

TIME OF SOWING

FACT SHEET

NORTHERN REGION

Balancing the risk for wheat

The optimal sowing date results in wheat flowering after the last frost but before heat stress events begin. Adequate reserves of soil moisture must also be available.

KEY POINTS

- Early planting can accelerate establishment and make full use of the growing season but can increase the risk of frost during critical growth stages and can increase the chance of crops running out of moisture before critical reproductive stages.
- Flowering time of wheat is controlled by the interaction of several factors that include temperature, day length and cold requirement. The degree of each is determined by plant breeding.
- Most Australian wheat varieties flower in response to the accumulation of temperature. Many varieties also have a slight cold temperature requirement. Some wheats grown in the northern region also flower in response to longer days.
- 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.
- Planting time can influence the severity of some root and leaf diseases. Rusts are not consistently affected by planting time.

PHOTO: EMMA LEONARD



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

Crops are now being planted earlier, even before the opening rains, due to increased adoption of no-till. While early planting can improve crop establishment, crops may also flower earlier. Yields can also be higher in dry seasons as long as frosts are not a major issue. However, on long-term average, the effects are not always large.

The optimal planting time for wheat is a compromise. Planting early will

increase the chance of frost damage at flowering. With late maturing varieties, it can also increase the bulk of crops and lead to stored soil water being used before flowering. In early maturing varieties, sowing early may actually reduce the bulk of the crop as development is hastened, as well as reduce rooting depth. This can lead to reduced yield potential and reduced access to deeper moisture and nutrients.

Planting too late will reduce yields as crops flower and ripen during increasingly hot and dry conditions. Crops will lack biomass and the rooting depth required to achieve potential yields (Figure 1, page 2).

However, planting time impacts different varieties in different ways, and the effect on development depends on the genetic make-up of the variety. Genes control the responses to the accumulation of

temperature, day length and cold requirement (vernalisation).

To ensure the crops flower at the optimal time, an understanding of how planting time affects flowering time as well as the frequency of frosts and high temperatures is important.

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

Controls of 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'.

Thermal time

The accumulation of average daily temperatures largely dictates development for most Australian wheat varieties, and Australian wheat crops will develop faster in warmer conditions.

The time and temperature relationship that governs plant growth and development is called thermal time and is measured in 'growing-degree days'.

Thermal time is simply the average daily temperature multiplied by the number of days. Plants will stop developing when temperatures are low but this base temperature depends on the plant species and can even differ between varieties. For the calculation, the average daily temperature needs to be above a base temperature for the crop; zero degrees is used as the default.

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

Vernalisation

Most Australian wheat varieties are called 'spring' wheats; they have a need for low temperatures but this

is much less so than the 'winter' types grown in parts of Victoria and NSW. This cold requirement is called 'vernalisation', and the low temperatures required may vary from three to 10 (or more) degrees above freezing. As temperatures become warmer within that range, the vernalisation rate is slower.

As most varieties have some sensitivity to vernalisation, this need for cold temperatures slows down the development of wheat, particularly in early planted crops.

Very early planting of a variety with a small cold requirement (for example, Axe[®]) will cause very early flowering. When a winter variety (for example, EGA Wedgetail[®]) is planted early, flowering is delayed until its cold requirement is met. Most Australian wheat varieties (for example, EGA Eaglehawk[®]) are intermediate for cold requirement (Figure 2).

Day length

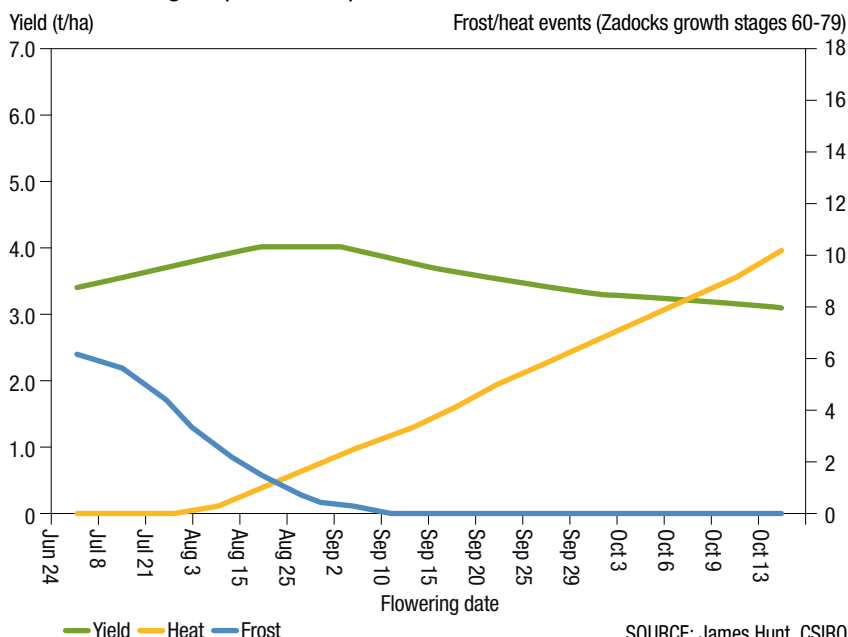
In some Australian wheat varieties grown in northern Australia, day length (photoperiod) can also impact

Table 1 Some varieties grown in northern Australia respond to day length (photoperiod). A variety sensitive to day length will flower later than a day length-insensitive variety when planted before 22 June. The difference in flowering dates is greatest with early planting. When planted after 22 June, the longer days cause less delay to flowering. (This table shows an example in Victoria where day length varies more than in the northern region)

Day length response of variety	Planting date					
	5 May	24 May	6 June	5 July	27 July	16 August
	Flowering date					
Medium	23 Oct	27 Oct	5 Nov	8 Nov	13 Nov	20 Nov
Weak	16 Oct	24 Oct	31 Oct	7 Nov	12 Nov	26 Nov
Difference	7 days	3 days	5 days	1 day	1 day	-5 days

SOURCE: Ray Flood, 1992

FIGURE 1 The best planting time results in wheat flowering when risk of frost, heat stress and dry conditions is lowest for maximum yield. In this example at Moree in northern NSW, the optimal flowering time is around late August (1889-2009)



SOURCE: James Hunt, CSIRO

PHOTO: EMIMA LEONARD



When planted early, large variation in flowering time can be identified in wheat varieties requiring little or moderate vernalisation. For later plantings the difference is reduced.

the length of time required to reach growth stages. Genetic studies and observations of wheat varieties grown in different latitudes suggest, however, that most varieties are not well characterised for responses to day length.

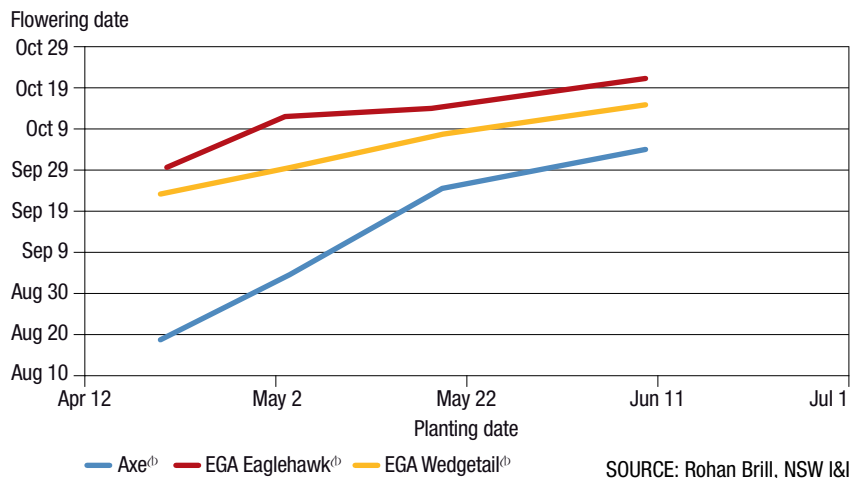
Day length, or photoperiod, can also impact on the length of time required to reach growth stages. Many Australian wheat varieties are day length-sensitive to varying degrees. The northern Australian varieties known to be day length-sensitive include Baxter[®] and EGA Wylie[®].

Day length-sensitive wheats are long-day plants; flowering is induced by days longer than a certain minimum (short nights).

Temperature and day length can work together to affect the duration of important stages like flowering and grain fill. The longer the days, the shorter the thermal time needed to initiate flowering in day length-sensitive wheat varieties.

Longer days combined with above average temperatures can cause early

FIGURE 2 When planting early, big differences in flowering time can occur in winter wheats and varieties requiring little or moderate vernalisation. This difference becomes smaller when the same varieties are planted later. Data are from Trangie, NSW, 2010



flowering and a shorter than normal duration of grain filling in day length-sensitive varieties. If this is combined with dry conditions, yields and quality will be poor.

The closer to the equator, the less variation in day length that occurs. In the southern hemisphere day length increases after 22 June (Table 1, page 2).

Modern Australian wheat varieties

Sowing time affects different varieties in different ways. Various combinations of genes are present in Australian wheat varieties that 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.

Some varieties, including Axe[®], have only a very small vernalisation response. If planted early, they may flower far too early as they do not have a strong cold requirement to delay development.

Varieties released before 1973 generally carried a photoperiod-sensitive gene, meaning they were more sensitive to day length. They also tended to flower later for a given planting date when planted before 22 June. This gene is present in EGA Wylie[®] and Baxter[®].

Australian wheat breeders now have tools to better identify the vernalisation and photoperiod genes in wheat varieties but there is a lot more to learn.

Early planting within the recommended planting window

Early planting of quick maturing varieties generally maximised yields in trials in north-west New South Wales in 2009 with a hot, dry finish but no frost problems. In that year, highest yields resulted from early (mid-August) flowering. In contrast, early flowering was of no advantage in the much wetter and cooler 2010 season (Figure 3).

Later plantings generally require different varieties. For example, the early maturing variety Livingston[®] was one of the highest yielding lines in the trial at Trangie, NSW, in the wet season of 2010 when sown late but ranked 13 out of 15 when sown on April 20, even though frost was not a major issue.

It cannot be assumed that all longer season varieties are better suited to early sowing than all early maturing varieties. For example, in the 2009 Trangie trial (hot, dry finish with no frost damage) earlier maturing varieties like Livingston[®], Ventura and Lincoln[®], sown on 18 May, performed better than late maturing varieties, Sunzell and Strzelecki[®], sown on 27 April

(Figure 3). In 2010, a wet year without severe frost damage, highest average yields came from early May planting.

Crop growth and haying-off risks with early planting

Given adequate rainfall and soil moisture, early planting can set the potential for high yields. It aids fast establishment and good early growth compared with later-planted crops due to warmer days. It also allows roots to grow deeply to access moisture later in the season.

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.

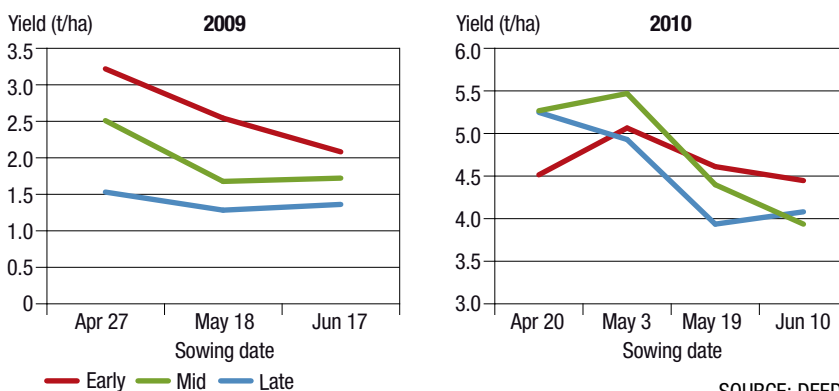
Very early planting of an early maturing variety with little or no vernalisation requirement and insensitive to day

length (for example, Axe[®]), 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 and nutrients later in the season, leading to lower yields.

If growth is excessive before flowering due to early planting and excess up-front nitrogen, yields can be reduced – even in the absence of frosts – when moisture is limited during grain fill. This is because the canopy has limited capacity to fill all grains, leading to lower yields and higher screenings. This is especially true for late maturing varieties.

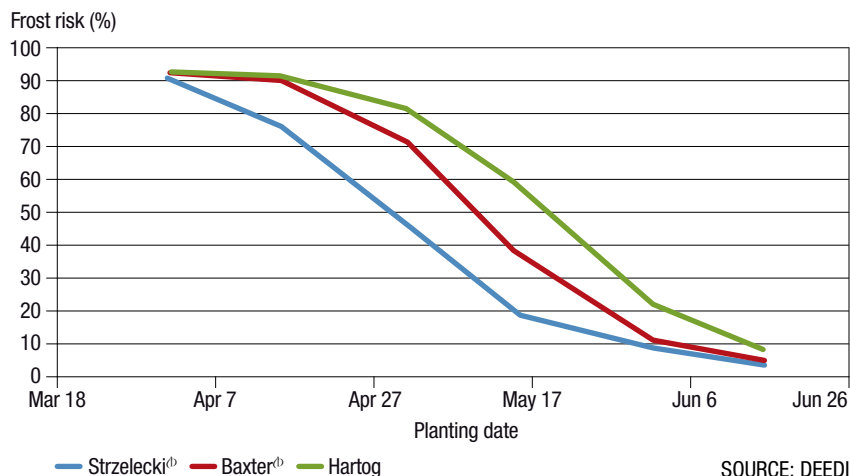
In recent dry seasons, early sowing within the sowing window has been beneficial. Early flowering crops can produce lower screenings and higher

FIGURE 3 Impact of planting time on the yield of early, mid and later maturing varieties, Trangie, NSW 2009 and 2010



SOURCE: DEEDI

FIGURE 4 Planting time and variety should be matched to minimise frost risk and heat stress during flowering and grain fill



SOURCE: DEEDI

This example shows percentage risk of severe frost from flowering onwards at St George, Queensland, when using different planting dates of an early variety (Hartog), a mid variety (Baxter[®]) and a long season variety (Strzelecki[®]). Early sowing favours longer season varieties.

Frost risk tables for Queensland are available at http://www.dpi.qld.gov.au/26_3537.htm#frost-probability

yields in seasons with a dry finish, as they generally mature under less hot and dry conditions. In those years, the benefit from early sowing in reducing moisture and heat stress has outweighed the effects of frost damage. When planted within the planting window, late planted crops generally produce higher screenings than earlier planted crops as they mature under hotter and drier conditions.

Frost risk of early planting

The main risk of early planting in the northern region is frost between flowering and early grain fill. The optimal flowering window is based on long-term climatic data (Figure 4, page 4). Frosts can still occur during the flowering window.

Planting time effect on disease

Foliar diseases

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

Delaying planting is not a useful tool for stripe rust control as it is not consistently affected by planting time. Most wheat varieties have some adult plant resistance. Later planting of these varieties allows this form of resistance to start working at an earlier growth stage.

However, early planting 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 planting can also mean less fungicide sprays are required if crops are further advanced.

Root diseases

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

Delayed planting increases severity of root lesion nematode (*Pratylenchus thornei*) and crown rot. These diseases exacerbate the effect of low soil moisture and reduce the ability of roots to access nutrients.

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

Delayed planting increases the number of whiteheads 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. In such conditions, yield losses due to crown rot in 2009 at Tamworth ranged from eight per cent in early-planted wheat (18 May) to 22 per cent in late planted wheat (1 July).

Variety and planting 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 shorter the sowing window, and the later the crop is sown, the less difference that will occur in flowering time, even between varieties

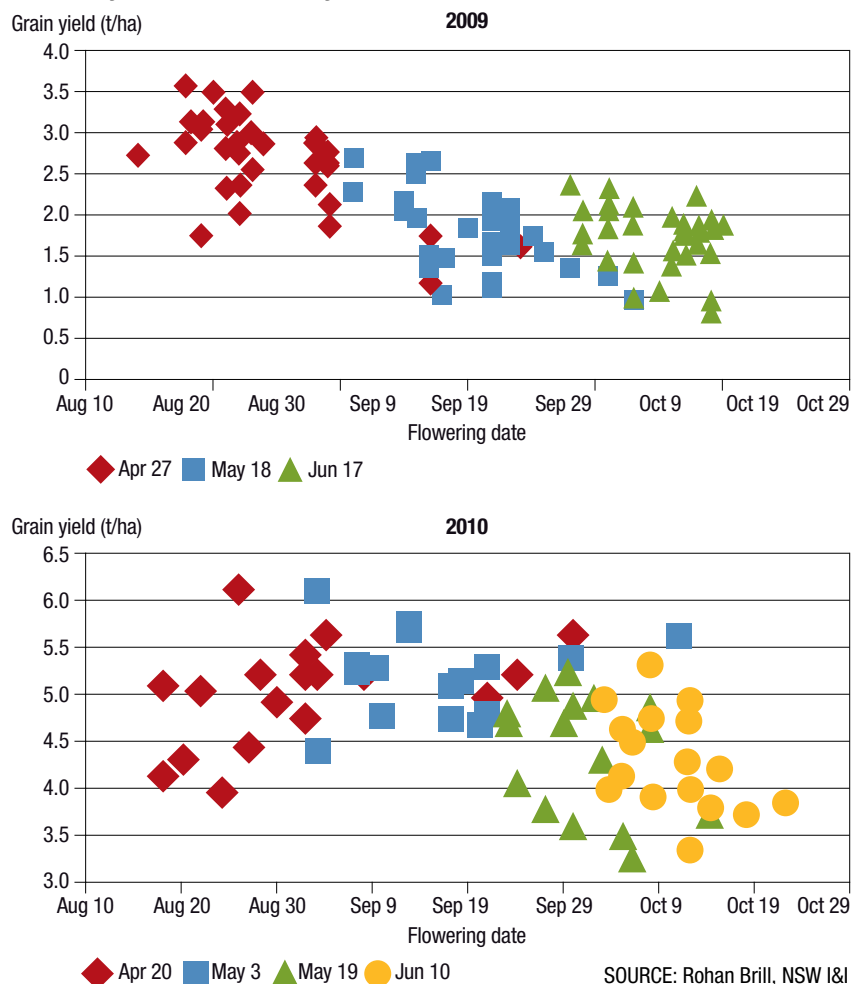
with different maturities (Figure 5). Recommended sowing times for individual varieties and regions are provided in Queensland and NSW government department crop guides. The commercial program Yield Prophet® can assist with variety selection.

Yield Prophet®

Yield Prophet® is an online decision support tool for growers and advisers accessed via a paid subscription. One function of the program assists in the process of selecting the best variety for a given sowing date or the best sowing date for a variety in a particular 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. The model was developed in the GRDC Northern Region. More information is provided for some varieties than others.

FIGURE 5 Average wheat yields in tonnes per hectare with up to four sowing dates at Trangie, NSW, in 2009 and 2010. While yields were best with late April sowing in 2009, a year with a hot, dry finish, early sowing did not increase yields in the wetter year of 2010



SOURCE: Rohan Brill, NSW I&I

Why plant early?

Advantages of early planting within the recommended window include:

- yield benefits in seasons with hot and dry finishes, particularly where frost is not a major problem;
- increased root depth, resulting in greater access to stored moisture and nutrients;
- better establishment from early planting provides competitive crops for weed control;
- crops which flower earlier will have a longer grain filling period;
- increased yield potential, especially in mid to late maturity lines;
- less yield loss from crown rot than in later planted crops;
- logistical benefits;
- less risk of a number of root diseases; and
- winter varieties are adapted to early planting.

Disadvantages of early planting include:

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

Useful resources:

- **Rohan Brill, NSW I&I** 0419 277 480 Email rohan.brill@industry.nsw.gov.au
- **Russell Eastwood, AGT** 03 5362 2111 Email russell.eastwood@ausgraintech.com
- **Neil Fettell, University of New England and NSW I&I** 02 6895 2099 Email neil.fettell@une.edu.au
- **Peter Martin, NSW I&I** 02 6938 1833 Email peter.martin@industry.nsw.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
- **Winter variety crop sowing guide, NSW I&I**
www.dpi.nsw.gov.au/agriculture/field/field-crops/winter-cereals/winter-crop-variety-sowing-guide
- **Wheat – diseases, physiological disorders and frost** www.dpi.qld.gov.au/26_3537.htm#frost-probability
- **National Variety Trials** www.nvtonline.com.au
- **GRDC Dual purpose crops fact sheet** www.grdc.com.au/uploads/documents/GRDC_Dual-PurposeCrops.pdf
- **GRDC Frost risk fact sheet** www.grdc.com.au/uploads/documents/GRDC_FS_Frost.pdf
- **Yield Prophet®** www.yieldprophet.com.au

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