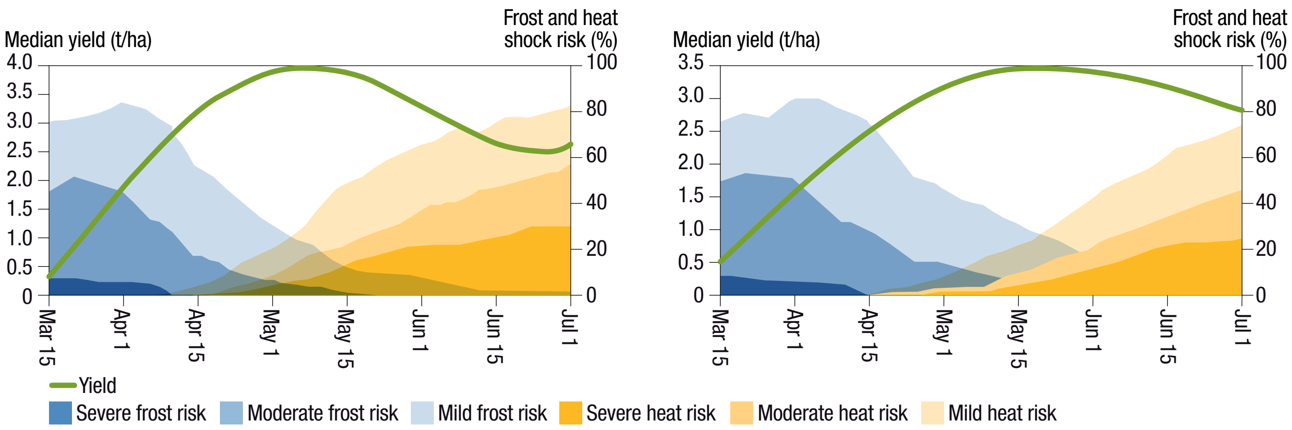
Yield Prophet® is an online decision support tool for growers and advisers accessed via a paid subscription. One part of the program can help in the process of selecting the best variety for a given sowing date or the best sowing date for a variety in their own paddock (Figure 4).

The model 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 regions there is more information than others; newer varieties and locations are supported by less data.

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.

FIGURE 4 An example of a report from Yield Prophet® showing the optimal sowing time of the main season variety, Yipti (left), is about two weeks before the early variety, Young⌽ (right) in a specific paddock at Culgoa in north-west Victoria. While early sown Yitpi produces highest potential yields, Young⌽ is likely to yield 0.5t/ha more if sowing is delayed until 15 June. Risk of frost and heat stress is based on long-term weather and relates to flowering and grain fill periods



SOURCE: Tim McClelland, BCG

Why sow early?

Advantages of early sowing include:

- yield benefits in seasons 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;
- deeper roots than late sown crops, allowing access to moisture later in the season;
- less yield loss from crown rot than in later sown crops;
- logistical benefits;
- less risk of several root diseases; and
- winter varieties are adapted to early sowing.

Disadvantages of early sowing include:

- dry sowing can be risky due to a false break, especially on heavier soil types;
- some early varieties are not suited to early sowing and will flower very early and will have less biomass and root depth at flowering, reducing potential yields;
- varieties which flower earlier are more at risk of frost damage in frost-prone areas;
- increased biomass increases haying-off risk, especially in drier springs;
- more risk of a number of leaf diseases and take-all;
- tall crops are more at risk of lodging;
- less opportunity for knockdown or mechanical weed control for herbicide resistance management; and
- complete reliance on in-crop weed control increases the chance of weed problems and poor establishment.

Useful resources:

- **Jan Edwards, NSW I&I** — **02 6349 9777 Email jan.edwards@industry.nsw.gov.au**
- **Russell Eastwood, AGT** — **03 5362 2111 Email russell.eastwood@ausgraintech.com**
- **Peter Martin, NSW I&I** — **02 6938 1833 Email peter.martin@industry.nsw.gov.au**
- **Penny Riffkin, Victorian DPI** — **03 5573 0926 Email penny.riffkin@dpi.vic.gov.au**
- **Yield response of wheat varieties to sowing time in NSW, 2009, Primefact 914, August 2010** — **www.dpi.nsw.gov.au/agriculture/field/field-crops/winter-cereals/yield-response**
- **Cereal disease Guide 2010, Agnote AG1160, Victorian DPI** — **new.dpi.vic.gov.au/notes/crops-and-pasture/cereals/ag1160-cereal-disease-guide-2010**
- **Winter variety crop sowing guide, NSW I&I** — **www.dpi.nsw.gov.au/agriculture/field/field-crops/winter-cereals/winter-crop-variety-sowing-guide**
- **Victorian Winter Crop Summary, Victorian DPI** — **new.dpi.vic.gov.au/agriculture/grain-crops/winter-2010/wheat**
- **Cereal Variety Disease Guide 2010, PIRSA** — **www.sardi.sa.gov.au/__data/assets/pdf_file/0016/86101/Cereal_Disease_Variety_Guide_2010__2_.pdf**
- **Wheat Sowing Guide 2011, SA** — **www.sardi.sa.gov.au**
- **National Variety Trials** — **www.nvtonline.com.au**
- **GRDC Fact sheets – Dual purpose crops, Frost risk** — **www.grdc.com.au**
- **Yield Prophet®** — **www.yieldprophet.com.au**

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