CROP PLACEMENT AND ROW SPACING FACT SHEET

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WESTERN REGION

A systems approach to row spacing

The depth of seed placement and the distance from the adjacent row both influence crop performance. With the greater uptake of no-till and precision farming the opportunies to vary row spacing by crop and sow on the inter-row have increased. However, increasing row spacing is not always beneficial to yield.

KEY POINTS

- Increased interest in no-till farming has created a trend for wider crop row spacing.
- In general, increasing row spacing has no effect on cereals when yields are less than 0.5 tonnes per hectare.
- In cereal trials with high yield potential (greater than 3.0t/ha), significant yield penalties have been recorded with wider row spacing.
- The yields of broadleaf and pulse crops vary in their response to wider row spacing.
- Precision agriculture makes inter-row sowing and fertiliser applications easier at wider row spacing. Weed control can be a major problem.

PHOTO: GUY MCMULLEN, I&I NSW

The higher the yield potential, the greater the negative impact of wider rows on wheat and barley yields.

The traditional row spacing in much of Western Australia has been 18 centimetres (seven inches) for cereals, but greater adoption of no-till farming systems has increased interest in wider row spacing such as 30 to 50 centimetres (Figure 1) depending on the crop type and region.

The most appropriate row spacing is a compromise between crop yield, ease of stubble handling, optimising travel speed, managing weed competition and soil throw and achieving effective use of pre-emergent herbicides. Although row spacing is a relatively simple thing to change, the effect on the whole farm system can be complex and can influence yield, time of sowing, machinery, herbicide, and seed and fertiliser costs, as well as the types of crops sown.

Effect on yield

Cereals

The impact of row spacing on cereal yield varies depending on the growing season rainfall, the time of sowing and the potential yield of the crop.

The higher the yield potential, the greater the negative impact of wider rows on wheat and barley yields.

Trials with high yielding barley crops, where the average yield was more than 3t/ha (range 2.7 to 3.4t/ha) found doubling row spacing from 18 to 36cm and from 25 to 50cm resulted in yield penalties in the order of 0.7t/ha.

WA wheat trials on row spacing from nine to 54cm found wider spacing decreased grain yield (Table 1, see page 3). The research found an average eight per cent decrease in yield for each 9cm increase in row spacing from nine to 54cm.

Reducing row spacing can increase cereal yields in many areas, but it can create problems with stubble and machinery, such as more blockages at seeding.

Cereals grown on wider row spacing tend to be taller and have a greater risk of lodging in high yielding years. At harvest crop lifters may be required.

The ideal row spacing for oaten hay is around 17.5cm. This reduces stem diameter, avoids lodging and keeps the hay windrow off the ground during curing. Cross sowing at wider row spacing may achieve the same result.

The response to row spacing is also

influenced by the time of sowing. Trials at Meckering, WA, examined the impact of row spacing on the yields of wheat and lupins and compared two sowing times – 19 May and 14 June (Figure 2). The trial found there was a greater rate of yield reduction with wide rows in later sown crops, which had less time for canopy development.

Broadleaf crops

Pulses respond positively to wide row spacing out to 25cm in low rainfall areas and 35cm in high rainfall areas.

Interest in wide row spacing for lupins has been driven by three factors:

- the ability to handle large amounts of stubble;
- the potential for more stable yields in low rainfall environments; and
- the potential use of inter-row spraying for weed control.

A series of field trials comparing lupin growth in rows 18 to 100cm apart found no significant difference in yields between 50cm rows and narrower, but large differences between trials, as a result of the environment.

Wider rows (50 to 60cm) have higher yield potential than narrow rows in the warm, dry environments of the medium to low-rainfall northern wheat belt. This is because the crop uses less water during winter so more is available at the end of the season to fill pods.

Narrower rows (less than 50cm) are more likely to have better yields in cooler, longer season climates, such as the Lakes districts and areas further south. In these areas, maximising yield potential through early plant growth and ground cover prior to the onset of winter is critical.

Pulses such as peas and lentils grown on wide row spacing (30 to 60cm) generally have a greater podding height. Harvesting height is improved if these crops are inter-row sown using the standing stubble as a trellis.

Harvest height is also an issue in lupins. In a series of nine lupin trials in 2004 and 2005 the lowest pods in 50cm rows were from six to 16 per cent higher than in 25cm rows in four trials and no different in five trials.

Canola trials in WA have shown an average yield loss of 13.7 per cent by taking row spacing from 18cm to 36cm. The extent of the yield loss varied from nine per cent through to 27 per cent in eight different trials (Table 2).

PHOTO: GUY MCMULLEN, I&I NSW

Lupins sown on wider rows (50 to 60cm) have higher yield potential than narrow rows in the warm, dry environments of the medium to low-rainfall northern wheat belt. This is because the crop uses less water during winter so more is available at the end of the season to fill pods.

FIGURE 1 Common row spacings in metric and imperial measurements

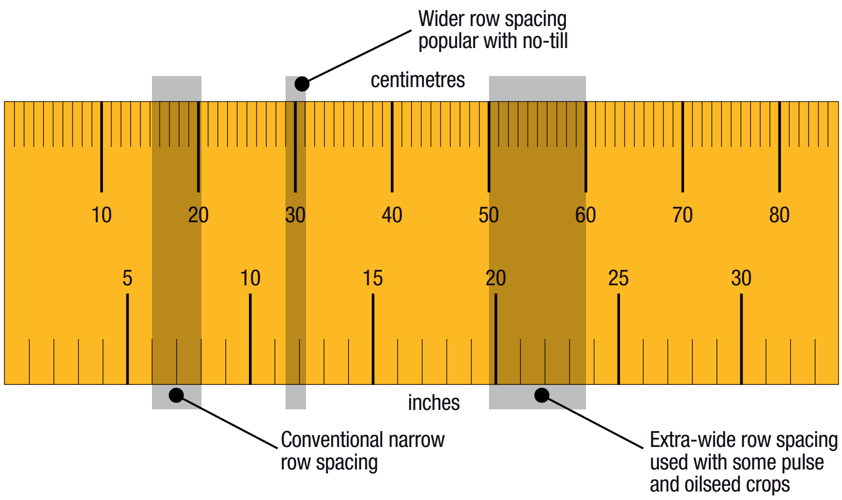
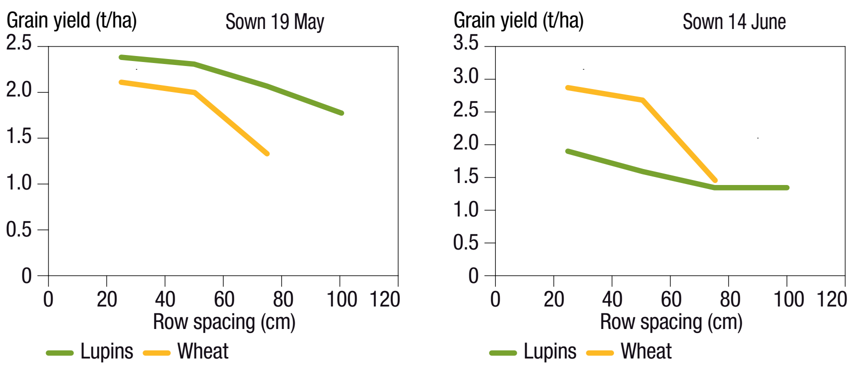


FIGURE 2 Grain yields of wheat, and lupins sown on different dates and with different row spacing at Meckering, WA, 2004



SOURCE: Bob French, Department of Agriculture and Food, Western Australia

Soil moisture

Closer row spacing can reduce evaporation by increasing the rate of canopy closure. Wider row spacing can increase evaporation from the soil between the rows but this can be off-set by inter-row stubble mulching and the interception and concentration of rainfall into the crop row.

Field experiments in South Australia during 2006 investigated the water and radiation use efficiency of wheat, barley and faba beans grown on conventional (18cm) and wide row spacing of 36 and 54cm (Table 3). The trial was conducted during a dry season (growing season rainfall 181mm; median 300mm) and found clear differences in the yield responses for the crops grown at different spacing.

The yield trends for wheat and barley were similar irrespective of row spacing. Doubling the row spacing from 18 to 36cm resulted in a two per cent loss in yield in barley and a five per cent loss in wheat. When row spacing was extended to 54cm a yield reduction of up to 24 per cent was recorded in both cereals.

The research found water use by wheat and barley was unaffected by the row spacing. In contrast the faba beans in both of the wider rows used less water during the early stages of crop development so more water was available later in the season for grain filling.

Weed competition

Increasing row spacing can create major weed problems, especially with ryegrass.

Wider spacing reduces the crop's ability to close the canopy and compete with weeds between rows. This delays inter-row weed suppression – the wider the rows the longer the delay. As row spacing increases to more than 40cm in cereals, canopy closure may never occur, making weed control extremely important.

Wider row spacing can allow weeds to be controlled using higher rates of incorporated by sowing (IBS) herbicides. Trifluralin and pendimethalin can be applied as a 'hot blanket' of herbicide and incorporated between the crop rows using a seeding bar fitted with tines not discs.

TABLE 1 Effect of row spacing on wheat yield in the absence of stubble 1982-85 in WA (yield from 18cm row spacing is taken as 100 per cent)

Number of trials	Row spacing (cm)					
	9	18	27	36	45	54
7	–	100	92	94	–	–
9	115	100	95	90	77	75
16	112	100	93	–	–	–
Mean response %	+14	–	-7	-8	-23	-25
kg grain/ha per cm change in row spacing	+24	–	-11	-5	-23	-5

SOURCE: Glen Riethmuller, Department of Agriculture and Food, Western Australia

TABLE 2 Increasing row spacing in canola trials in WA resulted in loss of yield across all regions

Location	Yield (kg/ha)		Yield loss (%)
	18cm	36cm	
Mt Barker	1445	1243	14
Wongan Hills	329	239	27
Tenindewa	1370	1130	18
Merredin	988	822	17
Frankland	2189	2016	8
Gairdner River	1608	1405	13
Esperance Downs	1768	1494	16
Avondale	441	400	9
Average	**1267**	**1093**	**13.7**

SOURCE: Glen Riethmuller, Department of Agriculture and Food, Western Australia

TABLE 3 Crop yield responses to row spacing in SA, 2006

	Mean (t/ha)		
Row spacing	Wheat	Barley	Faba bean
18cm	2.80	3.02	0.79
36cm	2.66	2.95	0.98
54cm	2.13	2.49	0.95

SOURCE: Gurjeet Gill and Sam Kleeman, University of Adelaide

Seeding depth

PHOTOS: EMMA LEONARD

The difference in emergence and development between wheat sown at 30 to 35mm and too deep or shallow.

In canola, poorer germination occurs with smaller seed.

Seeding depth is important for maximising crop yield.

Factors that influence a seedling's ability to emerge from depth include:

- seed size;
- seed treatments;
- coleoptile length (varies with variety);
- herbicides; and
- soil conditions including temperature.

Sowing too deep can delay emergence and establishment, reduce early seeding vigour, increase disease susceptibility and reduce yields.

In a season with a dry start, deep sowing into moisture is a tool that can ensure crops are established in their optimal sowing window. The deeper sowing may reduce crop germination but the yield from the earlier sowing may offset yield losses associated with delaying sowing to later in the season.

Deep sowing is only an option for soils that store soil moisture and can be cultivated to depth. Care should be taken to avoid bringing sodic clays into the topsoil which can increase dispersion, hard-setting and salinity. Some fungicidal seed treatments reduce coleoptile length in cereals and treated seeds should be shown at shallower depths.

A more uniform seeding depth is achieved with press wheels which minimise the variation in soil cover, provided they leave a regular, stable furrow. Care should be taken with press wheels when sowing lupins as a relatively low press wheel pressure of two to four kg/cm width can reduce emergence and yields. The ideal seeding depth for wheat is 30 to 35mm for semi-dwarf varieties, through to 50 to 70mm for tall wheat varieties that have a longer coleoptile.

Barley has a shorter coleoptile length than wheat and the ideal sowing depth is 20 to 30mm. Some barley varieties including Hindmarsh$^{\Phi}$ and Buloke$^{\Phi}$ have shorter than average coleoptile length. Deep sowing with these varieties is not recommended, especially with stubble retention, the use of seed fungicides containing triadimenol, or with the use of pre-emergent weed control with trifluralin.

Canola has small seeds and should be sown shallow with the ideal depth 12 to 25mm. Poorer germination occurs with smaller seed.

Sow lupin seeds 30 to 50mm below the soil surface. Sowing very deep, below 50mm, will reduce the occurrence of pleiochaeta root rot. Shallow sowing (20 to 30mm) will reduce rhizoctonia hypocotyl rot disease. The ideal seed depths to avoid these two diseases are incompatible, so a compromise is needed, hence the recommendation of 30 to 50mm. Deep sowing to chase moisture can be attempted but the risk of hypocotyl rot is increased. Lupin seed should never be sown deeper than 70mm as establishment is very uneven and weak.

WA research shows sowing lupins 50 and 80mm deep with good seedbed moisture delays emergence by one and three days respectively and reduces crop vigour, when compared to sowing 30mm deep. Deep sowing at 80mm on a loamy soil with limiting seedbed moisture delayed emergence by up to 10 days. Sowing at 80mm reduces plant numbers by between 20 and 30 per cent compared with sowing at 30mm when seedbed conditions were good; and by over 50 per cent in drier seedbeds. This reduced establishment does not necessarily reduce grain yield.

Pulses such as chickpeas and faba beans, which have hypogeal emergence where the cotyledons remain where the seed is sown and only the shoot emerges from the soil, tolerate sowing at depths of 50 to 80mm. Pulses must be sown below the depth at which herbicide is incorporated.

Lupins should only be sown on wide rows (greater than 25cm) if the paddock has few weeds and if selective herbicides still work well. Weeds germinating between widely spaced lupin rows will experience minimal competition and grow vigorously.

When modifying row spacing, do not leave tines in the ground that are not used for seeding. These stimulate the germination of ryegrass and throw herbicides out of the furrow, encouraging the ryegrass to grow unchecked. Removing tines also saves fuel and allows faster and easier seeding.

Wide row spacing allows for the potential of shielded spraying of weeds between crop rows but the potential of herbicide resistance is increased.

Equipment

Wide row spacing can cut machinery costs by reducing the number of sowing units on a machine, resulting in the option of using a smaller tractor and requiring less fuel at sowing.

Increased sowing speeds are also possible. Wider row spacing reduces the impact of soil treated with pre-emergent herbicide being thrown from one row into an adjacent row where it can reduce crop emergence. Soil throw distance increases with the square of speed, for example, doubling the speed will increase soil throw distance four times. Speed can increase approximately 1.4 times if row spacing is doubled.

Wide row spacing can improve the stubble handling ability of seeding equipment but there can be problems when stubble loads are heavy. Discs are ideal for stubble retention and are best suited to light soils but are not as versatile as tined machines, which can be easily reconfigured for different crop and soil conditions.

Triple disc seeders are less efficient at herbicide incorporation and pre-planting weed control than machines fitted with tines. However, tined machines are less able to cope with stubble than disc seeders and often require preparation of the stubble at harvest.

Wide row systems can potentially help with the move to disc seeders and zero-till systems.

PHOTO: EMMA LEONARD

Increasing row spacing can create major weed problems, especially with ryegrass.

Inter-row cropping

In combination with GPS guidance that provides at least +/-10cm accuracy, wide row spacing allows subsequent crops to be located on the inter-row.

Inter-row systems can improve stubble flow but it is important that tines do not catch the stubble row as this can cause establishment problems. When using RTK guidance that provides +/-2cm accuracy, the best results are achieved when the minimum wide row spacing is approximately 30cm.

Fertiliser

Fertiliser rates may need to be increased or decreased for wide row spacing.

One factor that leads to reduced fertiliser rates is the increased concentration of fertiliser in rows. Wider row spacing increases the concentration of nutrients per metre of row if the rate per hectare is maintained.

Increased fertiliser requirements can occur when there is incomplete exploration of the surface soil by plant roots, such as in dry years.

Soil fertility can vary between the row and inter-row space in wide row cropping systems. There may be residual applied phosphorus and nitrogen in the soil following a dry year. Nitrogen fixation (following pulses) or nutrient tie-up by stubble may affect soil fertility. This can influence fertiliser budgeting for the following crop.

Take equal numbers of soil samples from the row and inter-row for an average phosphorus and nitrogen content of the paddock.

If planning to precision sow (row or inter-row) there may be some value in having the row and inter-row samples tested separately. This will allow any potential variation in soil fertility to be exploited.

Sowing into an area of high residual fertiliser may reduce starter requirements, while sowing away from residual fertiliser will delay crop access, resulting in a similar effect to applying tactical fertiliser later in the season.

Banding fertiliser below the seed will help minimise the effects of fertiliser toxicity.

Options

Many no-till operations are sowing cereals and canola on 30cm rows and pulses on 30 to 65cm rows between the standing stubbles. Before changing row spacing it is important to do a critical and economic assessment of the benefits and costs of using wide row spacing.

Benefits

Wider row spacing allows:

- an ability to sow into greater quantities of retained stubble;
- a reduction in fuel and/or machinery costs during sowing;
- increased sowing speeds;
- subsequent crops to be sown on the inter-row;
- higher rates of trifluralin to be used (which may be necessary with high levels of retained stubble and poor soil incorporation) to improve grass weed control;
- reduced soil disturbance; and
- an opportunity for better moisture conservation for grain filling.

Costs

Potential costs include:

- lower yields with wider row spacing;
- greater weed competition;
- slower canopy closure by crops;
- increased evaporation from soil;
- changes to seeding and in-crop fertiliser management; and
- greater potential for lodging.

Useful resources:

- **Bob French, Department of Agriculture and Food, Western Australia** — **08 9081 1138 Email bob.french@agric.wa.gov.au**
- **Blakely Paynter, Department of Agriculture and Food, Western Australia** — **08 9690 2115 Email blakely.paynter@agric.wa.gov.au**
- **Glen Riethmuller, Department of Agriculture and Food, Western Australia** — **08 9081 3146 Email glen.riethmuller@agric.wa.gov.au**
- **Peter White, Department of Agriculture and Food, Western Australia** — **08 9368 3508 Email peter.white@agric.wa.gov.au**
- **Peter Martin, NSW Department of Primary Industries** — **02 6938 1999 Email peter.martin@industry.nsw.gov.au**
- **The Wheat Book – Principles and Practice, Bulletin 4443** — **www.agric.wa.gov.au**
- **Producing Lupins, Bulletin 4720** — **www.agric.wa.gov.au**
- **Sowing depth for chickpea, faba bean, lentil and field pea, Department of Agriculture and Food farm note no. 45/97**
- **Other related GRDC Fact sheets** — **www.grdc.com.au/director/events/factsheets**

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