Department of Primary Industries
Department of Regional NSW

Five tips for growing high-vigour canola seed

Colin McMaster (Project leader); Project team: Danielle Malcolm, Maurie Street, Ben O'Brien, Barry Haskins

www.dpi.nsw.gov.au

ISBN: 978-1-76058-761-1
jn 17059 V1

Published by NSW Department of Primary Industries,
a part of the Department of Regional New South Wales.

Disclaimer
The information contained in this publication is based on knowledge and understanding at the time of writing (December 2023). However, because of advances in knowledge, users are reminded of the need to ensure that the information upon which they rely is up to date and to check the currency of the information with the appropriate officer of the Department of Regional New South Wales or the user's independent adviser.

Any product trade names in this publication are supplied on the understanding that no preference between equivalent products is intended and that the inclusion of a product name does not imply endorsement by the department over any equivalent product from another manufacturer.

Recognising that some of the information in this document is provided by third parties, the State of New South Wales, the author and the publisher take no responsibility for the accuracy, currency, reliability or correctness of any information included in the document provided by third parties.

Always read the label
Users of agricultural chemical products must always read the label and any permit before using the product and strictly comply with the directions on the label and the conditions of any permit. Users are not absolved from any compliance with the directions on the label or the conditions of the permit by reason of any statement made or omitted to be made in this publication.

Acknowledgements
This project was funded through the Grains Research Development Corporate (GRDC) 'Improving production of grower-retained open pollinated canola seed using agronomic management to increase establishment in the MRZ and LRZ of the GRDC northern region'. Project code DAN1906-007RTX. Sincere appreciation to trial site hosts including Viridis Ag; Gindurra Canowindra; Jarvis family at Boona Mount, Tottenham; Haskins family at Ridgetop, Griffith; Fishpool family, Meryula, Tottenham; Radford family, Poitrel, Tottenham; and staff from Wagga Wagga Agricultural Institute. Agricultural drone data management: StevTech.

Images
All images are from DPI or acknowledged in the text.

Front cover: Canola establishment field trials site,
Tottenham, NSW. L–R Poor, medium and good establishment.

Department of Primary Industries
Department of Regional NSW

Five tips for growing high-vigour canola seed

Introduction

Canola seed has less energy reserves than larger-seeded crops and, as a result, is more sensitive to poor establishment across a range of seasonal conditions and agronomic management practices.

Open-pollinated (OP) canola is grown across a significant area in the low to medium rainfall zones across Australia. Growers often produce OP canola crops from retained seed, but poor establishment is commonly reported due to low vigour seed-lots. Research and field surveys have identified that growers often only establish half of what is sown, and if the autumn break was less favourable, it is likely to be much less.

The aim of this guide is to outline the key steps to improve canola establishment using grower-retained seed. How you manage this year's seed-crop could very well determine the success of next year's establishment and financial return.

Producing high-vigour canola seed-lots is most likely achieved through a series of small, incremental gains including seed-crop agronomy and environment. Research has highlighted that field establishment can range from 23–72% depending on how, and where the seed-crop was grown.

Key seed-crop principles

Principle 1. Prolonged and favourable conditions during seed-fill (reduce biotic and abiotic stresses), then slow seed moisture dry-down.

Principle 2. Grow large seed with low seed-chlorophyll. (See side note on seed chlorophyll ▸▸ ▷▷).

Principle 3. Ensure adequate phosphorus (P) nutrient uptake in the seed crop.

Principle 4. Retain large seed – target ≥1.8 mm.

Follow the **5 tips for growing high-vigour seed** to meet the key seed-crop principles.

Basic principles of seed chlorophyll

Why is seed chlorophyll bad? Because:

- it negatively affects seedling vigour and overall field performance, but might not restrict germination.
- seeds usually have poor seed-coat integrity and excessive leaching of seed internal metabolites.
- high chlorophyll seeds accumulate less biomass.

Lifecycle of chlorophyll within the seed

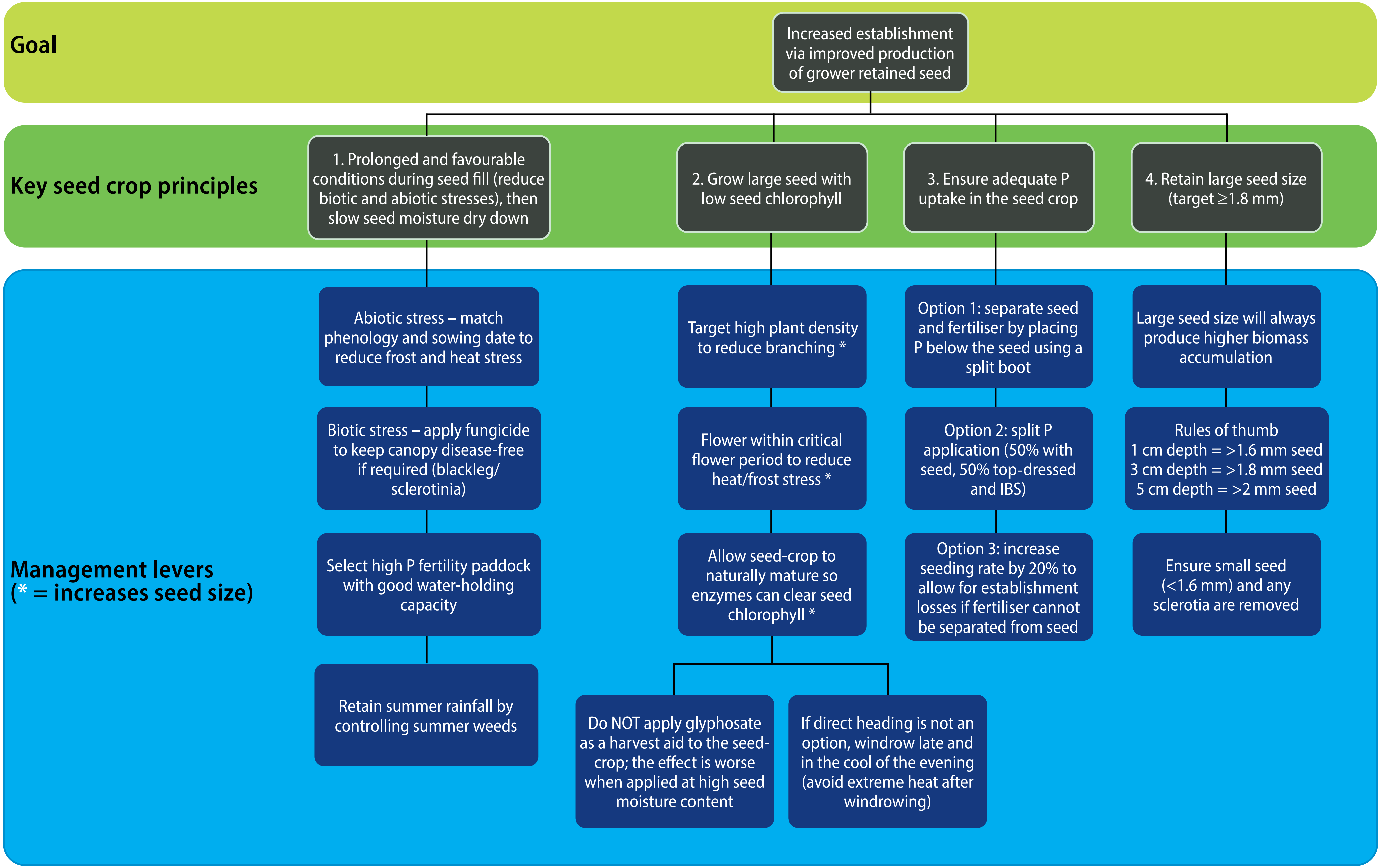
- The highest chlorophyll levels are at the start of seed formation (~20–30 days after the start of flowering). Levels degrade as the seed reaches harvest maturity (not physiological maturity).
- Enzymes within the seed break down the chlorophyll over time. The longer the duration, the more time enzymes have to remove the chlorophyll.

Conditions that contribute to high seed chlorophyll

- Any stress during seed fill (frost/heat).
- Frost can either damage or destroy the enzymes, leaving no mechanism for removing the chlorophyll.
- Rapid seed dry-down caused by high temperatures (or crop desiccation) and/or moisture stress can trap chlorophyll within the seed. Once seed moisture content is below 20%, the enzymes responsible for breaking down the chlorophyll can no longer function.

GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION
goa GRAIN ORANA ALLIANCE
AgGrow AGRONOMY + RESEARCH

Decision matrix to increase canola establishment via improved production of grower retained seed



Tip 1: Paddock selection and matching phenology with sowing time

- Ensure the seed crop flowers within the critical flowering period for your region.
- The aim is to provide favourable and prolonged conditions during seed fill, slow seed-moisture dry down with reduced abiotic (frost/heat) and biotic (blackleg/sclerotinia) stress.
- Seed-crops that flower too early (Figure 1 and Figure 2) have increased risk of frost damage, which can partially or fully destroy the enzymes responsible for breaking down seed chlorophyll, and hence reduce seedling vigour. Frost also reduces seed size.
- Seed-crops that flower too late (Figure 3) have increased risk of heat/moisture stress accelerating seed moisture dry-down and trapping chlorophyll within the seed.
- Select a high P fertility paddock (≥35 ppm Colwell P) if possible, and control summer weeds to increase summer rainfall storage to reduce the risk of moisture stress during the spring. Select a uniform soil type with good water-holding capacity.
- Growing season conditions will be a key factor for seed size; the duration and quality of flowering will determine the speed of seed-moisture dry down. Matching variety phenology and sowing time are the best way to reduce risk (Figure 4).
- Apply normal disease management strategies (e.g. fungicides).

Principle 1: Prolonged and favourable conditions during seed-fill, then slow seed moisture dry-down.

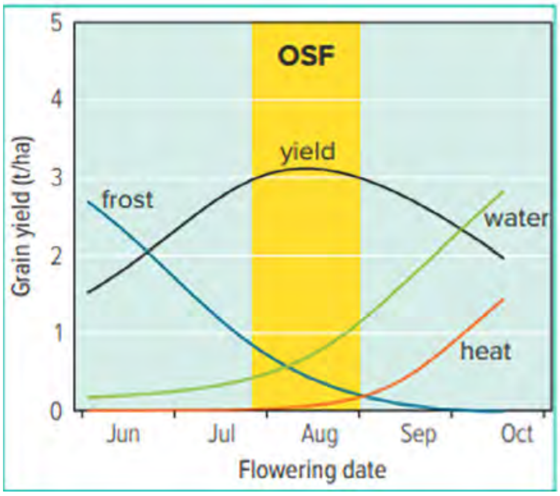


Figure 1. Frost, heat and moisture effects on canola grain yield. Source: *Twenty tips for profitable canola*, GRDC. (OSF = optimal start of flowering).

Figure 2. An example of fast phenology types flowering too early (first 2 plots) and will incur higher frost risk compared to the mid phenology type (3rd plot from left).

Figure 3. The plot on the left has finished flowering and is well advancing into seed fill, while the plot on the right is still flowering and seed fill will occur in much higher temperatures with quicker seed dry down period.

Region	Month and week	March				April				May			
	Phenology	1	2	3	4	1	2	3	4	1	2	3	4
Central west (north) Trangie, Gilgandra	Slow					Early	On time	On time	Late				
	Mid						Early	On time	On time	Late			
	Fast							Early	On time	On time	Late		
Central west (east) Canowindra, Wellington	Slow				Early	On time	On time	Late					
	Mid					Early	On time	On time	On time	Late			
	Fast						Early	Early	On time	On time	Late		
Central west (south) Condobolin, West Wyalong, Rankins Springs	Slow			Early	Early	On time	On time	Late					
	Mid					Early	On time	On time	Late				
	Fast						Early	On time	On time	Late			
South West Slopes Young, Cootamundra, Culcairn	Slow		Early	Early	On time	On time	On time	On time	Late	Late			
	Mid					Early	On time	On time	On time	Late	Late		
	Fast							Early	On time	On time	On time	Late	
Riverina Coolamon, Lockhart, Corowa	Slow		Early	Early	On time	On time	On time	Late					
	Mid					Early	On time	On time	On time	Late			
	Fast						Early	Early	On time	On time	Late		

Early – risk of frost, disease infection and lower potential yield.
On time
Late – risk of moisture and high temperature stress.

Figure 4. Matching phenology with sowing time across various locations in central/southern NSW. Source: *Twenty tips for profitable canola*, GRDC.

Tip 2: Target high plant density

Principle 2. Grow large seed with low seed-chlorophyll

- Ensure a high proportion of the seed yield is derived from the main stem, not lower branches.
- Seeds produced from the main stem:
  - have a longer seed fill duration (slower and preferential accumulation of assimilates and nutrients)
  - produce larger seeds
  - contain less seed chlorophyll compared with lower branches.
- Low plant density crops (Figure 5; figures 6–8) produce more side branches than high density crops. Buds tend to flower later and have a greater degree of immature seeds present when the crop is windrowed or harvested. The greater the degree of side branching, the higher the rate of immature seed at harvest.
- Up to a 4 percentage point increase in establishment from high plant density compared with low plant density (Figure 9).
- Key factors to help achieve a high plant density include:
  - reducing sowing speed
  - ensuring adequate fertiliser separation from the seed
  - reducing stubble loads if necessary
  - ensuring uniform seed placement.

Figure 5. Effect of plant density on canopy architecture. L–R = 6, 15 and 45 plants m^2.

Figure 6. Low plant density at 6 plants m^2.

Figure 7. Medium plant density at 15 plants m^2.

Figure 8. High (desired) plant density at 45 plants m^2.

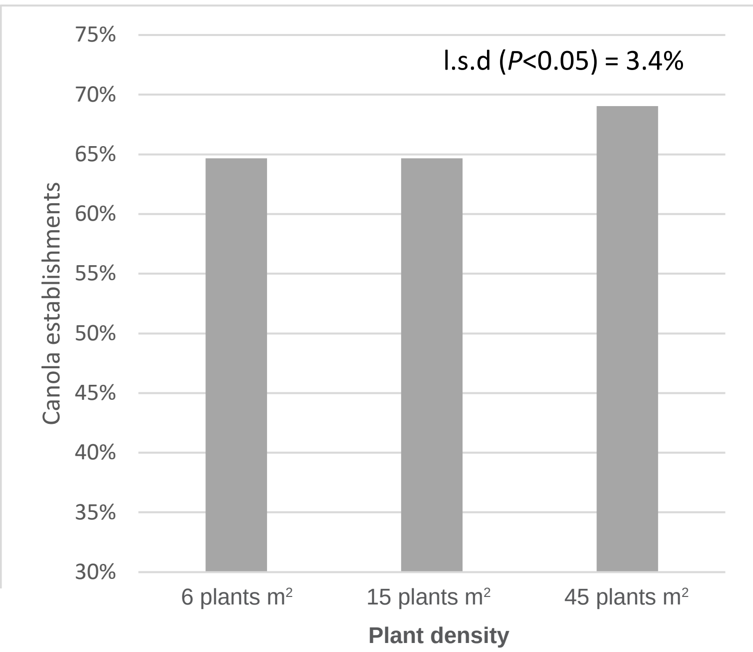


Figure 9. Effect of maternal plant density on canola establishment.

Maternal – the originating crop that produced the seed.

Tip 3: Apply adequate phosphorus fertiliser

- Ensure the seed-crop is not phosphorus (P) deficient yet maintain high plant density (Figure 10).

Principle 3. Ensure adequate phosphorus (P) nutrient uptake in the seed crop.

Figure 10. Maternal seed crop with 0 kgP/ha vs 30 kgP/ha (L–R).

Figure 11. Subsequent canola establishment using seed from Figure 10 (0P vs 30P, L–R).

Figure 12. Abnormal seedlings caused by P deficiency.

- Applying additional P to the maternal seed crop improved the following year's establishment by up to 12 percentage points on a low-P-fertility site. The magnitude of response is caused by the P fertiliser applied to the maternal seed and the P fertility status of the subsequent crop.
- Leaf area index per plant can increase by up to 7 percentage points following additional P to the maternal crop (Figure 11).
- Phosphorus-deficient seed-crops tend to produce high levels of abnormal seedlings (Figure 12), higher levels of electrolyte leakage, reduced hypocotyl length, reduced early ground cover and reduced seed storage capacity.
- Figure 13 illustrates the relationship between P rate and seed size on canola establishment.
- Application methods to apply P with the seed crop include:
  - separate seed and fertiliser via split boot (fertiliser banded ~2.5 cm below the seed)
  - split P application, 50% with the seed and 50% top-dressed
  - if the seed and fertiliser cannot be separated, increase the seeding rate by 20% to allow for establishment losses caused by the fertiliser.

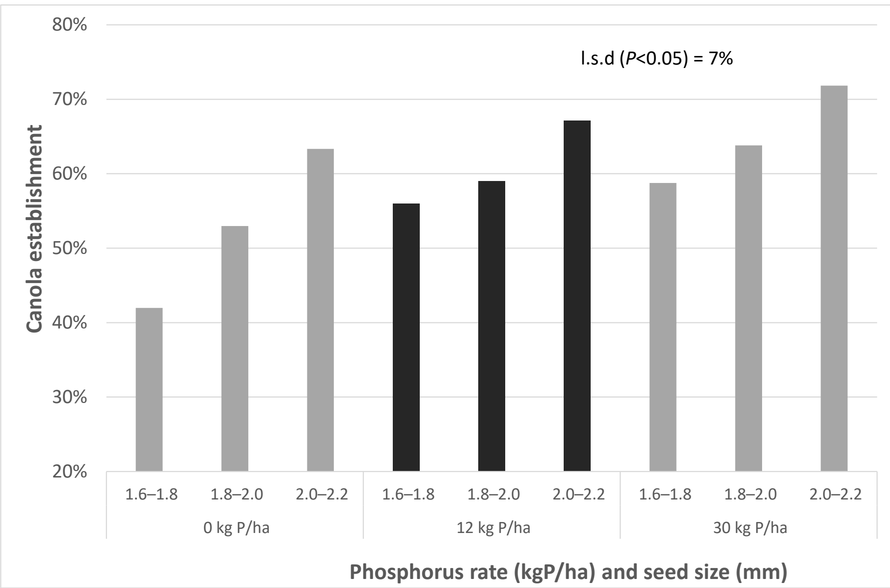


Figure 13. Effect of maternal seed-crop P rate from a low P fertility site (Colwell P = 8 ppm).

Tip 4. Allow seed-crop to naturally mature so enzymes can clear seed chlorophyll

Principle 1: Prolonged and favourable conditions during seed-fill, then slow seed moisture dry-down.

- Direct heading (Figure 14) is the preferred option for harvesting (the crop is allowed to naturally ripen) as this provides longer duration for enzymes to remove chlorophyll and increase grain size.

Figure 14. Direct headed canola.

- If direct heading is not possible, leave windrowing until ≥75% and the seed changes colour, and if conditions are hot, windrow in the cool of the evening to reduce the speed of seed-moisture dry down.
- DO NOT apply glyphosate as a harvest aid (desiccation) or late weed control (figures 15 and 16). The effect is more severe when applied at a higher seed moisture content.
- Glyphosate:
  - changes the metabolic process of seed development.
  - reduces seed vigour.
  - reduces hypocotyl length by up to 2.5 cm.
  - effect is more severe when applied at higher seed moisture content.

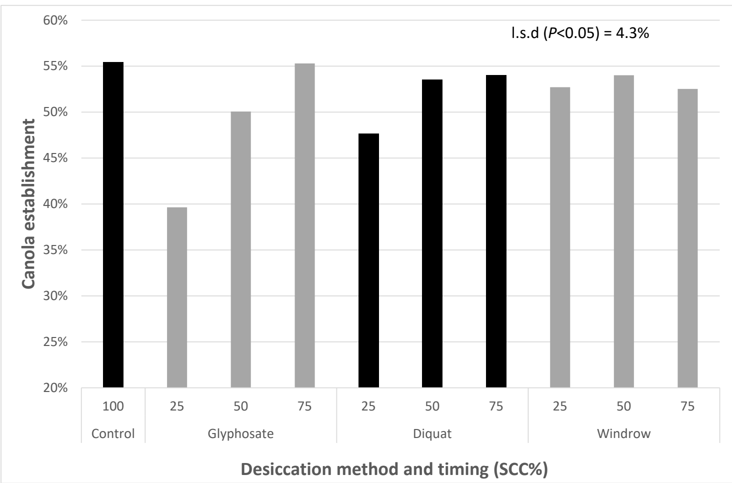


Figure 15. Effect of crop desiccation on canola establishment.

Figure 16. Effect of crop desiccation on canola establishment **Top row** R = 2 mm seed size – direct headed vs glyphosate @25%; **Bottom row** L–R = 1.8 mm seed size glyphosate @25% vs direct heading.

Tip 5: Grade and retain large sized seed

Principle 4: Grade and retain large sized seed.

- Aim to target ≥1.8 mm seed size (>4 g/1000 seeds or <256,000 seeds/kg).
- Bigger seed size = larger cotyledons = quicker biomass production.
- Seed weight (g) is increased by ~40% for every 0.2 mm increase in seed diameter.
- Large seed size becomes more critical as sowing depth increases (figures 17–19).
- The biggest gains in crop establishment came from removing <1.6 mm seeds.
- Small seeds (<1.6 mm) are characterised by high levels of seed abnormalities (40%) and high levels of electrolyte leakage (poor cell membrane integrity) compared with larger seeds.
- It is likely that smaller seeds would be more prone to seed burst in fully saturated conditions.

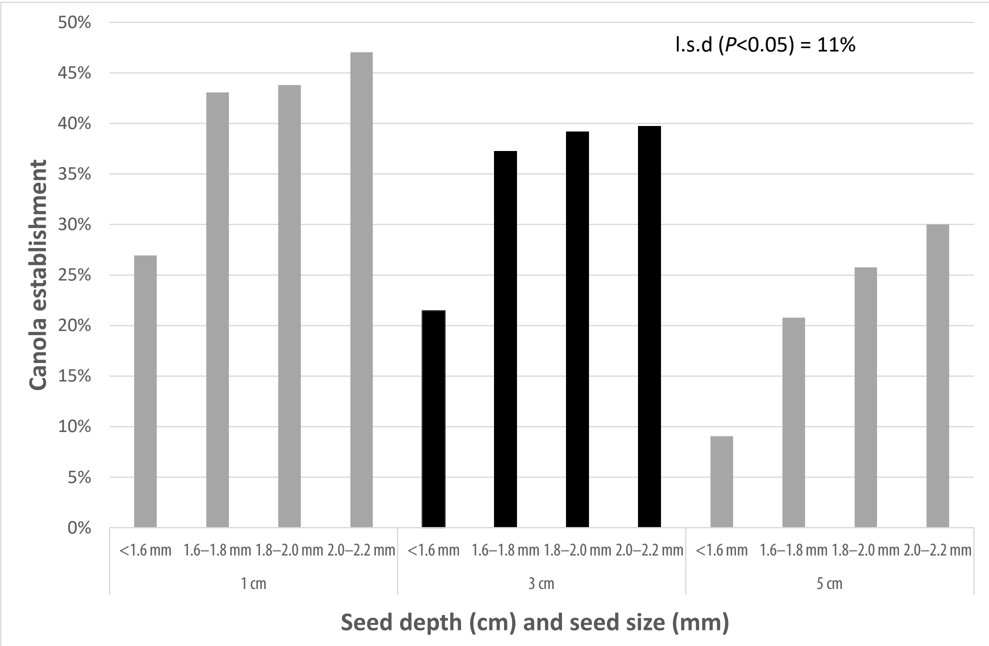


Figure 17. Effect of seed depth and seed size on canola establishment.

Figure 18. Effect of seed size on canola establishment.
Top to bottom = 1.8–2.0 @ 3 cm depth;
<1.6 mm @1 cm depth;
<1.6 mm @ 5 cm depth.

Figure 19. Effect of seed size on canola establishment.
Top to bottom = 1.8–2.0 mm @ 1 cm depth;
2.0–2.2 mm @ 5 cm depth;
<1.6 mm @ 1 cm depth.