WESTERN
MAY 2018

GRDC GROWNOTES™

GRDC™
GRAINS RESEARCH & DEVELOPMENT CORPORATION

TRITICALE

SECTION 3

PLANTING

INNOCULATION | 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 generally has a similar sowing time requirement to other cereals and should take a priority in the sowing schedule commensurate with its importance to the overall cropping enterprise. Triticale often suffers more from frost damage than wheat, hence it should generally be sown later.
- 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 and because plants tiller less than wheat. [1]
- Depending on seed size, triticale should be sown at a seeding rate of 75–100 kg/ha.
- Recommended sowing depth for Triticale ranges between 2–5 cm. [2]

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 [3]

3.1 Innoculation

Not applicable to this crop.

3.2 Seed treatments

Seed treatments are applied to seed to control diseases such as smuts, bunts or rust, and 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 triticale and there are now options to treat seed to provide seedling protection against stripe rust. [4]

Fungicide seed dressings are used to protect the triticale crop from seed borne disease such as loose smut. This treatment should form an integral part of the triticale disease management program and will vary with variety and sowing time. Seek local advice. [5]

When applying seed treatments, always read the chemical label and calibrate the applicator. Seed treatments are best used in conjunction with other disease-management options such as crop and paddock rotation, clean seed, and resistant varieties, especially when managing diseases such as stripe rust.

There are risks associated with using 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

1 Birchip Cropping Group. (2004). Triticale agronomy – 2004. http://www.farmtrials.com.au/trial/13801

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

3 Collier E, Oatway L. (2016). Triticale crop production. Alberta Agriculture and Forestry. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/fcd10571

4 Agriculture Victoria. (2012). Growing Triticale. http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-triticale

5 Waratah see Co. Ltd. (2010). Triticale: planting guide. http://www.porkcrc.com.au/1A-102_Triticale_Guide_Final_Fact_Sheets.pdf

If there is a delay in emergence due to decreased vigour, it increases exposure to pre-emergent attack by pests and pathogens, or to soil crusting; this may lead to a failure to emerge. The risk of emergence failure 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 (Figure 1).

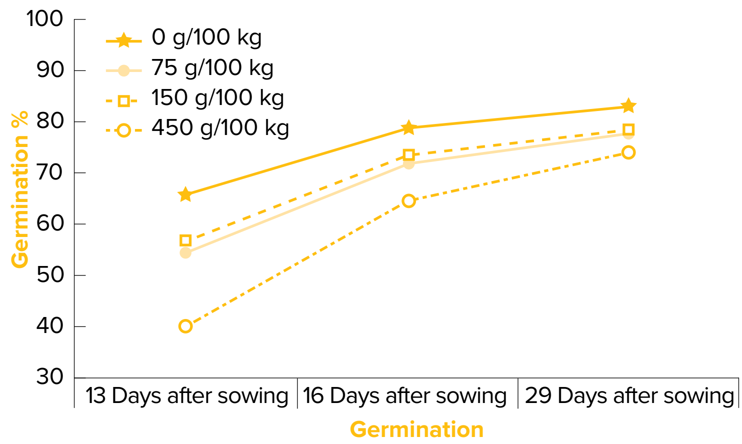

Figure 1: *Impact of seed-treatment fungicide on the rate of germination.*

Source: based on P Cornish 1986

Product registrations change over time and may differ between states and between products containing the same active ingredient. The registration status for the intended use pattern in your state must be checked on the current product label prior to use. [6]

3.2.1 Emergence problems

Caution should be taken in using seed treatment products used in smut and foliar disease control as they may reduce coleoptile length and cause emergence problems under some conditions.

Factors other than seed treatments can cause poor seedling emergence: these include deep sowing, surface crusting, short coleoptile varieties, soil temperatures and trifluralin.

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.

Because coleoptile lengths vary from one variety to another some varieties can tolerate deeper sowing than others. Coleoptile lengths vary greatly from one batch of seed to another. The source of seed is often more critical than the variety in determining coleoptile length. For this and other reasons farmers should seek to use the best seed possible.

Most emergence problems occur in heavy clay soils where surface sealing occurs. Extra care is required when treated seed and/or trifluralin is used in such soils. [7]

MORE INFORMATION

Cereal seed treatments 2016.

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

7 Wallwork H. SARDI. (2016). Cereal Seed Treatments 2016. http://rustbust.com.au/wp-content/uploads/2013/12/cerealseedtreat2016.pdf

MORE INFORMATION

GRDC Targeted nutrition at sowing Factsheet.

3.2.2 Fertiliser at seeding

The amount of nitrogen safely placed with the seed will vary depending on soil texture, amount of seedbed utilisation and moisture conditions. Higher amounts of nitrogen can be safely applied with the seed if it is a polymerised form of urea where the nitrogen is released over the period of several weeks. If soil moisture is marginal for germination, high rates of fertiliser should not be placed with the seed. Both nitrogen and phosphorous can be banded prior to 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 prior to seeding. [8]

3.3 Time of sowing

Key points:

- Crops sown early within the sowing window will establish faster and have the potential to maximise Water Use Efficiency.
- Early sowing increases the chance of frost damage and can limit weed control.
- WA wheat varieties flower in response to an accumulation of warm temperatures. Many varieties also have a mild cold temperature requirement to delay flowering and some varieties are affected by day length. Research in WA is teasing out the differences.
- Growers need to be selective with varieties for particular sowing times to ensure a spread of flowering dates. Models such as 'Flower Cal' and 'DM' from DAFWA or Yield Prophet™ can assist.
- Late sowing can increase severity of most root diseases early sowing increases severity of a number of leaf diseases. Rusts are not consistently affected by sowing time. [9]

In a Mediterranean environment, such as the WA grain belt, timeliness of sowing is one of the most important aspects of crop agronomy. The optimal planting time for cereals is a compromise. Planting early will increase the chance of frost damage at flowering. With late maturing varieties, it can also increase the bulk of crops and lead to stored soil water being used before flowering. In early maturing varieties, sowing early may actually reduce the bulk of the crop as development is hastened, as well as reduce rooting depth. This can lead to reduced yield potential and reduced access to deeper moisture and nutrients. The optimal sowing date results in flowering after the last frost and with adequate reserves of soil moisture before heat stress begins. [10]

Triticale generally has a similar sowing time requirement to other cereals and should take a priority in the sowing schedule according to its importance to the overall cropping enterprise. Optimum time of sowing depends largely on the variety being grown. Triticale often suffers more from frost damage than wheat, hence it should generally be sown later.

Acting promptly when a sowing window is available has proven critical over many seasons. Delayed sowing has generally proven costly although to sow very early increases frost risk. Triticale appears to be more sensitive to frost damage than other cereals. Dry sowing for a portion of the crop is an option which has proven very successful and can be considered for triticale as well as other cereals. [11]

Long season varieties, such as Endeavour⟮D and Tobruk⟮D, can be sown as early as mid-February if seasonal conditions (i.e. rainfall) allows. Tobruk⟮D should only be sown this early if it is going to be grazed. Main season varieties such as the traditional Tahara, and Berkshire⟮D should be sown at the same time as main season wheat, during May and early June.

---

8 Alberta Gov. (2016). Fall Rye Production. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex1269/$file/117_20-1.pdf

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

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

11 Agriculture Victoria. (2012). Growing Triticale. http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-triticale

MORE INFORMATION

GRDC Time of Sowing Factsheet – Western Region.

VIDEOS

WATCH: GCTV Extension files: Wheat sowing strategies.

WATCH: GCTV Extension files: Early sowing opportunities.

WATCH: Early sowing in the LRZ.

WATCH: GCTV15: Optimal flowering – follow up.

The widespread adoption of no-till farming means Western Australia's grain growers can now sow crops earlier. Yields are usually higher for earlier sowing within the recommended sowing window. Early sowing speeds establishment but crops can also flower earlier.

Sowing too late lowers yields as grain fill occurs during increasingly hot and dry conditions. Sowing too early will increase the chance of frost damage and can limit weed control options. With late maturity varieties, it can also increase the bulk of crops and lead to stored soil water being used up before flowering (haying off). In fast maturing varieties, sowing very early can reduce the bulk of the crop as development is hastened and root depth reduced. This can lead to lower yield potential and reduce access to deeper moisture and nutrients.

WA research has shown growers can lose yield by sowing too early or too late in years with an autumn break before mid May. However, with a late break (after mid May), early sowing proved best, with yields dropping with progressively later sowing. [12]

Table 1 outlines the optimum flowering window for cereal at locations across the WA wheatbelt. The dates are based on hundreds of sowing date trials across many locations over the past few decades.

Table 1: *The optimum cereal flowering window for locations across the Western Australian grain belt.*

Region	Sowing date
North east	25 August – 15 September
North west	3 September – 23 September
Eastern	1 September – 20 September
Central *	5 September – 25 September
Lakes *	1 September – 20 September
Great southern	16 September – 6 October
South Coastal	3 September – 2 October

* indicates that a damaging frost can occur in the first half of the window in some years

Source: DAFWA.

Lodging

Triticale can lodge because of:

- Height.
- Lush growth under conditions of high moisture and fertility.
- High seeding rates.

Earlier seeding appears to reduce this tendency towards lodging. [13]

3.4 Targeted plant population

The range of sowing rates varies with variety and end use (Table 2). Triticale grain size is larger than wheat, so higher sowing rates are needed to achieve the same plant density. Sowing rates approximately 20% higher than wheat are recommended for triticale (Photo 1). Before determining seed sowing rates, seed germination levels need to be known. [14]

12 GRDC. (2011). Time of Sowing Fact sheet – Western Region. www.grdc.com.au/GRDC-FS-TimeOfSowing

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

14 Jessop RS, Fittler M. (2009). Triticale production Manual – an aid to improved triticale production and utilisation. http://www.apri.com.au/1A-102_Final_Research_Report_.pdf

Photo 1: *Triticale paddock sown according to targeted plant population.*

Source: Liebman M in MCCC

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

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 and because plants tiller less than wheat. [15]

Table 2: *Recommended plant populations for different uses of Triticale.* [16]

Purpose/growing conditions	Best sowing rate (kg/ha)
Grain only	60–90
Grain and grazing	100–120
Undersowing pastures	35–45
Irrigation / high rainfall	100–120

Target plant population for Triticale can also vary according to rainfall (Table 3).

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: Crop Monitoring Guide – Top Crop Australia (Incitec/GRDC) in GRDC

Triticale does not tiller well. The desired plant density for triticale is 180 plants/m^2 up to 200 plants/m^2 in high rainfall zones. Depending on seed size this equates to a seeding rate of 75–100 kg/ha. If sowing is delayed, or when sowing on light sandy soils, the higher plant density should be the target. [17]

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

15 Birchip Cropping Group. (2004). Triticale agronomy – 2004. http://www.farmtrials.com.au/trial/13801

16 Birchip Cropping Group. (2004). Triticale agronomy – 2004. http://www.farmtrials.com.au/trial/13801

17 Agriculture Victoria. (2012). Growing Triticale. http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-triticale

For each tonne of grain per hectare the rule of thumb target is 40–50 plants/m^2 and about 100 heads/m^2.

APSIM modelling was conducted to explore the optimal sowing density of triticale in Mediterranean-type environments. The tested model was then used to explore management options to maximize triticale yield. The response to sowing density was cultivar and rainfall-environment dependent. The simulation analysis indicated that there was no yield advantage with higher sowing densities with a tall cultivar type in high yielding environments, despite its higher biomass growth rates. The highest yields were achieved at the early sowing date at the sowing densities between 100 and 300 plants/m^2 in the high rainfall regions for both short and the tall cultivars. The simulation study suggests that sowing a short cultivar with a reduced radiation use efficiency but early vigour growth could increase current yields across different regions, seasons and management options in the Mediterranean climate. [18]

When sowing triticale as a cover crop (i.e. undersown with pasture) reduce seeding rate to approximately 10 to 20% of normal, targeting 15—30 plants per m^2. [19]

Plant more weight of triticale seed per unit area than when planting wheat. This is because triticale has larger seeds than wheat (Table 4).

Table 4: *Typical values for characteristics of triticale.*

Seeds/kg	Volumetric grain weight (kg/hL)	Bulk densities	
		Kg/m^3	t/m^3
23,000	65	650	0.65

Source: NSW DPI

Seed size influences plant density, with large seeds requiring a higher sowing rate than smaller seeds to target the same population. '1000 seed weight' is a measure of seed size. 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. [20]

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
- tillage, e.g. no-till
- double-cropping
- soil fertility
- soil type
- soil moisture and seasonal outlook
- weed seed burden—higher sow rates for increased plant competition, e.g. if combatting herbicide-resistant ryegrass populations. [21]

18 Bassu, S., Asseng, S., Giunta, F., & Motzo, R. (2013). Optimizing triticale sowing densities across the Mediterranean Basin. *Field Crops Research*, *144*, 167–178.

19 Waratah see Co. Ltd. (2010). Triticale: planting guide. http://www.porkcrc.com.au/1A-102_Triticale_Guide_Final_Fact_Sheets.pdf

20 Condon K. (2003). Targeting optimum plant numbers. NSW Agriculture. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0007/168523/targeting-optimum-plant-numbers.pdf

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

3.5 Calculating seed requirements

Key points:

- Plant more weight of triticale seed per unit area than when planting wheat. This is because triticale has larger seeds than does wheat.
- 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.
- Choose and manage seeding rates to achieve target plant stand densities in the field.
- Triticale has the largest seed size of all common small-grained cereal crops. Ensure that your seed rate compensates for this.
- Rates are usually adjusted upwards when seeding forage mixtures or inter-cropped triticale.
- For mono-crop triticale forage production, recommended seeding rates are usually 25% higher than seeding rates for grain production.
- In two-component forage-crop blends using triticale, one guideline suggests each component consist of 75 percent of the normal seeding rate for the individual components alone. [22]

It is best to calculate the seeding rate using target plant population, germination percentage and seed count per kilogram, both available on the Seed Analysis Certificate which is available on request when you purchase the seed. [23]

The desired plant density for triticale is 180 plants/m^2 up to 200 plants/m^2 in high rainfall zones. Depending on seed size this equates to a seeding rate of 75–100 kg/ha. If sowing is delayed, or when sowing on light sandy soils, the higher plant density should be the target. [24]

Within limits, higher seeding rates in triticale lead to:

- Higher crop yields.
- Better weed competition.
- Earlier maturity.
- Fewer tillers per plant.
- Shorter plant height.

Seeding rates should generally be adjusted upwards for:

- Large seed size.
- Low seed germination rate.
- Deep seeding (not a recommended practice).
- High moisture and yield potential conditions.
- Heavy textured soils.
- Rough seedbeds.
- Heavy weed pressure conditions (especially in organic production).

Lower seeding rates may be suitable for dry conditions. Triticale does not tiller as freely as wheat, and has greater difficulty in compensating for low stand establishment. Growers should use their experience and local agronomist knowledge to adjust plant density targets to local conditions. [25]

22 Collier E, Oatway L. (2016). Triticale crop production. Alberta Agriculture and Forestry. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/fcd10571

23 Waratah see Co. Ltd. (2010). Triticale: planting guide. http://www.porkcrc.com.au/1A-102_Triticale_Guide_Final_Fact_Sheets.pdf

24 Agriculture Victoria. (2012). Growing Triticale. http://agriculture.vic.gov.au/agriculture/grains-and-other-crops/crop-production/growing-triticale

25 Collier E, Oatway L. (2016). Triticale crop production. Alberta Agriculture and Forestry. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/fcd10571

Because seed sizes may vary depending on production years and variety type, a fixed quote for the weight of seed needed to sow 1 ha is not always an accurate measure for obtaining a desired plant population per hectare. Note that triticale has a much larger 1000 kernel weight than do other cereals. Average graded seed sizes are:

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

The following formula (Figure 2) can be used to calculate sowing rates, taking into account:

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

To calculate 1000-seed weight:

- count out 200 seeds
- weigh to at least 0.1 g
- multiply weight (g) by 5 [26]

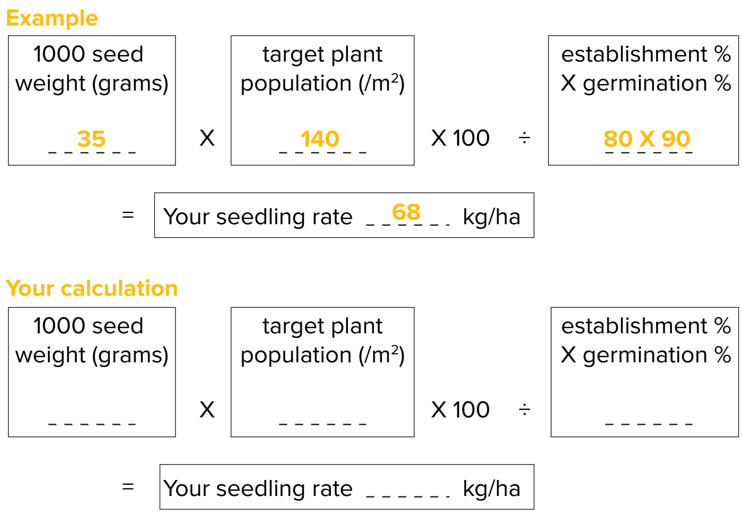

Figure 2: *Seeding rate calculator.*

3.5.1 Row spacing

Key points:

- 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 3.0 t/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.

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

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 opportunities to vary row spacing by crop and sow on the inter-row have increased (Figure 3). However, increasing row spacing is not always beneficial to yield.

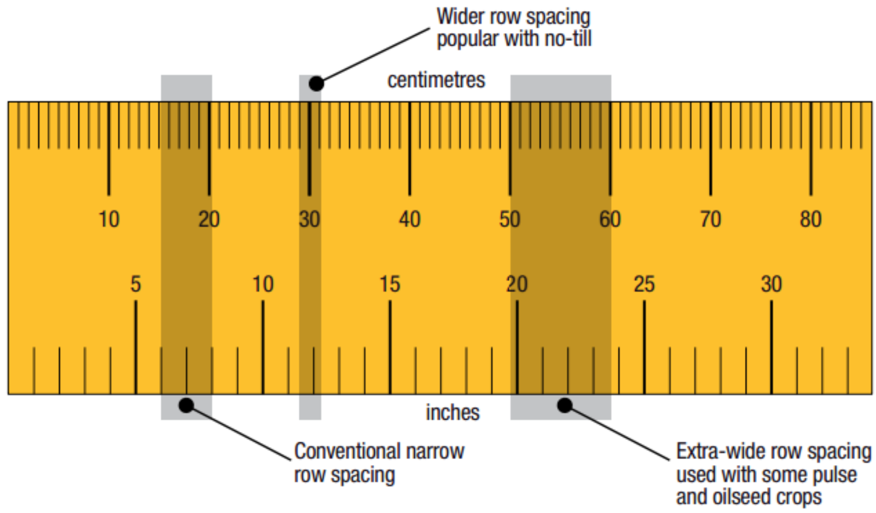

Figure 3: *Common row spacings in metric and imperial measurements.*

Source: GRDC

The traditional row spacing in much of Western Australia has been 18 cm (seven inches) for cereals, but greater adoption of no-till farming systems has increased interest in wider row spacing such as 30 to 50 cm depending on the crop type and region (Figure 4).

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.

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 cereal yields.

Western Australia wheat trials on row spacing from nine to 54 cm found wider spacing decreased grain yield. The research found an average eight per cent decrease in yield for each 9 cm increase in row spacing from nine to 54 cm.

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.

Figure 4: *Wide row (375 mm) spacing is a hallmark of disc seeding, allowing plants to develop vigorous root systems.*

Source: GRDC

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. 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. [27]

MORE INFORMATION

Crop placement and row spacing – Western region.

3.6 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. [28]

Recommended sowing depth for Triticale ranges between 2–5 cm. [29]

When using triticale as a forage crop, sowing depth will depend on seasonal conditions and the species and cultivar that is being sown. As a general rule, forage cereals are sown at an average depth of 3–4 cm. However, sowing too deep can affect emergence and shallow sowing can risk desiccation or damage from herbicide uptake. [30]

Triticale seed size is generally bigger than that of commonly grown wheat varieties. Consequently, triticale can be seeded deeper than other small cereals and therefore benefit from stored moisture in the soil, which allows better crop establishment early

27 GRDC (2011). Crop placement and row spacing Factsheet – Western Region. https://grdc.com.au/uploads/documents/grdc_fs_cropplacement_west2.pdf

28 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

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

30 Agriculture Victoria. (2012). Establishing forage cereals.

in the season, particularly in drought-prone areas. Seeding equipment needs to be seed to account for a seed that may be 10 to 20 per cent larger than wheat.

Seed placement during the sowing process 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 and if planted shallow (no more than 2.45 cm deep). At this depth crops should see uniform seedling emergence and early weed competition[31]

Shallow seeding allows for:

- More rapid emergence.
- Early vigour.
- Improved competition with weeds.

Due to its large seed size, triticale is able to emerge from deep seeding. However, this usually results in decreased emergence and less plant vigour. [32]

Seed size influences coleoptile length which is sensitive to sowing depth. Sowing depth influences the rate of emergence and the percentage that emerges. Deeper seed placement slows emergence; this is equivalent to sowing later. Seedlings emerging from greater depth are also weaker, more prone to seedling diseases, and tiller poorly (Photo 2).

Photo 2: *Reduced vigour with increased sowing depth.*

Source: DAFWA

Recent research has confirmed the importance of avoiding smaller-sized seed when deep sowing.

31 Mergoum, M., & Macpherson, H. G. (2004). *Triticale improvement and production* (No. 179). Food & Agriculture Org

32 Collier E, Oatway L. (2016). Triticale crop production. Alberta Agriculture and Forestry. http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/fcd10571

MORE INFORMATION

Monitoring sowing depth – 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 (does not know which way is up), the leaf usually buckles and crumples, failing to emerge and eventually dying. [33]

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

3.7 Sowing equipment

The use of minimum soil disturbance has advantages for the production of triticale. One study noted a slight yield advantage for triticale grown under zero tillage. Seeding equipment needs to be seed to account for a seed that may be 10 to 20% larger than wheat. [34]

As much as 60% of the final yield potential for a 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. [35]

Seeder calibration is important for precise seed placement and seeders need to be checked regularly during sowing (Photo 3).

Many growers use either a knife-point/press-wheel tyne system or a single disc. Disc seeders can handle greater quantities of stubble but experience crop damage issues with pre-emergent herbicide use. Tyne seeding systems do not have the same herbicide safety issues but usually require some form of post-harvest stubble treatment, such as mulching or burning.

Photo 3: *Seeder calibration is important for precise seed placement and seeders need to be checked regularly during sowing.*

Photo: Rohan Rainbow

33 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

34 Mergoum, M., & Macpherson, H. G. (2004). *Triticale improvement and production* (No. 179). Food & Agriculture Org

35 W Thomason (2004) Planting wheat: seeding rates and calibration. Virginia Cooperative Extension, http://www.sites.ext.vt.edu/newsletter-archive/cses/2004-10/plantingwheat.html