SECTION 3
Planting

More information

GRDC Update Papers: From soil throw to bentleg tine seeding research

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GRDC Update Papers: Strategies and tactics to extend whole farm water use efficiency; sow on time or early

GRDC Update Papers: Success with no-till into pasture ground

GRDC Update Papers: Sowing dates—getting the best from our varieties and optimising whole farm wheat yield

GRDC Update Papers: Adding value through pasture and fodder break crops

GRDC Update Papers: Good stubble bad stubble—more profit less profit

GRDC Update Papers: Pre-emergent herbicides and seeding system interactions

GRDC Update Papers: Nitrogen management in waterlogged crops

GRDC Videos: Lessons from 2014's early sown wheat in southern NSW

Barley is very versatile with respect to planting time and can be planted relatively early in the season. Preferred planting times are from late April to June, but this will vary for each variety and region depending on frosts and seasonal effects.

Early planting will generally produce higher yields, larger grain size and lower protein levels, making barley more likely to achieve malting quality. However, early crops are more likely to have exposure to frost, and growers should assess the frost risk for their area prior to sowing. Late plantings will often mature in hot, dry weather, which can reduce grain size, yield and malting quality.

The major determinant of barley profitability is yield. [1]To maximise yield, it is important to provide conditions for success. [2] Paddock selection and nitrogen (N) management can be the keys to producing malting quality.[3]

3.1 Seed treatments

Seed treatments are applied to control diseases such as smuts, bunts and foliar diseases and to control insects. When applying seed treatments, always read the chemical label and calibrate the applicator. Treat seed with appropriate fungicidal dressing; smuts and net form of net blotch may be seed-borne.

It is critical that seed treatments are applied evenly and at the right rate. Seed treatments are best used in conjunction with other disease-management options such as crop and paddock rotation, the use of clean seed, and the planting of resistant varieties.

Some risks are associated with the use of seed treatments. Research shows that some seed treatments can delay emergence by:

- slowing the rate of germination
- shortening the length of the coleoptile, the first leaf and the sub-crown internode

Any delay in emergence increases exposure to pre-emergent attack by pests and pathogens, or to soil crusting, which may lead to a failure to emerge. The risk of emergence failure is increased when seed is sown too deeply or into a poor seedbed, especially for varieties with shorter coleoptiles.

Seed dressings with systemic insecticides such as imidacloprid have been shown to have a net benefit for aphid control and yield improvement.[4]

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1 DAF Qld (2012) Barley planting, nutrition, harvesting. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

2 DAF Qld (2013) Barley planting disease guide 2013 QLD and NNSW. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/__data/assets/pdf_file/0018/53019/barley-planting-disease-guide.pdf

3 P Matthews, D McCaffery, L Jenkins (2015) Winter crop sowing guide 2014. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

4 DAF Qld (2013) Barley planting disease guide 2013 QLD and NNSW. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/__data/assets/pdf_file/0018/53019/barley-planting-disease-guide.pdf

Some seed treatments contain triazole fungicides (triadimenol and triadimefon). These seed treatments can reduce coleoptile length, and the degree of reduction increases as the rate of application increases.

Recent research with barley has shown that the highest registered rate of triadimenol can reduce emergence, and that the reductions are greatest in varieties with short coleoptiles when sown at depths greater than 50 mm. The results emphasise the need to sow varieties that have short coleoptiles at shallow depths and to take care with seed grading and the use of seed dressings.[5]

3.1.1 Choice of seed or in-furrow treatments

All barley crops should be treated with a product that controls powdery mildew. Use of imidacloprid for aphid and mite management has become common and it may affect the choice of fungicide delivery, i.e. growers are more likely to use a seed treatment than in-furrow fungicides.

Current seed treatments for the control of net form of net blotch are effective only for seed-borne inoculum and not for stubble-borne inoculum. The level of control of seed-borne infection is also not complete. Where growers think that they may have a problem with seed-borne infection, it is recommended they have the seed tested by the cereal pathology group at the South Australian Research and Development Institute. [6]

Systiva® (active ingredient fluxapyroxad), a new BASF product, is a seed-applied fungicide that provides longer term control of foliar diseases.

More information

Australian Pesticides and Veterinary Medicines Authority

3.2 Time of sowing

Sowing too early increases the risk of frost damage; sowing too late will increase protein and screenings. [7]Early planting can also increase the risk of net-blotch infection, which requires a timely fungicide program.

Factors to consider with regard to planting time:

- Sowing at the right time is critical for optimising grain yield and can influence grain quality.
- Early planting may increase the frost risk, but early-planted crops have the highest yield potential and are more likely to make malting quality.
- Planting too early can result in the crop running quickly to head if it experiences a warm late autumn or warm early winter; variety choice can be important here.
- Later maturing and shorter stature varieties are preferred for early planting to avoid tall, lush early growth.
- At flowering, barley can tolerate a frost temperature 1°C lower than wheat.
- A frost of –4°C at head-height during flowering can cause 5–30% yield loss; barley is more susceptible than wheat to frost at grainfill.
- A frost of –5°C or lower at head-height can cause 100% yield loss.
- A strongly negative April–May Southern Oscillation Index is a good indicator of late frosts.
- Hot and dry weather during spring can reduce the grainfill period and affect yield and grain size, particularly if night temperatures do not fall below 15°C.

[5] N Fettell, P Bowden, T McNee, N Border (2010) Barley growth & development. PROCROP Series. Industry & Investment NSW/NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/516180/Procrop-barley-growth-and-development.pdf

[6] H Wallwork (2014) Cereal Seed Treatments 2014. SARDI, http://www.naturalresources.sa.gov.au/files/715d15f9-3801-41f4-b30f-a35d00d1df6a/cereal-seed-treatments-for-2014-gen.pdf

[7] P Matthews, D McCaffery, L Jenkins (2015) Winter crop sowing guide 2014. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

- Later planting and later flowering generally result in declining yield potential due to higher temperatures and moisture stress during flowering.[8] [9]

Sowing time determines when a crop matures, and ideally, flowering and grainfill should be in the cooler part of spring. Sowing on time maximises the chances of achieving high yields and malting grade. Sowing after mid-June usually limits yield potential and results in smaller grain and higher protein, rendering the grain less likely to be accepted as malting.

Aim to sow in the earlier part of the indicated optimum time to achieve the maximum potential yield (Table 1). Selection of the actual date should allow for soil fertility and the risk of frost damage in particular paddocks. [10]

Table 1: Barley time of sowing guide.

This table is a guide only and has been compiled from observations of the breeder and local departmental agronomists. >, Earlier than ideal; X, optimum sowing time; <, later than ideal but acceptable

Mallee	April				May				June				July			
Baudin(b, Gairdner, Wimmera(b			>	X	X	X	X	X	<	<						
Commander(b, Compass(b, Fathom(b, Fleet(b, Keel			>	X	X	X	X	X	X	<	<	<				
Buloke(b, Hindmarsh(b, La Trobe(b, Scope(b, Skipper			>	>	X	X	X	X	X	<	<					
Wimmera	**April**				**May**				**June**				**July**			
Flinders(b, Gairdner, GrangeR(b, Navigator(b, Oxford, Wimmera					>	X	X	X	X	X	<	<				
Keel					>	>	X	X	X	X	X	X	X	<	<	
Baudin(b, Fleet(b					>	>	X	X	X	X	X	X	<	<		
Fathom(b, Hindmarsh(b, La Trobe(b, Skipper					>	X	X	X	X	X	X	X	<	<		
Buloke(b, Commander(b, Compass(b, Scope(b							>	X	X	X	X	X	<	<		
North central	**April**				**May**				**June**				**July**			
Flinders(b, Gairdner, GrangeR(b, Navigator(b, Wimmera(b				>	>	X	X	X	X	X	X	<	<			
Fleet(b					>	>	>	X	X	X	X	X	<	<		
Buloke(b, Commander(b, Compass(b, Scope						>	>	X	X	X	X	<	<			
Fathom(b, Hindmarsh(b, La Trobe(b, Skipper					>	X	X	X	X	X	X	X	X	X	<	<
Keel							>	>	X	X	X	X	X	X	<	<
North east	**April**				**May**				**June**				**July**			
Flinders(b, Gairdner, GrangeR(b, Navigator(b, Oxford, Wimmera				>	X	X	X	X	X	X	<	<				
Baudin(b					>	>	X	X	X	X	X	<	<			
Keel						>	>	X	X	X	X	X	X	X	<	<
Buloke(b, Commander(b, Compass(b, Scope(b							>	>	X	X	X	X	<	<		
Fathom(b, Hindmarsh(b, La Trobe(b, Skipper						>	X	X	X	X	X	X	X	<	<	
Fleet(b							>	>	X	X	X	X	X	<	<	

8 DAF Qld (2012) Barley planting, nutrition and harvesting. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

9 DAF Qld (2013) Barley planting and disease guide. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/__data/assets/pdf_file/0018/53019/barley-planting-disease-guide.pdf

10 P Matthews, D McCaffery, L Jenkins (2015) Winter crop sowing guide 2014. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

More information

[GRDC Update Papers: Management effects on barley varieties—nitrogen management and time of sowing]

South West	April				May				June				July			
BaudinⒹ, CapstanⒹ, Gairdner, GrangeRⒹ, NavigatorⒹ, Oxford, WestminsterⒹ, WimmeraⒹ					>	>	X	X	X	X	X	<	<	<		
CommanderⒹ, CompassⒹ, FathomⒹ, FleetⒹ, HindmarshⒹ, La TrobeⒹ							>	>	X	X	X	X	<	<		

FAQ 3.3 Targeted plant population

3.3.1 Seeding rates

Seeding rate is the amount (in kg) of seed needed to plant in order to establish the target plant population. To determine seeding rate you need to know the target plant population, the number of seeds per kg, the germination percentage of the seed and the likely field establishment.

The number of seeds per kg will vary depending on variety and the season in which the seed was produced. To calculate this figure, count the number of seeds in a 20-g sample and multiply by 50. Newer varieties tend to have larger seed and it is important to take note of this when determining planting rate. [11]

Seeding rates that are too high may reduce grain size and increase lodging, especially under irrigation; seeding rates that are too low will reduce yield potential.

Lower rates should be used when there is limited subsoil moisture at sowing, and in drier areas. High seeding rates tend to decrease grain size and increase screenings in barley. [12]

3.3.2 Plant population

Although barley can produce a large number of tillers, best yields will be achieved with an established plant stand of 80–120 plants/m^2. Barley can tolerate quite high plant populations without significant yield reductions; however, if plant populations fall below 80 plants/m^2, yield can be reduced. Lower plant populations can also encourage excess or late tillering, resulting in a less even crop and delayed harvest. Late tillers often have smaller seed, which also affects the quality of the crop.[13]

Plant population is influenced by seeding rate, row spacing and emergence percentage. Target plant populations vary with yield potential, seasonal conditions and sowing date. Current recommendations for southern regions range from 120 to 200 plants/m^2, depending on variety and rainfall zone. When populations fall below 50 plants/m^2, yield is affected. At <30 plants/m^2, the paddock should be resown unless it is undersown with a legume.

Barley is able to compensate for lower-than-ideal plant populations to some degree by increasing tiller numbers. However, targeting plant population at sowing makes the most efficient use of water and nutrients. To reach a target plant population for the environment and seasonal conditions, adjust sowing rates to allow for:

- soil moisture
- sowing date: higher rates with later sowings (tiller capacity is more limited with later sowings)
- seed germination percentage
- seed size

[11] DAF Qld (2012) Barley planting, nutrition and harvesting. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

[12] P Matthews, D McCaffery, L Jenkins (2015) Winter crop sowing guide 2014. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

[13] DAF Qld (2012) Barley planting, nutrition and harvesting. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

- seedbed conditions
- tillage (e.g. increase sowing rate with no-till)
- soil fertility (increase sowing rate with increasing yield potential)
- soil type (e.g. crusting)
- field losses (e.g. increase sowing rate if there is a problem with insects)

Appropriate seeding rates are important in barley for both grain yield and grain quality. Trials at Rankins Springs, New South Wales, in 2005 showed that yield increased with seeding rate up to about 120 plants/m^2 in most varieties, whereas kernel weight decreased with each increase in plant density for all varieties.

Retention also decreased with increases in plant density in all varieties except Buloke⚲, although the decline was only minor in Schooner. The effect of grain shape was evident. Buloke⚲ had the heaviest grains but was intermediate for retention, whereas Baudin⚲ had high retention values and the lowest kernel weights. High seeding rates should be avoided in Gairdner. [14]

3.3.3 Calculating sowing rate

To achieve total ground cover and establish the foundation for maximum yield, a crop density of 120–200 plants/m^2 is needed.

Sowing rate can be calculated by knowing the seed weight, germination percentage and the required plant density. For example, with barley seed with seed weight 4.5 g/100 seeds, germination percentage 95%, and required plant density 170 plants/m^2: sowing rate = 4.5 x (10/95) x 170 = 80.5 kg/ha. [15]

An alternative formula is: sowing rate = (plants/m^2 x 1000-seed weight/100) ÷ (establishment % x germination %)

Crop establishment

Establishment in the field can be affected by a number of factors such as:

- seedbed moisture
- seed–soil contact
- high temperatures
- disease
- soil insects and soilborne diseases
- depth of planting (may be inaccurate or variable)
- certain seed treatments that reduce coleoptile length
- herbicide residues
- germination and vigour of the seed

The impact of poor establishment and seedling vigour will be lessened if seedbed requirements are matched to machinery capabilities and seed quality.

Surface sealing may be a problem if heavy rains fall immediately after sowing and prior to emergence. The emerging shoot is often unable to penetrate the hard surface crust that forms as the soil dries. The problem is more prevalent on soils with declining organic matter, especially red-brown earths and grey clays. Gypsum application may help alleviate this problem on hard-setting clays. [16]

14 N Fettell, P Bowden, T McNee, N Border (2010) Barley growth & development. PROCROP Series. Industry & Investment NSW/NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/516180/Procrop-barley-growth-and-development.pdf

15 Agriculture Victoria (2012) Growing wheat. AG0548. DEDJTR Victoria, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-wheat

16 DAF Qld (2012) Wheat—planting information. Department of Agriculture and Fisheries Queensland, https://www.daf.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/wheat/planting-information

Establishment depends on seedbed conditions, soil moisture, presence of insect pests, and climate. Establishment percentage is the percentage of seed planted that establishes on planting moisture. Establishment may be as high as 95% under ideal conditions, or drop to as low as 40% with rough seedbeds, early planting and limited moisture. [17]

How to measure your plant population

Here is a simple way to check the plant population in your cereal crop.

Cut to size a 1-m length of steel rod or wooden stick. While the crop is still young, preferably no later than day 20 after sowing (to identify individual plants easily), place the 1-m rule along a row and count the number of plants along this row. Do this 10 times at different locations to get a representative count, and calculate the average.

An establishment rate of 70% means that for every 10 seeds planted, only seven will emerge to produce a plant. [18]

More information

[GRDC: Crop placement and row spacing—Southern Fact Sheet]

3.3.4 Row-spacing effects

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

Row spacing is a compromise between:

- ease of stubble handling;
- optimising seedbed utilisation and travel speed;
- managing weed competition and soil throw; and
- achieving effective use of pre-emergent herbicides.

Although row spacing is relatively simple to change, the effect on the whole-farm system can be complex. A change can influence yield, time of sowing, machinery choice and setting, herbicide type, seed costs, and fertiliser type and timing. Using different row spacing for different crop types will influence the types of crops sown and their sequence in the rotation.

Effect on yield

The higher the yield potential, the greater the negative impact of wide rows on cereal yields.

The impact of row spacing on yield varies depending on the growing-season rainfall. In trials in the Victorian Mallee, wide row spacing at 30 cm has been shown to improve yields of wheat and barley slightly where the yield potential is low (<1 t/ha). Other trials on wide row spacing and the effect on yield in cereal crops with low yield potential (1–2.5 t/ha) have been inconclusive.

Generally, increasing row spacing up to 30 cm has no effect on wheat yield when yield potential is <3.5 t/ha. In higher rainfall zones, where yields are >3.5 t/ha, significant yield decreases have been recorded in crops with wider row spaces.

Trials conducted over three consecutive years by Southern Farming Systems near Geelong, Victoria, have shown that row spacing of 40 cm reduced wheat yield by ~6% compared with row spacing of 20 cm.

17 P Keys, AM Bach (2010) Plant population for Queensland. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/wheat/plant-population

18 NSW DPI District Agronomists (2007) *Wheat growth and development*. PROCROP Series, NSW Department of Primary Industries 2007, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/449367/Procrop-wheat-growth-and-development.pdf

3.4 Sowing depth

Barley does not tolerate waterlogging, so good paddock drainage and management are essential for high grain yields. [19]

Pay close attention to sowing depth, particularly when direct-drilling and for varieties with a short coleoptile. The ideal depth is 3–6 cm for sowing into moist soil. If dry sowing is being considered, target a sowing depth of 3–4 cm, particularly on a hard-setting or slumping soil, to avoid problems with crop emergence.

Sowing depth is the key management factor for uniform, rapid emergence and establishment. Sowing depth influences the rate of emergence and the percentage of seedlings that emerge.

Deeper seed placement slows emergence; this is equivalent to sowing later. Seedlings emerging from greater depth are also weaker and tiller poorly. The coleoptile may stop growing before it reaches the soil surface, and the first leaf then emerges from the coleoptile while it is still below the soil surface. The leaf is not adapted to pushing through soil, so it usually buckles and crumples, failing to emerge and eventually dying. [20]

More information

Hart Field Site: Trial results 2013 (pp. 16–19)

A few tips:

- Avoid the shorter coleoptile (dwarf) varieties.
- Avoid seed dressings that contain triadimenol, which can shorten the coleoptile and make emerging from depth more difficult.
- Try to minimise the amount of soil placed back over the top of the planting furrow. [21]

in focus

3.4.1 Barley varieties differ in coleoptile length and emergence from deep sowing[22]

An ability to establish well under a range of seedbed conditions is desirable in cereal varieties. Moisture-seeking, heavy stubble residues, rain between seeding and emergence, and the requirement to avoid soil-applied pre-emergent herbicides can result in the need for plants to establish from a depth greater than ideal. This study measured the emergence of up to 12 Australian barley varieties from three seeding depths in the field in three seasons. The effects of seed size and seed-applied fungicide were also determined.

Deeper seeding reduced the rate and the number of plants emerging, and there were large differences among varieties in final emergence. Emergence was related to coleoptile length and not to plant height. Seed treatment with triadimenol reduced emergence, particularly with deeper seeding, and the size of this reduction differed among varieties. These results emphasise the need to sow at shallow depths when using varieties that have short coleoptiles and to take care with seed grading and the use of seed dressings.

Dubbo Update 2010—seeding depth responses

Twelve barley varieties were sown at three depths (44, 87, and 112 mm of soil above the seed) at Condobolin in 2008, using seed from a common 2007 site. Seed was graded

19 P Matthews, D McCaffery, L Jenkins (2015) Winter crop sowing guide 2014. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/agriculture/broadacre/guides/winter-crop-variety-sowing-guide

20 N Fettell, P Bowden, T McNee, N Border (2010) Barley growth & development. PROCROP Series. Industry & Investment NSW/NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/516180/Procrop-barley-growth-and-development.pdf

21 DAF Qld (2012) Barley planting, nutrition and harvesting. Department of Agriculture and Fisheries Queensland, http://www.daff.qld.gov.au/plants/field-crops-and-pastures/broadacre-field-crops/barley/planting-nutrition-harvesting

22 NA Fettell. Agricultural Research & Advisory Station, Condobolin, University of New England.

into three sizes and was untreated, except for one lot of medium-size seed, which was treated with the higher registered rate of triadimenol. Emergence results are shown in Figure 1.

Deeper sowing reduced emergence in all varieties. At 87 mm, the reduction was greatest for Buloke⟑, Gairdner and Fitzroy⟑ (average 57% emergence) and least for Fleet⟑ and Commander⟑ (73%). At 112 mm, there was a similar pattern, with Buloke⟑, Gairdner, Fitzroy⟑ and Hindmarsh⟑ having the poorest emergence (40%) and Fleet the best (64%). Emergence was related to coleoptile length and not to plant height. Buloke⟑, a tall variety, has a short coleoptile and emerged poorly from depth, whereas Baudin⟑, a semi-dwarf variety, emerged well from depth.

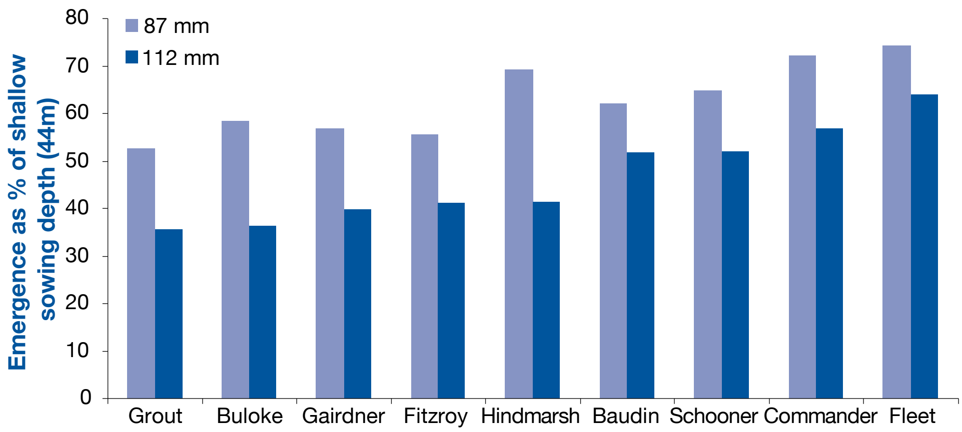

Figure 1: Plant emergence for medium (87 mm) and deep (112 mm) sowing as a percentage of the emergence from shallow (44 mm) sowing, 2008.

The experiment was repeated in 2009, using seed from a common 2008 site, but without the three seed-size treatments. Sowing depths were 52, 77 and 101 mm, and soil moisture content remained high (with no crusting) throughout the establishment period. Emergence results are shown in Figure 2. Deeper sowing reduced emergence in most comparisons, although the reductions were generally less than in 2008, possibly because the sowing depths were more similar. At both 77 and 101 mm, Fleet⟑ showed the least reduction in emergence, followed by Buloke⟑, Commander⟑ and Schooner. Hindmarsh⟑ and Grout⟑ showed the poorest emergence, particularly from 101 mm. The variety responses were generally similar to 2008 with the exception of Buloke⟑, which performed much better in 2010.

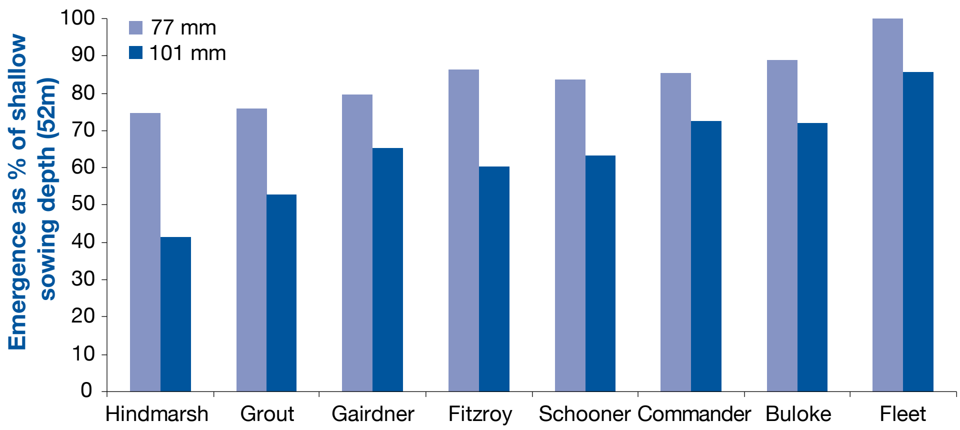

Figure 2: Plant emergence for medium (77 mm) and deep (101 mm) sowing as a percentage of the emergence from shallow (52 mm) sowing, 2009.

Seed treatment with triadimenol suppressed emergence in all varieties in 2008 (Figure 3), particularly at deeper sowing depths, in line with its known effect of shortening coleoptile length. The effect of triadimenol was greatest where varieties with short coleoptiles were sown at 87 or 112 mm, resulting in emergence values only 20-40% of those for untreated seed.

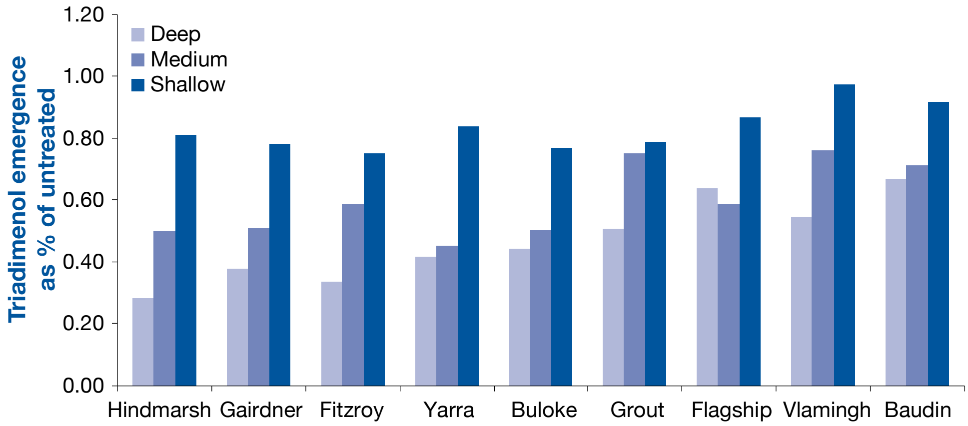

Figure 3: Plant emergence of triadimenol treated seed as a percentage of the emergence of untreated seed, compared at shallow (44 mm), medium (87 mm) and deep (112 mm) sowing in 2008.

Triadimenol also reduced emergence in 2009, but the effect was much smaller than in 2008, particularly with deeper sowing (Figure 4). Averaged over 12 varieties, triadimenol reduced emergence by 11% at the two shallower depths and 19% with deep sowing.

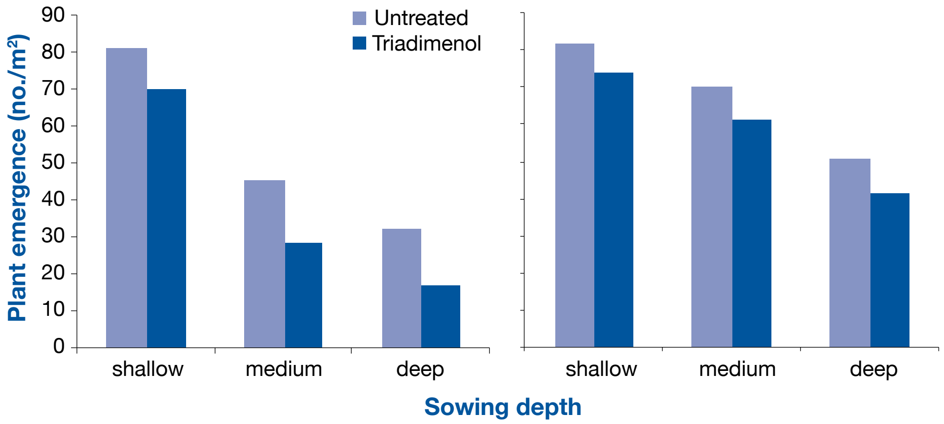

Figure 4: Plant emergence from untreated and triadimenol-treated seed, averaged over 12 varieties, in 2008 (left) and 2009 (right).

3.5 Sowing equipment

During the shift from conventional farming systems to no-till farming systems, the effective use of herbicides has become increasingly important. A well-planned herbicide strategy, in conjunction with non-chemical control methods, can mean the difference between no-till succeeding or not.

Over the past 5–6 years, it has become apparent that the rapid change in farming systems has overtaken farmer knowledge on how to use many herbicides in conservation farming systems. Older, more traditional herbicides that were designed for use in cultivated systems can still be used very effectively in no-till systems; however, they are usually used in a different manner. In addition, many herbicide labels (especially older type or generic herbicides) have the same content now as they did 10–15 years ago. Some products with generic counterparts even have quite different label claims for the same active ingredient. This creates many problems for farmers and agronomists wanting to use these herbicides in modern, no-till farming systems.

Residual herbicides at sowing are very effective for controlling a wide range of weeds, both in-crop and well into the following summer. Some residual herbicides also have valuable knockdown properties. This is very useful because knockdown herbicide options prior to sowing are limited for hard-to-kill weeds.

Knowing the chemistry and mode of action of each herbicide is vital to enabling the best combination of crop safety and weed control. Heavy rainfall just after sowing, when combined with certain soils, can lead to crop damage.

Some herbicides are mobile with soil water, and others are less mobile. Mobility can also change with time for particular herbicides. In the case of Boxer Gold®, the longer it is allowed to bind to soil particles, the less chance there is of the herbicide becoming mobile in the soil. Other herbicides such as Logran® are mobile regardless of binding period.

The incorporated-by-sowing (IBS) application technique appears the safest way of using most residual herbicides, because the seed furrow is left free of high concentrations of herbicide. The soil from that furrow is thrown on the inter-row, where it is needed the most. In-furrow weed control is generally achieved by crop competition and/or small amounts of water-soluble herbicides washing into the seed furrow. For this reason, best results with IBS application are achieved when water-soluble herbicides are used either solely or in conjunction with a less-soluble herbicide.

Because of the furrow created by most no-till seeders, post-sowing pre-emergent (PSPE) applications of many herbicides are not ideal and are usually not supported by labels. The herbicides can concentrate within the seed furrow if washed in by water and/or herbicide-treated soil. For volatile herbicides that need incorporation following application, PSPE is not a viable option.

Tine seeders vary greatly in their ability to incorporate herbicides effectively. There are many tine shapes, angles of entry into the soil, breakout pressures, row spacings and soil surface conditions. Each of these factors causes variability in soil throw, especially when combined with faster sowing speeds (>8 km/h). Consequently, residual herbicide incorporation is variable between seeders. There are therefore no rules of thumb for sowing speed, row spacing and soil throw. You must check each machine in each paddock.

Disc machines show similar variability in their ability to incorporate herbicides. Disc angle, number of discs, disc size, disc shape, sowing speed, closer plates and press-wheels all have an impact on both soil throw and on herbicide-treated soil returning into the seed furrow. Some discs can throw enough soil for incorporation of herbicides such as trifluralin.

In all cases with tines and discs, crop safety is usually enhanced by applying herbicides IBS rather than PSPE.

Knife-points and harrows cause a lot of herbicide-treated soil to return into the seed furrow and they are therefore not preferred for IBS application. Knife-points and press-wheels do a much better job. [23]

Seeder calibration is important for precise seed placement, and seeders need to be checked regularly during sowing.

More information

GRDC Update Papers: Options for using more residual herbicides in northern no-till systems

GRDC Fact Sheets: Stubble management

3.5.1 Using pre-emergent herbicides with different seeding equipment

Seeder design has changed dramatically in recent years, aiming to maximise trash flow and seed placement uniformity while minimising soil disturbance. This has led to increased uptake of knife-point and press-wheel seeders and, more recently, disc seeders.

[23] B Haskins (2010) Residual herbicides at sowing using disc and tyne no till seeding equipment. Riverine Plains, http://riverineplains.com.au/_literature_53801/Residual_Herbicides_-_Barry_Haskins

Each seeder will create a different environment for an establishing crop, and it is essential to understand this before using pre-emergent herbicides. Furthermore, this environment may change with IBS or PSPE incorporation methods. In general, a great deal of difference is achieved for crop safety between seeders in IBS systems, and less difference in PSPE application methods. The PSPE technique relies on uniform seeding depth and flatter seedbeds without pronounced furrows. The focus here is on the IBS method of incorporation, this method being preferred in conservation-farming systems.

Pre-emergent herbicides that are incorporated by sowing require the sowing process to ensure that they are incorporated effectively and that the seed is placed into a micro-environment that allows safe and effective germination. In all cases, the ideal situation is using a knife-point or disc followed by a press-wheel. Press-wheels provide the seed with good soil contact, and minimise the amount of herbicide-treated soil from the inter-row being dragged into the seed furrow. They also allow seeders to pass through stubble without the machine becoming choked with trash. All seeding gear is different, which, in turn, creates varying seedbed conditions.

In tined seeders, variations include:

- angle of tine entry to the soil
- soil-throw
- width and shape of seeding point
- breakout pressure of tine
- depth uniformity across machine
- trash flow ability across machine
- press-wheel size and shape

In disc seeders, variations include:

- ability to penetrate compacted soils
- ability to achieve controlled soil-throw onto the inter-row
- angle of disc entry to the soil
- size, shape and width of disc
- seed placement in furrow, i.e. bottom or side
- closing plates or closing wheels that allow consistent closure of the seed slot without returning herbicide-treated soil onto the seed
- depth gauge wheel placement and size
- press-wheel angle, size and shape

Other factors not associated with the type of seeding system also influence seedbed conditions. These include soil type, soil moisture, soil compaction, row spacings, seeding depth and sowing speed.

There is no rule-of-thumb for soil throw, row spacing and sowing speed because of the variability discussed above. The only way to check for adequate soil throw is to check every scenario.

The suitability for pre-emergent herbicides in both tine- and disc-seeding systems has attracted much research over the past few years. Unfortunately, many herbicide labels will not support the use of some pre-emergent herbicides with disc seeders because of the greater risk of crop damage arising from the varying machine designs that form very different seedbed conditions.

Irrespective of the disc seeder, research in southern New South Wales has clearly shown that a well set-up tine seeder will offer greater crop safety than a well set-up disc seeder. This is mostly because a knife-point and press-wheel will place more soil on the inter-row, minimising the amount of herbicide-treated soil washing into the seed furrow. Soil-throw in tines is also better controlled, resulting in less herbicide-treated soil in a typically wider furrow.

As shown in Figure 5, this research has also demonstrated that some herbicides and rates of a particular herbicide are better suited to a disc-seeder system than are others. This is usually correlated with how a seedling metabolises a particular herbicide if they contact each another. Figure 5 demonstrates that trifluralin at higher rates is not suited to disc-seeding systems, because crop vigour may be adversely affected. [24]

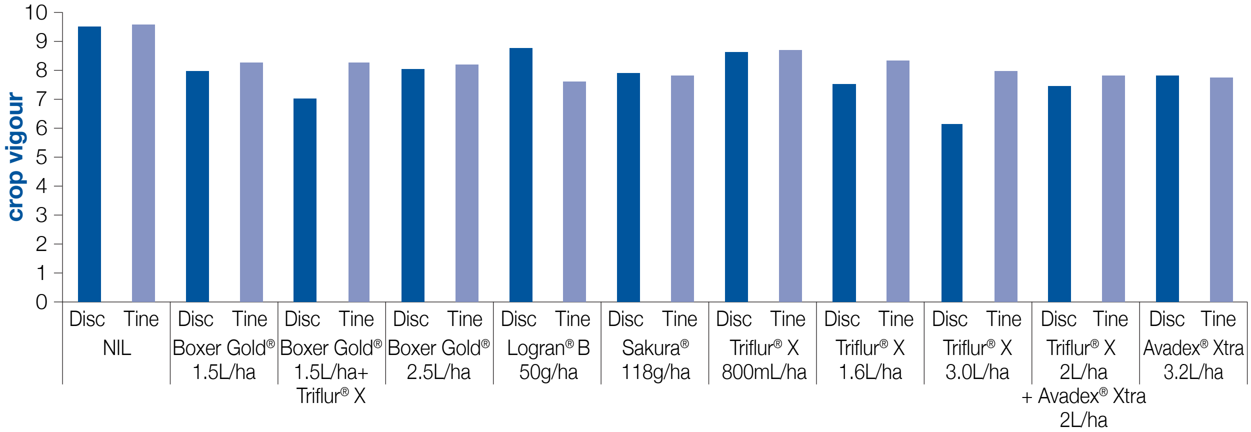

Figure 5: Difference in crop safety between discs and tines across a number of commonly used, pre-emergent herbicides in trials held across southern and central NSW. Various disc and tine seeders were used for these trials. 0, No crop vigour; 10, vigorous crop.

[24] B Haskins (2012) Using pre-emergent herbicide herbicides in conservation farming systems. NSW Department of Primary Industries, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0003/431247/Using-pre-emergent-herbicides-in-conservation-farming-systems.pdf