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GRDC GROWNOTES™

GRDC™ GRAINS RESEARCH & DEVELOPMENT CORPORATION

TRITICALE

SECTION 3

PLANTING

SEED TREATMENTS | TIME OF SOWING | TARGETED PLANT POPULATION | CALCULATING SEED REQUIREMENTS | SOWING DEPTH | SOWING EQUIPMENT

Planting

Key messages:

- Triticale is not usually prone to infection from smuts and bunt. However, it is good insurance to apply a seed dressing to the grain when it is being graded.
- Triticale is generally sown at much the same time as other cereals. Optimal temperature for germination in triticale is 20°C.
- Triticale is more easily damaged by frost damage than wheat, so sowing should be planned to achieve flowering outside of the frost window if the crop is for grain only. Forage crops should be sown earlier when autumn moisture is adequate where grazing can help mitigate frost risk.
- Aim to achieve the same plant populations as for wheat; i.e. set the seeder 25–40% above the setting recommended for wheat, as triticale grain is larger.
- Depending on seed size, triticale should be sown at a seeding rate of 60–100 kg/ha (for grain only), 100–120 kg/ha (grain and grazing).
- The recommended sowing depth for triticale is 2–5 cm.

Most cultural practices needed for growing triticale can be taken directly from wheat. These include:

- managing for seedbed preparation
- seeding rate
- seeding depth
- seeding date
- seeding methods [1]

3.1 Seed treatments

Fungicidal seed treatments are applied to triticale seeds to protect the crop from seed-borne diseases such as smuts, bunts and rusts, and also to control insects. Triticale is not usually prone to infection from smuts and bunt. However, it is good insurance to apply a seed dressing to the grain when it is being graded. Stripe rust may be a problem in some triticale varieties, so it is advantageous to treat seeds to provide seedling protection against this rust in high risk areas. [2]

Fungicidal seed dressings treatment should form an integral part of the triticale disease-management program. What products are used will vary with variety and sowing time. Seek local advice. [3]

When treating seed, always read the chemical label and calibrate the applicator. Seed treatments work best when they are used in conjunction with other disease-management practices such as crop and paddock rotation, using only clean seed, controlling the 'green bridge' in the paddock and planting resistant varieties. This is especially important when managing diseases such as stripe rust.

3.1.1 Emergence problems

there are risks with using seed treatments. Research shows that some can delay emergence by:

- Slowing the rate of germination.
- Shortening the length of the coleoptile, the first leaf and the sub-crown internode.

1 Alberta Agriculture and Forestry (2016) Triticale crop production. Revised. Alberta Agriculture and Forestry, http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/fcd10571

2 Agriculture Victoria (2012) Growing triticale. Note AG0497. Revised. Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-triticale

3 Waratah Seed Company (2010) Triticale: planting guide. Waratah Seed Company, http://www.porkcrc.com.au/1A-102_Triticale_Guide_Final_Fact_Sheets.pdf

MORE INFORMATION

Cereal seed treatments 2018

A delay in emergence due to decreased vigour increases the exposure of seeds to pre-emergent attack by pests and pathogens, or to soil crusting, hostile soil temperatures, and potential damage from some pre-emergent herbicides such as Trifluralin of chlorsulfuron (Glean), which can also reduce the coleoptile length; these may lead to a failure to emerge at all. The risk of this occurring increases when seed is sown too deeply or into a poor seedbed, especially in varieties with shorter coleoptiles. As the amount of certain fungicides increases, the rate of germination slows; e.g. triazoles can cause a lot of damage to emerging crops.

Product registrations change over time, and products containing the same active ingredient may have different registration details in different states. Therefore, before using any chemical, always check the registration status for the way you intend to use it in your state; this is usually on the current product label. [4]

Sowing too deep is a common cause of emergence problems. The coleoptile, which surrounds the first leaf until the shoot emerges, protects and guides the shoot as it grows through the soil. If seed is sown deeper than the length of the coleoptile the plant can fail to emerge (Figure 1). Because coleoptile lengths vary from one variety to another, some varieties can tolerate deeper sowing. Coleoptile lengths also vary greatly from one batch of seed to another; in fact, the source of seed is often more critical than the variety in determining coleoptile length. [5]

Coleoptile length is influenced by seed size and several other factors, including variety, temperature, low soil water and certain seed dressings, such as those with the active ingredient triadimenol or flutriafol. Trifluralin and several Group B pre-emergent chemicals can also affect coleoptile length. Growers should read the label when using any seed-dressing fungicide for cereals, in order to see what affect it may have on coleoptile length. [6]

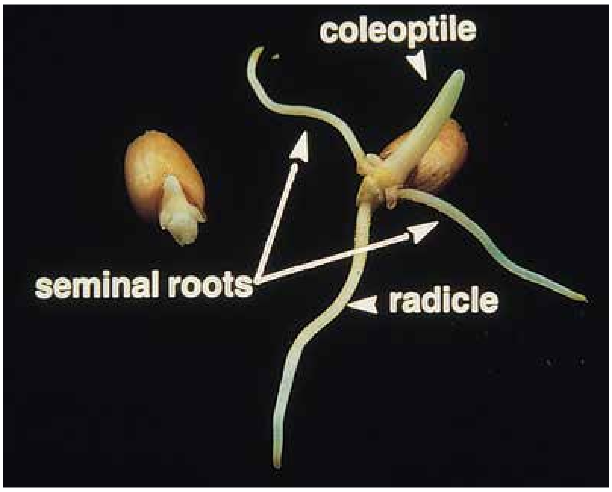

Photo 1: *A larger seed will sprout a longer coleoptile, which is useful if for deeper planting allowing access to soil moisture in a dry season.*

Photo: David L. Hansen, University of Minnesota

3.1.2 Fertiliser at seeding

The amount of nitrogen that can be safely placed alongside seed when planting will vary depending on the soil texture, the amount of seedbed utilisation, and moisture conditions. Higher amounts of nitrogen can be applied with the seed if it is a polymerised form of urea, where the nitrogen is released over several weeks. If soil moisture is marginal for germination, high rates of fertiliser should not be placed with

4 NSW DPI District Agronomists (2008) Wheat growth and development. Procrop Series. NSW DPI, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/449367/Procrop-wheat-growth-and-development.pdf

5 H Wallwork (2017) Cereal seed treatments 2016. SARDI, http://pir.sa.gov.au/__data/assets/pdf_file/0005/237920/_final_web_CerealSeed_Treatments_2017-18_booklet.pdf

6 J Pumpa, P Martin, F McCrae, N Coombes (2013) Coleoptile length of wheat varieties. NSW DPI, http://www.dpi.nsw.gov.au/agriculture/broadacre-crops/winter-crops/wheat,-barley-and-other-winter-cereals/coleoptile-length

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VIDEOS

WATCH: GCTV Extension Files: Wheat sowing strategies

WATCH: GCTV Extension Files: Early sowing opportunities

WATCH: Early sowing in the LRZ

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the seed. Both nitrogen and phosphorous can be banded before seeding, but take care to avoid loss of seedbed moisture and protective crop residue.

Place phosphorous with or near the seed at seeding time, or band before seeding. [7]

For more information, see Section 2.3.4 Safe rates of fertiliser to sow with seed.

3.2 Time of sowing

Key points:

- Early sowing can accelerate establishment and allow the crop to make full use of the growing season, but it can increase the risk of frost during critical growth stages and the risk of haying off in a dry finish.
- The flowering time of triticale is controlled by the interaction of several factors that can include temperature, day length, and the variety's need for cold temperatures.
- Most Australian triticale varieties flower in response to the accumulation of warm temperatures. Many varieties also have a cold-temperature requirement (vernalisation), and some varieties flower in response to longer days.
- Winter triticale can be sown earlier than spring triticale in suitable regions, as their 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 nutrient management. [8]

Triticale is generally sown at much the same time as other cereals. The optimum time of sowing depends largely on the variety being grown and the use of the crop; i.e. forage or grain (Table 1). [9]

Acting promptly when a sowing window is available has been proven to be critical to farming success over many seasons. Delayed sowing has generally shown to be costly, although to sow very early increases frost risk in some varieties . Dry sowing for a portion of the crop has been very successful, and can be considered for triticale (as well as other cereals). [10]

Long-season varieties such as Endeavour⍉ and Tobruk⍉ can be sown as early as mid-February if good rains allow and soil temperatures are not too high. Tobruk⍉ should only be sown this early if it is going to be grazed. Main-season varieties such as the traditional Tahara and Berkshire⍉ and the newer varieties of Astute⍉ and Chopper⍉, should be sown at the same time as main-season wheat, during May and early June.

In a study comparing the tolerance of cereal seeds to a range of temperatures, triticale was found to be more sensitive than wheat and barley to germination temperature. [11] Very low temperatures can damage triticale seedling during germination and emergence (Figure 3). [12]

Table 1: *Suggested sowing times for triticale in NSW, 2017.*

uary	March	April	May	June	July

7 Alberta Agriculture and Forestry (2016) Fall rye production. Agdex 117/20–1. Revised. Alberta Government, http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1269/$file/117_20-1.pdf

8 GRDC (2011) Time of sowing. Factsheet. GRDC, https://grdc.com.au/resources-and-publications/all-publications/factsheets/2011/03/time-of-sowing

9 P Matthews, D McCaffery, L Jenkins (2016) Winter crop variety sowing guide 2016. NSW DPI, https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/winter-crop-variety-sowing-guide

10 Agriculture Victoria (2012) Growing triticale. Note AG0497. Revised. Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-triticale

11 T Buraas, H Skinnes (1985) Development of seed dormancy in barley, wheat and triticale under controlled conditions. Acta Agriculturae Scandinavica, 35 (3), 233–244.

12 Alberta Agriculture and Forestry (2016) Triticale crop production. Revised. Alberta Agriculture and Forestry, http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/fcd10571

Variety Weeks	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2
Endeavourⓓ	>	★	★	★	★	★	★	★	<	<										
Cartwheel		>	★	★	★	★	★	★	<	<										
Tobrukⓓ▲		>	★	★	★	★	★	★	★	★	★	★	★	★	<					
Crackerjack 2						>	★	★	★	★	★	<	<							
Tuckerbox									>	★	★	★	★	★	★	<				
Yowie										>	★	★	★	★	★	<				
Astuteⓓ, Berkshireⓓ▲, Bison, Fusion, Goanna, Hawkeye, Rufus▲, Tahara▲											>	★	★	★	★	★	<			
Chopperⓓ▲, KM10												>	>	★	★	★	★	★	<	<

Aim to sow in the earlier part of the optimum time indicated to achieve maximum potential yield, particularly in western areas. Soil moisture, soil fertility and the likelihood of frost in a particular paddock at flowering influence the actual sowing date.
> Earlier than ideal, but acceptable.
★ Optimum sowing time.
< Later than ideal, but acceptable.
▲ Outclassed.

Source: NSW DPI

MORE INFORMATION

GRDC factsheet, Time of sowing, Northern Region

3.3 Targeted plant population

Key points:

- Know the germination percentage of the triticale seed to be sown.
- Plant a higher sowing rate of triticale seed than when planting wheat. This is because triticale has larger seeds than does wheat; in fact, it has the largest seed of the common small-grained cereals.
- Adjust seeding rates to achieve targeted plant densities for specific triticale uses and conditions.
- Keep in mind that optimum seeding rates vary depending on what the triticale will be used for.
- For mono-crop triticale forage production, recommended seeding rates are usually 25% higher than for grain production. [13]

The plant population, which is determined by seeding rate and establishment percentage, can be an important determinant of tiller density and, later, head density. [14] Target plant densities should reflect the tillering capacity of the variety. For example, to achieve target tiller numbers, varieties that don't tiller much should be sown at higher plant densities than those that grow a lot of tillers (Photo 2). Target tiller numbers relate to the number of tillers that can be sustained to produce optimum yields. These often relate to rainfall, e.g. target tiller number for 500 mm rainfall zone is approximately 500 tillers/m^2.

Seed size influences plant density, too, with large seeds requiring a higher sowing rate than smaller seeds in order to target the same population. It should be determined for each seed lot, as results vary depending on how old the seed is and conditions it has been grown under. [15]

13 Alberta Agriculture and Forestry (2016) Triticale crop production. Revised. Alberta Agriculture and Forestry, http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/fcd10571

14 G Butler, W Manning, L Serafin (2003) Population density studies in sorghum and wheat. GRDC Update Paper. GRDC, http://www.grdc.com.au/Research-and-Development/GRDC-Update-Papers/2003/09/Population-density-studies-in-sorghum-and-wheat

15 K Condon (2003) Targeting optimum plant numbers. Agnote DPI-431. NSW DPI, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/168523/targeting-optimum-plant-numbers.pdf

Photo 2: *Triticale paddock sown according to targeted plant population.*

Source: Midwest Cover Crops Council

The range of sowing rates varies with variety and end use (Table 2).

Triticale sown for grazing should be sown at a seeding rate to obtain 150 plants/m^2 (100–120 kg/ha), which is the same as grazing wheat. Grain-only triticale target population can be reduced to 100–120 plants/m^2 (60–100 kg/ha), as for main-season grain-only wheat.

When sowing triticale as a cover crop (i.e. under-sown with pasture) reduce seeding rate to approximately 10–20% of normal, targeting 15–30 kg/ha. [16]

Table 2: *Recommended plant populations for different uses of triticale.*

Purpose or growing conditions	Best sowing rate (kg/ha)
Grain only	60–100
Grain and grazing	100–120
Under-sowing pastures	15–30
Irrigation, high rainfall	100–120

Source: NSW DPI

The target plant population for triticale will also vary according to rainfall (Table 3). [17] Aim to achieve the same plant populations as for wheat; i.e. set the seeder 25–40% above the setting recommended for wheat as triticale grain is larger than wheat grain (23,000 seeds/kg). [18]

Average graded seed sizes are:

- large, 24,000 seeds/kg
- medium, 27,500 seeds/kg
- small, 30,000 seeds/kg

16 Waratah Seed Company (2010) Triticale: planting guide. Waratah Seed Company, http://www.porkcrc.com.au/1A-102_Triticale_Guide_Final_Fact_Sheets.pdf

17 N Poole (2005) Cereal growth stages. GRDC, https://www.researchgate.net/file.PostFileLoader.html?id=5780fa6bf7b67e860b4def31&assetKey=AS%3A381929540079624%401468070506798

18 Birchip Cropping Group (2004) Triticale agronomy 2004. Online Farm Trials, http://www.farmtrials.com.au/trial/13801

Target plant numbers to account for differences in tillering capacity. Triticale does not tiller well. The desired plant density for triticale is 150 plants/m^2, and up to 200 plants/m^2 in high rainfall zones. Depending on seed size this equates to a seeding rate of 60–100 kg/ha. If sowing is delayed, or when sowing on light sandy soils, plant at the higher plant density. [19]

Lower seeding rates may be suitable for dry conditions. Triticale has greater difficulty in compensating for low stand establishment. Use grower experience and local agronomist feedback to adjust plant density targets to local conditions. [20]

Table 3: *Plant-establishment densities for triticale.*

Average rainfall (mm)	250–350	350–450	450–550
Planting populations (plants/m^2)	160–180	180–200	200–220

Source: GRDC

Despite the ability to compensate, targeting a variety's optimum plant density 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:

- sowing date—higher rates with later sowings
- seed germination percentage
- seed size
- seedbed conditions
- type of tillage, e.g. no-till
- soil fertility
- soil type
- soil moisture and seasonal outlook
- weed-seed burden—higher sowing rates for increased plant competition, e.g. if combatting herbicide-resistant ryegrass populations. [21]
- whether the crop is going to be undersown or not.

3.4 Calculating seed requirements

- Key points:
- Choose and manage seeding rates to achieve target plant stand densities in the field.
- Alter sowing rates to account for target population, seed size and germination. [22]
- Rates are usually adjusted upwards for forage crops and downwards when undersowing triticale

It is best to calculate the seeding rate using target plant population, germination percentage and seed count per kilogram, which are available on the seed analysis certificate that is available when you purchase the seed. [23]

For information on seed quality testing, see Section 2: Pre-planting.

The following formula (Figure 1) can be used to calculate sowing rates, taking into account:

19 Agriculture Victoria (2012) Growing triticale. Note AG0497. Revised. Agriculture Victoria, http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-triticale

20 Alberta Agriculture and Forestry (2016) Triticale crop production. Revised. Alberta Agriculture and Forestry, http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/fcd10571

21 NSW DPI District Agronomists (2007) Wheat growth and development. Procrop Series. NSW DPI, https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/449367/Procrop-wheat-growth-and-development.pdf

22 K Condon (2003) Targeting optimum plant numbers. Agnote DPI-431. NSW DPI, http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/168523/targeting-optimum-plant-numbers.pdf

23 Waratah Seed Company (2010) Triticale: planting guide. Waratah Seed Company, http://www.porkcrc.com.au/1A-102_Triticale_Guide_Final_Fact_Sheets.pdf

- target plant density
- germination percentage
- seed size
- establishment, usually 80%, unless sowing into adverse conditions.

To calculate 1,000-seed weight:

- count out 200 seeds
- weigh to at least the nearest 0.1 g
- multiply weight (g) by 5 [24]

Example

1000 seed weight (grams) ___35___ X target plant population (/m²) ___140___ X 100 ÷ establishment % X germination % ___80 X 90___

= Your seedling rate ___68___ kg/ha

Your calculation

1000 seed weight (grams) ______ X target plant population (/m²) ______ X 100 ÷ establishment % X germination % ______

= Your seedling rate ______ kg/ha

Figure 1: *Seeding-rate calculator.*

3.5 Sowing depth

Optimum planting depth varies with planting moisture, soil type, seasonal conditions, climatic conditions, and the rate at which the seedbed dries. The general rule is to plant as shallow as possible, provided the seed is placed in the moisture zone, but deep enough that the drying front will not reach the seedling roots before leaf emergence, or to separate the seed from any pre-emergent herbicides used. [25]

Recommended sowing depth for triticale is 2–5 cm. [26]

Because triticale seed is generally bigger than other small-grain cereals, it can be seeded deeper than them. This allows to take advantage of moisture stored in the soil, which allows better crop establishment early in the season, particularly in drought-prone areas

Seed placement during sowing is very important when dealing with triticale cultivars. Triticale varieties equal and in many cases exceed the winter hardiness of the best wheats if planted early during autumn. At this depth crops should see uniform seedling emergence and early weed competition. [27] Shallow seeding also encourages early vigour.

24 P Matthews, D McCaffery, L Jenkins (2016) Winter crop variety sowing guide 2016. NSW DPI, https://www.dpi.nsw.gov.au/agriculture/broadacre-crops/guides/publications/winter-crop-variety-sowing-guide

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

26 DAFWA (2015) Monitoring sowing depth. DAFWA, https://www.agric.wa.gov.au/mycrop/monitoring-sowing-depth

27 M Mergoum, H Gómez-Macpherson (eds) (2004) Triticale improvement and production. FAO Plant Production and Protection Paper No. 179. Food and Agriculture Organisation, http://www.fao.org/docrep/009/y5553e/y5553e00.htm

Planting too deep is equivalent to sowing later. It usually results in decreased emergence, less plant vigour, [28] fewer tillers (Photo 3), [29] and greater susceptibility to diseases.

Photo 3: *Reduced vigour comes with increased sowing depth.*

Source: DAFWA

Crop emergence is reduced with deeper sowing because the coleoptile may stop growing before it reaches the soil surface, with the first leaf emerging from the coleoptile while it is still below the soil surface. As it is not adapted to pushing through soil (and does not know which way is up), the leaf usually buckles and crumples, failing to emerge and eventually dying. [30]

For more information, see Section 4: Plant growth and physiology.

3.6 Sowing equipment

As much as 60% of the final yield potential for a cereal crop is determined at planting. Seeding too thinly, using poor quality seed, and uneven stands result in end-of-season yield losses that cannot usually be overcome.

Choosing a seeding system suited to growers' specific needs can have significant benefits in crop performance. Getting the seeder set-up right is critical for rapid seed germination, uniform crop emergence and good early vigour. Due to the diverse nature of soils and climatic conditions there is no one-size-fits-all solution.

As part of the GRDC stubble initiative, Mallee Sustainable Farming and Dr Desbiolles have compiled dedicated guidelines on seeder technologies including a simple

28 Alberta Agriculture and Forestry (2016). Triticale crop production. Revised. Alberta Agriculture and Forestry, http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/fcd10571

29 DAFWA (2015) Monitoring sowing depth. DAFWA, https://www.agric.wa.gov.au/mycrop/monitoring-sowing-depth

30 NSW DPI Agronomists (2007) Wheat growth and development. Procrop Series. NSW DPI, https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0006/449367/Procrop-wheat-growth-and-development.pdf

table to assist grain growers in selecting the right seeding configuration for their situation (Table 4).

Table 4: *Seeder set up guide.*

	Seeder options	Stony soils	Non-wetting gutless sands	Rhizoctonia pressure	Marginal moisture	High residue	Pre-emergent herbicide (IBS)	Notes
Seeder operation	Deep-till sowing	××	✓ If backfill is not diluted	✓✓	✓ If backfill is not diluted	o	o	For sub-seed disturbance, moisture seeking. Note: tillage depth to suit seed row spacing
Seeder operation	High speed sowing (TINES)	××	✓	✓	✓	✓	✓	High speed tine sowing possible with controlled soil throw not affecting adjacent seed rows
Seeder operation	High speed sow- ing (DISCS)	××	✓ If clearing of top soil improved	✓ If disc penetration maintained	✓ If seed placed in moisture	✓ If hair-pinning not an issue	✓✓ To improve incorporation	Maximum speed to suit paddock conditions and seeder technology
Seeder operation	Inter-row sowing	o	× In non-wetting sand	✓✓	✓✓	✓✓	✓✓	RTK required with good seeder tracking capability and straight stubble rows
Seeder operation	On-row or near-row sowing	✓	✓✓ In non-wetting sand	××	✓	××	× High risk for crop damage	
Furrow opener	Narrow point	× Esp. for paddock roughness	✓✓	✓✓	✓ If seeking moisture delving	✓ If good residue management	✓✓	Tine seeders remain the mainstream technology in the Mallee
Furrow opener	Single disc	✓✓	✓ If high soil disturbance	× Esp. with low soil disturbance	✓ If moisture seeking capable	✓✓	× Only with best practice	Best practice paddock management improves the potential of disc seeders
Furrow opener	Triple disc	✓✓	✓✓	✓ With best management	✓	✓✓	✓ With higher disturbance	

	Seeder options	Stony soils	Non-wetting gutless sands	Rhizoctonia pressure	Marginal moisture	High residue	Pre-emergent herbicide (IBS)	Notes
Seed placement	Centre row banding	✓✓	✓✓ Esp. with seeding at tillage depth	✓✓ Esp. with deep till furrows	✓ If seeds are placed into moisture	✓✓ Esp. if inter-row sowing	✓✓	Easiest to match with low soil disturbance and water harvesting furrows
	Paired row banding or band seeding	✓ If contact and extra disturbance is minimised	✓ Esp. with seeding at tillage depth	✓ If coupled with best rhizoctonia management	✓✓ If seeds placed on undisturbed soil	✓ If good residue management	✓✓	Improved soil/seed contact on undisturbed soil base
	Side banding	✓ If tillage depth is minimised	✓ If seeds are placed into moisture	✓ If coupled with best rhizoctonia management	✓✓	✓ If good residue management	✓✓	Improved soil/seed contact on undisturbed side ledge
Fertiliser placement	With seeds	✓ Subject to SBU threshold for toxicity	× Unless wetting is sufficient	o	××	o	o	Note: Increased fertiliser toxicity risks in low moisture environment
	Deep or split banded	✓ If tillage depth is minimised	✓✓	✓✓	✓✓	o	o	Deep banding often requires deep-tilled furrows
Furrow closing	Press wheels	✓ If hard rubber tyres	✓✓ Esp. if very wide tyre and wetting agent	o	✓✓	✓✓	o	Soil to seed contact and water harvesting furrow benefits
	Rotary harrows	×	××	o	✓ Esp. Following press wheels	✓ For spreading clumps	× Unless safe to do so	Equalising soil throw and residue clumps
	Seed pressing & loose cover	✓ Subject to durability	✓	o	✓✓	o	✓ If control over row contamination of herbicide	Insulation of furrow moisture under loose cover. This option preferred for compaction sensitive, weak textured soils

Key: ×× not recommended at all; × avoid if possible; ✓ possible under conditions; ✓✓ recommended; o no direct issue either way

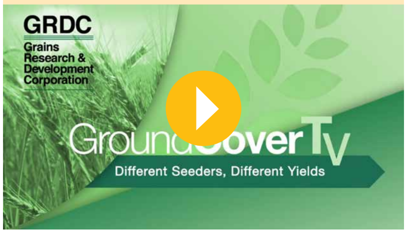
Source: Mallee Sustainable Farming).

3.6.1 Air seeders

An air seeder is a planter which has planting tynes mounted on a heavy duty frame, a central pneumatic seed and fertiliser delivery system, and a ground opener for seed and/or fertiliser placement (Photo 4). In most cases the sowing tyne will be followed by a press wheel that This method drags a tyne or knife-point through the soil and drop seeds in behind it with a press wheel at the back closing it up. The press wheel helps to cover the seed and aid with seed-soil contact.

VIDEOS

WATCH: GCTV19: Different seeders, different yields. Local R&D—valuable solutions for the HRZ grain growers



This system offers many options and adaptations to meet a variety of conditions. The planter's main frame is carried on and controlled by wheels inside the frame. The attitude (fore - aft) levelling is controlled by caster wheels in front of the frame (floating hitch type).

This method of depth control is superior on land with sharp hills or gullies. When the ground opener type is chosen, the appropriate seed row finishing equipment must be installed on the rear of the air seeder.

Photo 4: *A New Holland T9 tractor with a Case Flexicoil PTX 600 airseeder bar towing a Flexi-Coil 3850 air cart bin used to sow cereal seed.*

Source: GRDC.

3.6.2 Disc seeder

No-till farming has brought new thinking to cropping and figuring out ways to sow into the stubble left from the previous crop has seen farmers turn to disc seeders.

In disc seeding, a metal disc rolls along the ground, cutting open a furrow like a pizza cutter, with a press wheel following behind to press soil back into the slot (Photo 5).

Photo 5: *A John Deere Disc seeder.*

Source: GRDC.

Unlike air seeders, where straw and chaff are moved to the side as the openers and shanks pass through, the openers on disc drills must cut through crop residue. This allows disc seeders to handle much greater stubble loads than air seeders, which is a major advantage. Disc seeders leave the soil undisturbed and the soil surface relatively flat and free from deep furrows.

Disc drills cut through straw and anchored stubble does not usually cause plugging problems. Therefore, excessive crop residues create problems for disc drills by interfering with disc penetration into the soil and causing 'hairpinning' (forcing of uncut straw or chaff into the opener furrow). When hairpinning occurs, the straw and chaff 'pop-up' after the drill passes leaving the seed on the soil surface. Cutting coulters in front of the openers, residue manager or row cleaner attachments, down pressure on the discs, opener design, and sharpness of the discs all influence soil penetration and the ability of disc drills to cut through crop residues.

While Disc seeders can handle greater quantities of stubble, they can experience issues with pre-emergent chemicals and subsequent crop damage.

MORE INFORMATION

Disc seeders under the microscope

Bentleg opener seeding research

3.6.3 Disc seeders versus tyne seeders

In most cases, discs are better able to handle stubble, but tynes still have a strong following for a variety of reasons. The upshot is that no two farms are the same. Soil conditions, prevailing weather and farming preferences mean there are literally hundreds of different seeder setups, but there are some general rules of thumb (Table 5). [31]

Table 5: *Comparisons between Disc and tyne seeders.*

Factor	Disc seeders	Tyne seeders
Seeding	In ideal conditions, where the ground is firm but not compacted, a disc machine will achieve more consistent seed depth thanks to better contour following with the close vicinity of a depth gauge wheel. The disc cuts open a narrow slot and the seed is placed at the bottom against the wall, helping it achieve better germination. In less-than-perfect conditions, such as sticky mud and soft, sandy soils, discs are not so effective.	In less-than-ideal soil conditions a tyned seeder is capable of achieving consistent results. There is a much greater margin for error and in no-till seeding, tyned machines are widely used. Advancing tyne seeder technology is achieving similar results to discs in seed placement. Tynes are also better at incorporating pre-emergent herbicides and controlling grass weeds.
Sowing in stubble	Zero-till farming is the main driver behind disc seeder technology with a disc able to either cut through the stubble and trash or avoid it altogether as it creates a furrow. The challenge for discs is that they need to penetrate the soil and trash so the seed isn't just dropped on top, so the seeders can be much heavier and discs need to be kept sharp. They also don't work so well in soft, sandy soils or wet conditions where stubble stems can fold around the disc and be pushed into the furrow, an occurrence known as hairpinning, which restricts seed germination.	Tynes are not as good at getting through heavy stubble where length and quantity can cause it to clump up on the tyne, which leads to blockages. The operator then has to stop and lift the seeder to clear the blockage, then turn around to try to pass through that section again which can mean uneven seeding. Some areas will not be sown and full of weeds while another will be overseeded which leads to clumps of straw.

31 J Law (2016) Disc seeders versus tyne seeders. The Weekly Times. http://www.weeklytimesnow.com.au/machine/crop-gear/disc-seeders-versus-tyne-seeders/news-story/773acc05475aa4d6bbb5a3622d23f444

Factor	Disc seeders	Tyne seeders
Soil Disturbance	Generally speaking, discs have less soil disturbance because the channel they cut through the soil can be as narrow as the thickness of the metal, so in situations where low disturbance is desirable, better results will be achieved. Less soil disturbance also means closer row spacings because there is little impact on neighbouring rows. However, discs can also be configured to achieve more disturbance, if that's what's desired, by setting them at an angle or doubling them up.	Dragging what is effectively a metal stake through the ground will disturb the soil and on average a tyne will throw more out each side meaning you can't have your rows too close together. However, tyne design is also advancing to reduce the amount of soil throw. They are also effective at cutting through compacted soil making them good for farmers who don't use controlled traffic farming. Tynes don't require as heavy a frame as a disc seeder to get through compacted ground.
Wear and damage	A disc is mounted on bearings that can wear quickly in rougher ground and the disc itself will lose its edge. A disc seeder module is also more complex than a tyne setup, so there is more that needs monitoring. However, on rocky ground, the disc rolls over the stone rather than dig it up, which reduces impact and will achieve better seeding.	The knife point on a tyne also wears, but not as quickly and will still work effectively even when it's worn. They're also easier to replace. Breakout systems, which cause the tyne to flick up when a rock is hit, also help to reduce damage, although this can cause the seed to be scattered out the back. Hydraulic breakouts reduce this effect.
Cost	A disc seeder will be more expensive to purchase than a comparable tyned machine. The frames are heavier, the seeder modules more complex with rollers, gauge wheels and other contour-following technology. These costs are offset by the reduced amount of power (about 2hp per row less than a tyned seeder) needed to haul a disc seeder and the speed at which it can operate.	There is less complexity in a tyned machine so they are by nature much cheaper. They are easier to maintain, wearing parts such as knife points are cheaper to replace and manufacturers are happier to provide warranty on their machines. Some tyned machine makers also offer disc kits so a farmer can swap systems depending on conditions to make it a cost-effective best of both worlds.

Source: The Weekly Times.

MORE INFORMATION

Disc v tyne seeder demonstration Illabo 2013

Making the change from tyne to disc

The following tips have been developed to support growers making the transition:

- Sow dry/early to overcome stickiness in clay soils: the more residue the less this will be a problem.
- Harvest management is critical: residues need to be spread uniformly so discs cut through an even layer of chaff.
- Harvest cereals short, before using the disc for the first time to help with residue flow.
- In the first year using a disc system, sow deep, as the gauge wheel could ride high on the old tyne furrow.
- Row cleaners may be needed to level the ridges and furrows for your disc and gauge wheel. Consider a once-off harrowing or prickle chain to level paddocks to ease the transition from tyne to disc. Level paddocks are critical for good seed placement.
- If wet, wait until conditions dry a little for disc sowing.

- Consult your agronomist regarding pre-emergent herbicides. Also note that you cannot band urea when using discs.
- Standing stubble is better. Once you have mastered using discs, aim to cut stubble as high as possible (consider a stripper front). [32]

3.6.4 Setting up and calibrating the seeder

Seeder levelling

To ensure that all tynes are sowing at the same depth, adjust the machine on a level surface.

Coulter alignment

Pull the machine into the ground to check alignment. If alignment is out, raise the machine, slightly loosen the nuts on the coulter assembly and reposition using a straight-edge and a heavy hammer. Recheck in the ground. The next four adjustments must be made in the paddock after you have run the machine at the speed at which you propose to sow.

Tyne tension

Correct tension allows the tyne to vibrate, creating loose soil (tilth) while maintaining the correct point angle. Tyne tension should be in the range 260–400N. Use lower tensions on sandy friable soils. Too much tension results in excessive point wear. Depth Sowing depth is not as critical as the amount of loose soil over the seed. Check the depth to the bottom of the furrow after travelling at least 200m. The rule of thumb for depth is: 'to the first knuckle of your index finger'. For early autumn or spring sowings, when warm, dry conditions after sowing are likely, this depth is necessary. In cold, wet winter conditions, sow more shallowly.

Tilth and speed

The amount of loose soil covering the seed is critical, regardless of the depth of the furrows. Aim for only 5–10 mm of loose soil over the seed. It is important to note that more seed fails to emerge by being buried under too much soil than by any other cause. There is too much tilth if less than 5% of the seed and fertiliser is visible in the furrow. Speed must be increased (up to 12 km/h) to throw more loose soil out of the furrow.

There is too little tilth if a high percentage of seed and fertiliser is visible in the bottom of the furrow. A single loop of heavy chain attached at either side of the seeder can be used to sweep soil from the edges into the furrow. Whatever device you use must follow the contour of the ground and not bulldoze loose soil on top of the seed.

In conventional seedbeds, deep seed burial is also likely, especially where the seedbed is loose and fluffy.

- Rolling to firm the seedbed before sowing is recommended for loose seedbeds.
- If using harrows, try to direct the seed tubes back so the seed lands in the last row of the harrows.
- When direct-drilling, a good rule of thumb is that 5% of the seed and fertiliser should be visible in the furrow.

Soil types and moisture

Often both soil type and moisture will vary within a paddock and as sowing proceeds. Try to sow different soil types in separate blocks and check the soil cover over the seed with changes in soil type. [33]

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32 T Somes (2017) Sowing into stubble–why seeder calibration and set up is critical. GRDC. https://grdc.com.au/Media-Centre/Media-News/North/2017/03/Sowing-into-stubble-Why-seeder-calibration-and-set-up-is-critical

33 H Allan, E Havilah, H Kemp (1997) Establishing Pastures–Machinery. NSW DPI. Dairy Link. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0016/163123/establishing-pastures-1-10.pdf

Calibration

A frequently neglected but essential part of any cropping program is accurate calibration of machinery. Seeder calibration is important for precise seed placement, and seeders need to be checked regularly during sowing. All seeders should be carefully calibrated before sowing starts. This should be done every season because seed size varies and machinery wear can alter rates.

The simplest method of calibration is as follows:

1. Place some of the seed to be sown in the planter box.
2. Unhook the seeding tubes and tie bags over the outlets in order to collect any seed which would normally go down the tube.
3. With the sowing mechanism engaged, drive the planter over a measured distance (D, metres) with a minimum distance of 100 m.
4. Remove the bags of seed and weigh them on accurate scales (W, kg).
5. Measure the width of the planter in metres (P).

The formula for sowing rate is: = kg/seed per ha.

For example, if 0.61 kg of seed was collected from a 6-m wide planter over a distance of 100 m, the sowing rate would be:

$$\frac{100 \times 0.61}{6} = 10.17 \text{ kg seed/ha}$$

If there are a large number of sowing outlets, seed may be collected from a minimum of a quarter of them. In such cases do not forget to multiply the weight of seed collected from each outlet by the actual number of outlets. Sowing is the most critical operation in the cropping program. Too much seed leads to waste and a probable yield reduction, while too little leads to probable yield reduction. Make sure to take the time to calibrate accurately. [34]

Point maintenance

Seed placement and furrow profile can be adversely affected using worn points. Attention to point wear is essential, particularly when you are direct-drilling with narrow points that have to carve a channel through undisturbed soil. Expensive steel points can quickly become irretrievably ruined if they are not regularly hard-faced and maintained. An alternative in abrasive soils are cast points. [35]

3.6.5 Sowing into stubble

Key points:

- Bar clearance and tyne layout influence a machine's ability to cope with heavy stubble loads.
- Select a seeder based on your farming system, cropping environment and financial position.
- Stubble management starts at harvest: height and residue spread will impact sowing.

When it comes to optimising winter crop establishment there are vital steps grain growers can take to improve planting outcomes, particularly when sowing into stubble.

Seeder blockages

One of the major challenges when working in a stubble retained system is blockages in sowing implements, particularly in irrigated and high rainfall zones, where yields and stubble loads are generally high. Blockages become an increasing issue when

VIDEOS

WATCH: Over the Fence North: Conditions are key to accurate seed placement

34 T Price, B Beumer, P Graham, P Hausler, M Bennett (2008) Agnote: Machinery calibration: Boom-sprays, seeders and fertiliser applicators. DPIR NT https://dpir.nt.gov.au/__data/assets/pdf_file/0011/232967/711.pdf

35 H Allan, E Havilah, H Kemp (1997) Establishing Pastures–Machinery. NSW DPI. Dairy Link. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0016/163123/establishing-pastures-1-10.pdf

stubble loads are above three tonne per hectare (3 t/ha), or if chaff and straw hasn't been chopped and spread evenly at harvest.

Using seeding equipment designed for retained stubble systems will minimise blockages, but does require a significant capital investment. This research has also found modification to the profile and tyne layout of the seeder bar can reduce stubble clumping and blockages, and improve the machine's ability to cope with heavy stubble loads (ranging from 5–7 t/ha). Utilising inter-row sowing and wider row spacings has also helped growers sow through retained stubbles with greater ease. Disc seeders will cope with sowing into paddocks with much higher stubble loadings.

Seeder set-up and modifications

It is possible for simple modifications to be made to the seeder that will enable it to better cope with stubble. Seeder modifications that will enable sowing into stubble include:

- A straight rather than a curved shank will avoid residue building up.
- Shanks with a rounded cross section have improved residue flow, compared to square shanks.
- Vertical or slightly backward leaning shanks promote a constant off-balancing effect on residue, reducing build up.
- Sudden changes of shape in shank profile inhibits residue flow and promotes clumping. High 'C' shapes, where the upper part of the 'C' is above the stubble flow work well.
- 'Stream-lined' designs with recessed bolt heads for point mounts also reduce residue catching.
- Existing curved shank tynes can be improved by retrofitting stubble tubes to make the face of the shank round and more vertical.
- Long knife-point openers can increase the effective vertical clearance of short tynes, but their break out rating needs to sustain the greater lever arm effect.
- Tyne shank add-ons (Pig Tails or other plastic/metal guards) improve trash flow around the tyne.
- Tread wheel residue manager's hold down the stubble beside the shank as it moves through.
- Row cleaners move stubble away from the disc to prevent hair pinning and assist in crop establishment.
- Residue pinning wheels (Morris Never-Pin wheels) hold the stubble on either side of the disc to assist in cutting ability.

Selecting a seeder when sowing into stubble

As part of the GRDC stubble initiative, Southern Farming Systems (SFS) has conducted extensive trial work on seeding system performance in relation to stubble retention. Key findings from this work include:

- Real time kinematic (RTK) guidance is a critical component to inter-row sowing
- Each seeder has varying capacity to handle retained stubble
- As a rule, discs handle higher loads than tyne and press wheel machines
- Wider tyne spacing across and along the bar will improve stubble handling
- Changing the angle of sowing direction slightly can minimise blockages
- Guidance auto steer on seeder bars will improve inter-row sowing
- Tynes and discs have varying degrees of soil throw and crop safety for pre-emergent herbicides
- Isolation of fertiliser from seed will limit seed burn. [36]

MORE INFORMATION

Sowing into stubble–why seeder calibration and set up is critical

Profitable stubble retention systems for the high rainfall zone

36 T Somes (2017) Sowing into stubble–why seeder calibration and set up is critical. GRDC. https://grdc.com.au/Media-Centre/Media-News/North/2017/03/Sowing-into-stubble-Why-seeder-calibration-and-set-up-is-critical

3.6.6 Sandy soil systems

Sandy soils present the highest risk of the soil drying out quickly and reducing germination.

Recent research work suggests the following strategies should be considered for more reliable crop establishment in sandy soils, where marginal moisture conditions are encountered:

- Place seed in contact with undisturbed soil moisture. This requires side banding or paired row banding able to place seeds on undisturbed ledges, or single shoot systems able to band seeds at furrow tilling depth. Deep furrow sowing capabilities may be required to reach moisture, or else growers can use low rake angle openers, low speed and compact seed banding systems to delve deeper.
- Minimise the fertiliser applied with seeds to control fertiliser toxicity, and use a double shoot system, with side or side plus vertical separation.

It is important to note that a lack of sub-seed disturbance may increase the severity of rhizoctonia damage on young seedlings, and the use of liquid banding technology to combine in-furrow trace element application and fungicide protection at sowing may be necessary as part of a mitigating strategy.

Seed-fertiliser separation is particularly important in small seeded crops like canola for successful germination on sandy soils.

Obtaining high Seed Bed Utilisation (SBU) is important to manage fertiliser toxicity risks. In marginal moisture conditions, including non-wetting soils, it may be necessary to have full separation between seed and basal fertiliser, preferably banded at depth to maintain the maximum crop establishment potential.

Successful use of high SBU systems requires careful selection of equipment to suit growers' conditions.

When selecting for a higher SBU system, there are many factors to consider including single or double shoot, distinct split-rows or a wide band sowing, integrated opener design or wing attachment for an existing opener, and fertiliser placement relative to the seed zone.

In order to better establish crops in marginal soil moisture, it is important to select a design able to place seeds on undisturbed soil moisture, being aware that some systems will instead place seeds into furrow backfill, at greater risk of diluted moisture and potentially pre-emergent herbicide damage.

For more information about Fertiliser toxicity and optimising SBU, see Section 2: Pre-planting.

3.6.7 Managing herbicide toxicity

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 can mean the difference between making no-till work, or not. Recently 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 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 today as they did 10–15 years ago. Some products with generic counterparts have different label claims for the same active ingredient.

This creates problems for farmers and agronomists wanting to use these herbicides in our modern, no-till farming systems. Residual herbicides at sowing are very effective for controlling a wide range of weeds both in-crop and 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 paramount to enable 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, while others are less mobile. Mobility can also change with time for particular herbicides.

The incorporation by sowing (IBS) application technique seems the safest way of using most residual herbicides, as 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 in IBS application occur 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-emergence (PSPE) applications of many herbicides are not ideal and are usually not supported by labels, as the herbicides can concentrate within the seed furrow if washed in by water and/or herbicide treated soil. Obviously, for volatile herbicides that need incorporation following application, PSPE is not a viable option. Tyne seeders vary greatly in their ability to incorporate herbicides. There are many tyne 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 each seeder. There are, therefore, no rules of thumb for sowing speed, row spacing and soil throw.

It is important to 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 soil throw and on herbicide-treated soil returning into the seed furrow. In all cases with tynes and discs, crop safety is usually enhanced by IBS rather than PSPE application of herbicides. [37]

Tyne seeders are reliably safest at ensuring crop safety, as long as the following guidelines are adhered to:

- Control speed to ensure no soil throw reaches adjacent furrows and the majority of herbicide is concentrated over the inter-row zone
- Ensure seeds are placed at sufficient depth with clean backfill to achieve adequate physical separation between crop seed and herbicide (known as 'positional selectivity').
- Create stable furrows to limit the risk of contaminated soils backfilling over time, and leaching of soluble herbicides into the seed zone.

Care must be taken with disc seeders when using pre-emergent herbicides. Trials in SA lower-north in 2012/13 showed that trifluralin significantly reduced wheat emergence with single discs, by up to 50%. However, using triple discs or applying Sakura® caused no damage.

The greater safety with triple disc systems is explained by their soil throw features being akin to a knife point system. Further, the inclusion of residue managers fitted ahead of the single disc openers significantly reduced crop damage. Growers should always follow herbicide labels to assess suitability for disc seeders. [38]

VIDEOS

WATCH: Study sows the seed for best-practice with disc seeders

MORE INFORMATION

Seeding systems and pre-emergence herbicides

37 B Haskins (2010) Residual herbicides at sowing using disc and tyne no-till seeding equipment. Industry & Investment NSW. https://riverineplains.org.au/wp-content/uploads/2016/12/ResidualHerbicides.pdf

38 J Desbiolles, R Barr (2016) Selecting a seeding system for your soil. GRDC. https://grdc.com.au/Media-Centre/Media-News/South/2016/03/Select-a-seeding-system-for-your-soil