Tactical use of nitrogen in canola to manage risk and include break crops in northern Wimmera

Southern agribusiness trial extension network

Project final report PRI00002

Pritchard Agricultural Consulting and Extension and Wallup Ag Group

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INTRODUCTION

While some things never change, this cannot be said for canola. Despite a long run of tough seasons, Australian growers have adapted their farming practices to reduce both production and financial risk in growing crops while maximising profitability.

For canola, successful crop establishment is the key to achieving high yielding crops. Vigorous and even early establishment provides excellent weed competition and makes management decisions for timing of operations straightforward. This booklet aims to provide the latest information from trials and demonstrations and from successful growers as they strive to produce high yielding canola crops.

In contrast to current grower practices outlined in this book practices were quite different to 25 years ago when the canola industry was established, with the release of canola quality and blackleg resistance cultivars. For example, growers were advised to cultivate soils deeply to avoid hardpans and provide an ideal seedbed. Seed was commonly droppedon the bare soil surface and harrowed it in, hoping for the best. Integrated pest management did not come into the equation and blackleg management meant choosing a variety with good resistance rating and only growing canola in a paddock every four years. Sowing in mid-June in some medium rainfall areas was common and recommended sowing rates were as high as 7 kg/ha. Weed control could be difficult as no herbicide tolerant varieties were available to growers.

Case studies to showcase successful crop establishment techniques
This booklet contains case studies of nine outstanding growers from a range of rainfall zones across Australia. They are finding success using modern cropping techniques to maximise establishment and cost-efficiency for canola production on their farms. For many growers in low and medium rainfall areas, selecting canola for a given year means considering a number of seasonal and market factors to minimise financial and production risks. No-till croppers have modified their machinery, sowing rates, row spacing, time of sowing, pest and disease management techniques, fertiliser strategies, weed management and variety choice to successfully get the crop up and make the most of the growing season.

Trials and demonstrations
The results from Better Oilseeds trials and demonstrations from each canola-growing State in 2008 are presented in this book. These provide new information on a range of issues that farmers need to consider before sowing a crop of canola. These include fertiliser strategies, blackleg management, sowing time, variety choice, seed source, herbicide tolerance type and management of dual purpose canola for grain and grazing.

The Better Oilseeds project
The Better Oilseeds project is jointly funded by the Grains Research and Development Corporation and the Australian Oilseeds Federation. The project provides much-needed support for oilseed growers, aiming to lift production of oilseed crops: canola, sunflower, soybean and safflower, ensuring critical mass and consistency of production and improving the quality of grain.

Australian oilseed production peaked in 1999, but the peak was less than what many analysts believed was the potential. In recent years, lower rainfall and/or lower prices have resulted in the crop area declining from the 1999 peak and have also contributed to oilseeds disappearing from some farms in traditional growing areas. The return to more favourable seasons in many cropping regions has seen a record crop produced in 2011/2012, around half a million tonnes more than 1999.

The project aims to put aside the weather and price factors and look at ways to support the industry to improve the skill level of advisers and growers enabling them to more reliably produce oilseeds under current climatic conditions and to take advantage of more favourable seasons when they occur.

SUMMARY

This booklet focuses on canola establishment and presents results from seven trials/demonstrations and nine grower case studies from each canola growing state. The growers presented here have found success with canola and are outstanding in their on-farm practices of crop preparation and sowing to maximise establishment of their canola stand.

Trials and demonstrations
The trials and demonstrations in 2008 covered a range of factors growers needed to consider when planning to sow canola and provides knowledge on how to achieve successful crop establishment.

Varieties
In Western Australia, 10 growers across the wheat-belt sowed canola variety demonstrations. The Oilseeds WA/Better Oilseeds canola variety demonstrations in conjunction with National Variety Trials data provide growers with the required information to select a canola variety suited to their region in Western Australia.

In 2008 the Better Oilseeds team in Victoria chose to test Roundup Ready canola in the Wimmera in 2008 and compare it with varieties of other herbicide tolerance types in a demonstration. The demonstration gave hundreds of growers the chance to see the new technology alongside popular Clearfield and triazine tolerant canola varieties, and to view differences in weed control. Results are presented in “GM Canola – Performances and Experience in 2008” which can be downloaded on www.grdc.com.au/director/events/grdcpublications.

Seed quality
A trial at Cummins on SA’s Eyre Peninsula in 2007 found that size matters when it comes to canola seed, where sowing larger seed increases yield. In contrast, trials at South-east SA and again at Cummins in 2008 found no effect of seed size on canola yield.

And while size can matter, the source of the seed is also important. A trial at Cummins found in nearly all cases, yields were reduced when using farmer-retained seed rather than certified seed, with yield loss up to 26% in 2008.

Sowing rates and row spacing

In South-east SA, three trials looked at the effect of sowing rates on hybrid canola yield. Sowing rates of hybrids are an important consideration for growers. Hybrid seed is often much larger so there are fewer individual seeds per kg of seed sown. However, the increased vigour from hybrids resulted in a higher percentage of seed successfully establishing. However, the high cost of seed relative to the open pollinated varieties is a limitation. The trials aimed to see "how low can you go?" and found the two hybrids tested could be sown at 2 kg/ha without yield loss. The exception was at one site were weed competition was high, demonstrating that early weed control is very important when crops are sown at low rates.

A very low rate (1 kg/ha, or 20 seeds/m^2) often reduced yield of both hybrids and open pollinated varieties in trials in South-east SA and the Eyre Peninsula in 2008. This contrasted with a Better Oilseeds trial at Lameroo, in 2007, where low sowing rates (1 and 2 kg/ha) improved canola yields under extremely dry conditions compared with the highest rates (5 and 7.5 kg/ha) for the variety Bravo TT, while sowing rate had no effect at other sites which received more rain that year.

In New South Wales, the results from the second year of a three year trial at Old Junee are presented to determine the optimal row spacing and sowing rate for a hybrid Clearfield and an open pollinated triazine tolerant variety. Results so far have found that widening the row spacing from 18 to 22 to 30 cm tended to reduce the number of plants established; despite this, yields and oil content were unaffected. The results to date demonstrate the ability of canola to compensate for lower plant densities in some environments which may have been influenced by wider row spacing and/or lower sowing rates. The authors caution that where target plant densities are high with wide row spacing, the number of plants per row may be too high, leading to taller, spindly plants at risk of lodging.

Time of sowing

A trial at Riverton in SA's mid-north high rainfall zone found delayed sowing in 2008 from 29 April to 12 May generally reduced canola yields and oil content. Crops sown later within the sowing window are more likely to experience hotter and drier conditions during pod filling, and later maturing varieties tend to be most affected.

Nutrition

Nitrogen (N) fertiliser is usually the highest single cost for canola growers, so getting it right is imperative. The Better Oilseeds trial at Kerang, Victoria, in 2008 aimed to determine optimal N rates and timing for irrigated canola. The "rule of thumb" for N rates for canola was that the crop needed 80 kg of total N (all sources) to produce one tonne of grain. The question of N rates arose over a number of years when canola trials at the site consistently yielded more the theoretical N-limited potential:

- was this due to later timing of the fertiliser application improving its efficiency?
- were other sources of N becoming available to the crop during the season?
- or has canola's N requirements been overestimated?

Results from the 2008 Kerang trial were consistent with variety trials in recent years (supported by the Victorian Irrigated Cropping Council). It was found that 60 kg/ha total

N was sufficient to produce a tonne of grain at the irrigated trials site, regardless of timing. Higher rates did not improve yields. A new "rule of thumb" has now been established for irrigated canola assuming 60 kg/ha total N is required to produce a tonne of grain.

Timing of N application was also evaluated in dryland canola at Riverton, SA in 2008. In contrast to the Kerang irrigated trial, the trial found that N applied at stem elongation produced lower yields than N applied at sowing. It seems likely that the dry finish to the season in 2008 limited uptake of topdressed N and results would be different in a wetter season.

Disease management
Management for the disease blackleg in canola focuses on strategic planning. Surveys of crops in south-east SA and Lower Eyre Peninsula in 2008 found internal infection of blackleg in many varieties. Infection levels of some varieties were higher than expected, including several varieties considered to have excellent blackleg resistance. A Fact Sheet providing recommendations on management of these varieties in the 2010 season is on page 27. The Lower Eyre Peninsula survey showed most paddocks had internal blackleg infection levels below 10%, therefore unlikely to suffer a yield or oil content penalty. But 12 paddocks had average infection levels between 20 and 40%, potentially reducing yield by 7 to 14%, plus reduced oil content.

In the south-east, the level of yield loss at a certain level of internal infection was twice as high in 2008 (with its dry spring) as measured in the good spring of 2001.

A trial at Moyhall in south-east SA found the fungicide Jockey did not reduce yield loss in varieties with different levels of blackleg resistance in 2008, however work from previous year's has seen increased yields.

Grazing
Grazing of canola crops and bringing them through to harvest is a relatively new concept and taking off rapidly in the high rainfall zones, giving producers vital feed during the winter while still producing a crop. A trial at Riverton in SA found simulated grazing during the vegetative phase reduced grain yield by an average of 13% and oil content by 0.5 percentage points. In the 2008 trial, the effect of grazing on yield was not significantly different among varieties, but this aspect will be further investigated.

A similar trial was undertaken at Cummins on SA's Eyre Peninsula which showed differences in the yield reduction with the five different varieties tested. On average, simulated grazing reduced grain yield by 35% in 2008. The best-performing varieties in the trial were Tarcoola and Hyola 76. Early dry matter production (80 days after sowing) was similar in all varieties, except in ATR-Marlin which was much lower. In 2008 the dry spring did not allow the grazed crops time to recover, in other trials with average spring rainfall grazed crops had less or no yield reduction from grazing.

Case studies
A number of case studies are also presented from across Australia highlighting the adaptability of growers who have modified their sowing systems to suit their environments, evolving with increasingly dry conditions and modifying their methods as the season requires.

Most current canola growers in the high rainfall zone will not change their rotations. While canola growers in the medium to low rainfall zones generally adhere to rotations, their decision to sow canola is more likely to be influenced by factors such as grain prices, the timing of the autumn break and subsoil moisture levels at the time of sowing. Those in the high rainfall zone often prefer not to dry sow, whereas in areas with less rainfall, dry sowing is more common and provides the opportunity to get the crop in early to make the most of the limited growing season rainfall. Some growers in these areas will “sow by the calendar”. For one grower in southern NSW, if no soil moisture is present at the end of April, canola is sown dry.

Canola is usually grown after a cereal in a continuous cropping rotation or after a pasture, particularly if grass weeds are present, to allow for a break from grass weeds before sowing a cereal. One grower from the southern Wimmera typically grows canola after a legume crop to make the most of available nitrogen.

Minimum till and no-till have become increasingly popular. The grower studied aim to retain as much stubble as possible, although this depends on sowing equipment and stubble loads. A number of factors driving minimum or no-till practices include: less wind erosion (in the low rainfall zone), timeliness of sowing, moisture conservation, less need for burning stubble, less cultivation and associated costs and better soil structure from increased organic matter. The desired result is timelier sowing and better crop establishment.

Knife points are most commonly used in the case studies. However, on some heavy soil types, growers may switch to inverted T-points if sowing into moisture to minimise smearing of the soil. One South Australian farming family uses disc openers to allow them to fully retain stubbles where there is high stubble load. Press wheels are considered ideal for canola to provide good seed-soil contact, particularly when sowing into marginal moisture, preventing the seed from drying quickly. Water from small rainfall events also enters the furrow more readily to improve germination. Growers state press wheels, combined with good stubble cover, have made a major difference to canola establishment in low rainfall areas. care with seed placed fertiliser – probably a major issue in 2011!

Inter-row sowing is becoming more popular for growers in the low and medium rainfall zones, but can be difficult for growers in the high rainfall zone as wider rows may limit potential yields. Inter-row sowing with discs can also be difficult when discs wander.

Sowing rates for growers vary from 2 to 5 kg/ha. Sowing rates for hybrids were lower, due to the cost of seed and the excellent early vigour of hybrids. One grower said he used a higher sowing rate when dry sowing, while another sowed at a heavy rate to compensate for early insect damage.

Growers may also alter their herbicide applications when dry sowing. Two growers case studied said they reduced their trifluralin rate and delayed the application of triazine herbicides. One grower would not compromise his weed management even if the plant population is low or patchy as a major reason for growing canola in a rotation is its usefulness in weed (and disease) control for subsequent crops.

WALLUP AG GROUP CANOLA EXPO

Summary

The Wallup Ag Group held a Canola Expo on 01 September 2011 with coordination and support provided by Pritchard Agricultural Consulting and Extension and the Victorian Department of Primary Industries.

The event included presentions by from canola industry service providers and researchers and inspection of the trial and demonstration established as part of the same project.

Issues covered included:

1. Canola in the crop sequence
2. Breeding canola types and varieties
3. Soils and nutrition
4. Pests and diseases of canola
5. Harvest and marketing

Advertising and networking with growers

Flyers
The Victorian Department of Primary Industries provided access to its active Wimmera grower group database and distributed to flyers to half its members, 362 grower households in the region. These included members from the following groups:

- Brim Topcrop group
- Nhill South Topcrop & Landcare Group
- Netherby-Broughton Topcrop group
- Natimuk Topcrop group
- Wallup Ag Group (formerly Wallup Topcrop group)
- Horsham South Topcrop Group
- Horsham East Topcrop Group
- Sheep Hills Topcrop Group
- Woorak Topcrop & Landcare Group
- Lubeck Topcrop Group
- Kaniva Topcrop Group

Text messages
A text message reminder to 201 growers was sent by the Vic DPI two days before the event. The Wallup Ag Group also sent a text message reminder to its own members.

Radio and newspaper ads
The event was advertised on 3WM and Mixx FM radio, plus four advertisements were taken out in the Wimmera Mail Times and one each in the Herald-Weekly Times

(Vic/S. NSW), Weekly Advertiser (Wimmera), Dimboola Banner and Warracknabeal Herald. See appendix.

Media release
A media release was prepared and sent to media outlets in Victoria, SE South Australia and S. NSW and published in a number of papers, including the Wimmera Mail Times, Hopetoun Times, Dimboola Banner, Warracknabeal Herald and an abridged version in the Herald Weekly Times. The media release was modified to target the reader base.

The media release was also sent to an extensive database including agronomists, researchers, some growers, GRDC panel members and the wider canola industry.

Other media coverage
The Expo was reported in the Warracknabeal Herald and Wimmera Mail Times' Wimmera Farmer supplement the Wednesday after the event. See appendix.

Websites and emails
A website supporting the project was established on the International Plant Nutrition Institute website (http://anz.ipni.net/portals/Wallup%20Ag%20Group) and the Expo was advertised on this site. This site had over 200 page views from July 01 until December 01, 2011.
It was also on the GRDC website (diary dates) and distributed in the ORM southern region ag diary email.

Signage
Three composite signs were made for the trial site and to direct attendees to the Expo. The signs bore the GRDC and Wallup Ag Group logos, and smaller logos for in-kind contributors to the trial and demos.

Attendance

More than 70 people attended the Expo. Names and contact details of attendees were taken on the day, although the list was incomplete.

In addition to the Expo, the Wallup Ag Group visited the trial and demo twice with presentations by Felicity Pritchard.

In-kind contributors

Seventeen organisations or companies provided in-kind contributions towards the Expo, including:

1. Wallup Ag Group members
    - Preparation for Expo/working bee at hall/set up
    - Chairing sessions
    - Organising catering
    - Helping with trial topdressing, erecting signs

2. Victorian Department of Primary Industries, particularly Ashley Wallace and Roger Armstrong
    - Printed and flyers and provided mailing list
    - Sent text reminders to growers
    - Microphone
    - Presentation at Expo

3. International Plant Nutrition Institute, particularly Rob Norton
    - Advice on trial design
    - Presentation at Expo
    - Hosting website and uploading photos and information

4. University of Melbourne and Incitec Pivot, particularly Peter Howie and Lee Menhennet
    - Sowing, spraying and harvesting of trial
    - Presentation at Expo

5. Pacific Seeds, particularly Anton Mannes and Andrew Easton
    - Hybrid seed for demo site
    - Presentations at Expo

6. Pioneer Hi-Bred, particularly Henk Vrolijks
    - Hybrid seed for demo site
    - Presentation at Expo

7. Monsanto, particularly Tony May
    - Presentation at Expo
    - Provision of refreshments

8. Nuseed, particularly Rob Christie
    - Advice for trial design
    - Presentation at Expo

As well as the following companies and organisations who presented at the Expo:

9. GRDC Southern Panel – Susan Findlay
10. Birchip Cropping Group – Simon Craig and Claire Browne
11. Nufarm – Mark Slatter
12. Cargill Australia - Scott Whiteman
13. Canola Breeders – David Leah
14. Viterra – Wayne Burton
15. Marcroft Grains Pathology – Steve Marcroft
16. Grain Assist – Alastair Beaumont
17. Additional in-kind contribution was provided by Felicity Pritchard.

Program

Time	Presentation	Presenter
9:00	Tea and coffee	Companies will have displays in the hall
9:30	Welcome	Bruce Crafter, Wallup Ag Group President (5)
	CHAIR: Bruce Crafter	
9:35	GRDC opening address	Susan Findlay-Tickner, GRDC Southern Panel member (10)
9:45	Canola in the crop sequence • Canola's break crop benefits in the Wimmera, keeping canola in the rotation in the Wimmera in the good and bad years • Which canola type for which paddock? Guiding growers through the maze of conventional, TT, Clearfield and Roundup Ready canola choices	Felicity Pritchard, PACE (15) and Claire Browne, BCG (10 + 5) Mark Slatter, Nufarm (15+5)
10:35	Breeding, canola types and varieties • How hybrid canola is developed and why hybrid seed costs more • New Pioneer Hi-bred hybrids • New Pacific Seeds hybrids • New Nuseed varieties and growing Monola • Cargill hybrids and growing Cargill specialty oilseeds • New Canola Breeders varieties and hybrids • New Viterra Roundup Ready hybrids and growing Juncea canola • Roundup Ready® canola update	Andrew Easton, Pacific Seeds (20+5) Henk Vrolijks Pioneer Hi-Bred (5+5) Anton Mannes, Pacific Seeds (5+5) Rob Christie, Nuseed (10+5) Scott Whiteman, Cargill (10+5) David Leah, Canola Breeders (5+5) Dr Wayne Burton, Viterra (10+5) Tony May, Monsanto (5)
12:20	Lunch	Companies will have displays in the hall
1:00	Soils and nutrition for canola – field sites	

2:00	Travel to canola N timing x rate trial site (20) Trial background/treatments Nitrogen nutrition in canola in Wimmera: rates, timing, effect on oil content Nitrogen product choice, fertiliser placement for better canola establishment Travel to demo site hybrid vs OP, starter fertiliser (15). Demo details. Subsoil constraints of canola and other crops in the northern Wimmera; water use of canola Return to Wallup Hall (15)	Felicity Pritchard, PACE; Ian Schmidt, Wallup Ag Group (10) Assoc. Prof. Rob Norton, International Plant Nutrition Institute (15+5) Lee Menhennet, Incitec Pivot (10+5) Rob McRae, Wallup Ag Group (5) Assoc. Prof. Roger Armstrong, Vic DPI (10+10)
3:00	Afternoon tea	Companies will have displays in the hall
	CHAIR: Rob McRae	
3:30	Pests and diseases New and emerging canola pests in stubble retention systems, pest management, monitoring methods Managing blackleg and other diseases – latest research findings and recommendations	Dr Stuart McColl, CESAR Consultants (20+10) Dr Steve Marcroft, Marcroft Grains Pathology (20+10)
4:30	Harvest and marketing Windrowing vs direct heading vs Podceal; keeping residues out of canola Grain marketing – global and domestic trends, marketing strategies for growers	Simon Craig, Birchip Cropping Group (10+5) Alastair Beaumont, Grain Assist (10+10)
5:05	Closing remarks and summary	Trevor McRae, immediate past president Wallup Ag Group
5:10	Evaluation	
5:15	Refreshments	

GRDC-WALLUP AG GROUP TRIAL
Canola nitrogen rate and timing

Trial location: “Scott’s”, Ailsa Road, Wallup, Victoria
Trial co-operator: Ian Schmidt

Felicity Pritchard and Rob Norton

Key messages

- A trial was undertaken to determine if nitrogen rates for canola can be reduced in the Wimmera without loss of yield. It also aimed to determine how late nitrogen can be topdressed.
- Nitrogen rate is more important than timing.
- A total 80 kg N/ha/tonne of grain yield – the popular ‘rule of thumb’ has stood up as the best treatment over a range of timings. However, results from this trial suggest a lower rate (60 kg) can provide similar yields as long as it is applied early.
- Canola can respond to late applied nitrogen (early flowering) but less efficiently than earlier applied nitrogen in a season with a dry spring.

Background and aims

Nitrogen fertiliser is often the single biggest variable cost to canola growers in the northern Wimmera.

Throughout the drought, canola was commonly dropped from the rotation in the region as it was seen as a risky crop. To counter some of this risk, some growers changed from pre-drilling all nitrogen fertiliser to splitting or deferring all nitrogen fertiliser applications.

Current recommendations suggest deferring N to the eight leaf stage is possible so long as reasonable amounts of N are present in the soil at sowing time, with rates far more important than timing. Defering allows growers to better assess seasonal conditions and therefore yield potential before committing to N application.

Research in CW NSW in wetter seasons the 1990s showed N could be applied at flowering and still provide yield response in a good season. The wet season of 2010 created many questions from growers about how late N fertiliser could be applied to canola.

In addition to timing, the ideal rate of N is queried as well as the efficiency with which N is used when applied early or later in crop growth.

Canola seed typically contains 40 kg N per tonne of grain, and a normal nitrogen use efficiency is around 50%. Therefore, current recommendations suggest canola requires 75 to 80 kg N from all sources to produce each tonne of grain. However, more recent trials by IREC/Better Oilseeds and demonstrations by Topcrop State Focus in 2001 suggest that a figure of 60kg N would probably suffice, particularly for higher yielding crops. The exception is in waterlogged situations.

The trial aims to determine the optimal timing of N fertiliser and the rates for the northern Wimmera.

Site details

Paddock history: 2010 Barley. April 2011 stubble was burnt and harrowed. In May 2011, the paddock was prickle chained immediately following trifluralin application.
Sowing date: 20 May 2011.
Sowing rate: 5.6 kg/ha; seed size 212,900 seeds/kg.
Variety: Pioneer 44Y84
Plot size: 1.74 m x 20 m (6 rows)
Row spacing: 290 mm
Herbicide and insecticides:

Date	Crop stage	Product	Rate (per ha)
18 May 2011	Bare earth, incorporated	Lorsban	
	Bare earth, incorporated	Treflan®	1.5 L??(Boxhead)
20 May 2011	Post-sowing, pre-emergence	Lorsban	Check with peter
		Endosulfan	
		Mouseoff (zinc phosphide)	1 kg
7 July		Mouseoff (zinc phosphide)	1 kg
Ca. 27 July	Post emergence	Intervix Select	*boxhead*
15 August		Mouseoff (zinc phosphide)	1 kg

Soil type: Wimmera grey cracking clay (vertosol).
Soil pH_{Ca}: 8.30 (water), 7.70 ($CaCl_2$).
Colwell P: 22 ppm
EC: 0.19 dS/m
ESP: 1.3%
Soil available N: 3.9 mg/kg nitrate and 0.9 kg/ha ammonium, equating to 34.8 kg/ha available N in top 60 cm at sowing (17 kg/ha N in top 10cm).
Estimated in-crop mineralisation 40.8 kg/ha N.
Fertiliser: 50kg/ha triple super (20.7% P) at sowing plus varying urea rates.
Plant available water: 45.6mm to 60cm depth; 71mm to 100cm depth in early May 2011.
2011 growing season rainfall: mm (1 April – 31 October 2011).
Windrowed: 5 November 2011
Harvested: 22 November 2011.

Method

Sowing:

The trial was sown dry two days prior to rain into cultivated soil with Incitec Pivot/University of Melbourne small plot cone seeder with trailing press wheels. Urea was drilled below the seed at varying rates in the one pass.

Seed was treated with Jockey and Gaucho. The hybrid 44Y84 was chosen as the trial co-operator was using two other Clearfield varieties in the same paddock, and open pollinated early variety (44C79) and a mid-maturing hybrid (45Y82). The 44Y84 gave the opportunity to showcase a new, early maturing hybrid within the same herbicide tolerance group.

Trial design:
A randomised complete block design with three replicates was used to compare three rates of nitrogen with nine timings, as well as control plots which received no urea.

Potential yield calculations:
Potential yield at sowing was calculated as 2.12 t/ha using the modified French-Schultz equation, assuming a water use efficiency of 9.5 kg/ha/mm for a 19 May sowing (Robertson M and Kirkegaard J (2005).

The calculation included plant-available subsoil water to 100cm depth, rather than 60cm, which is used by fertiliser companies and advisers. Soil moisture was measured in early May. Plant available water (PAW) was determined from APSoil (CSIRO) soil property figures for upper and lower limits that were determined at the nearby property of Trevor McRae. PAW to 60 cm depth was estimated as 46mm; to 100 cm depth PAW was 71 mm.

Fertiliser rates:
The three rates of nitrogen (from all sources) per tonne of potential yield were based on the assumptions of:

1. 80 kg N/ha (used by agronomists)
2. 60 kg N/ha (used by DPI Kerang)
3. 40 kg N/ha (low rate for comparison)

Soil mineral nitrogen at sowing was measured as 35 kg N/ha to 60 cm deep, and it was estimated that in-crop mineralisation would contribute an additional 41 kg N/ha during crop growth, The N demand of the crop, based in the three N efficiencies and the yield potential was adjusted for mineral N at sowing and in-crop mineralisation, so that the urea rates applied were:

1. 204 kg urea /ha (2.12 t/ha * 80 – 35 – 41 = 94 kg N)
2. 112 kg urea /ha. (2.12 t/ha * 60 – 35 – 41 = 51 kg N)
3. 20 kg urea /ha. (2.12 t/ha * 40 – 35 – 41 = 9 kg N)

Fertiliser timing:
Timing of application were pre-drilling and topdressing treatments at stem elongation and early flowering, plus combinations of split applications:

1. All urea pre-drilled (20 May)
2. All topdressed at stem elongation (4 Aug two hours before 6 mm rain, with 13mm over four consecutive days; ideal)

3. All topdressed at early flowering (11 September during cool weather, before forecast showers which did not eventuate - but no other rainfall forecast beyond then. Some pods beginning to form on lower stems.)
4. Half pre-drilled and half topdressed at stem elongation
5. Half pre-drilled and half topdressed at early flowering.

Harvest:
The trial was windrowed and harvested with a plot windrower and harvested with a plot harvester and grain weighed on site.

Grain quality:
Subsamples were cleaned and analysed for oil and moisture content with a NIR spectrophotometer, with four to seven readings recorded per subsample, depending variation in readings. The CV for the different readings was 0.01 in 90% of subsamples; 0.02 for the remainder. The oil content was standardised to 8.0% moisture for data analysis.

Data analysis:
Data was analysed with a general Analysis of Variance using Genstat version 14.2. Treatments included rate, timing and a third “Any N” treatment, which referred to whether or not the plots received any added N, i.e. control *vs* treated plots. Treatment structure was specified as rate x timing nested within the Any N treatment. Block structure was specified as plot within replicate nested in replicates.

Results

Observations 4 August – first topdressing

- Excellent establishment.
- Crop at eight leaf growth stage with buds visible under leaves and some plants beginning to elongate.
- Mouse damage in replicate 1 buffer and some signs of mouse grazing in the plot 16. Northeast part of replicate 1 less vigourous, possibly due to mouse grazing or denser volunteer barley population.
- Pre-drilling treatments clearly visible, with high N rates considerably more lush with darker green leaves than plots with no N pre-drilled.
- Weeds beginning to die. Volunteer barley yet to show signs of herbicide effects, and are fairly dense in northeast plots.

Observations - 1 September, four weeks after first topdressing

- Pre-drilled plots with high and moderate rates continue to look the best, although these rates which were also topdressed early appear to be catching up. The low rate appears nitrogen deficient, as do those plots without N applied.

CONTROL – No N

	Low Rate 10 kg N	Moderate Rate 50 kg N	High Rate 100 kg N
All pre-drilled			
Split half pre-drilled, half stem elongation			
Split half pre-drilled, half early flowering			
All Stem Elongation			

Effect of rate

- The addition of at the top rate enabled the presowing estimated yield to be achieved.
- Addition of nitrogen fertiliser compared with control plots increased yield by an average 35 per cent.
- Increasing rates improved yield, with highest yield of 2.12 t/ha achieved with the highest rate. The lowest rate was no different to the control.
- Oil content was inversely related to nitrogen rates. The effect of N rate on oil content was highly significant ($p<0.001$). However, more importantly, oil yield increased with nitrogen rate due to higher grain yields.

Table 1: Increasing nitrogen rate increased canola yield (t/ha) but reduced oil percentage (t/ha). Oil yield increased with nitrogen rates.

Rate	Mean yield	Oil % standardised to 8.5% moisture	Oil yield (t/ha)
High	2.12	41.89a	0.89
Moderate	1.85	42.82b	0.79
Low	1.50	43.68c	0.66
Control (no added N)	1.36	43.95c	0.60
LSD* (5%) when comparing high, low and medium rates	0.15	0.52	
LSD when comparing rates with control	0.25	0.90	

*NB: The LSD is the least significant difference. Here, when comparing two nitrogen rates, the difference between yields needs to be 0.15 t/ha or more to be significant. Otherwise, the differences may well be a chance finding.

Effect of timing

Timing alone did not affect yield or oil content ($p>0.05$).

Interaction timing x rate

Where yields exceeded 2.0 t/ha, they were not significantly different from each other.

Table 2: Nitrogen rate and rate x timing interaction affected canola yield.

Rate	Timing						
	All predrilled	All topdressed stem elongation	All topdressed early flowering	50:50 split; predrilled & topdressed stem elongation	50:50 split; predrilled & topdressed early flowering	Control (no added N)	LSD (5%)
High	2.11	2.30	1.92	2.10	2.16	1.36	0.33
Moderate	1.80	2.11	1.63	2.03	1.69		
Low	1.60	1.37	1.67	1.55	1.32		

For the high and moderate rates, yields were highest nitrogen topdressed at stem elongation or with a split application of nitrogen pre-drilled and topdressed at stem elongation. Pre-drilling all nitrogen produced highest yields for high nitrogen rates only.

Topdressing at early flowering alone was too late to maximise yields, although when rates were high, there was still a yield response - compared with the control.

Low rates of nitrogen sometimes produced higher oil content, with some delayed applications increasing oil content further (Table 3). In contrast, this trend was not evident with the moderate and high rates, where delayed N often reduced oil content compared with pre-drilled N.

Table 3: Nitrogen rate and rate x timing interaction affected oil content (%).

Rate	Timing						
	All predrilled	All topdressed stem elongation	All topdressed early flowering	50:50 split; predrilled & topdressed stem elongation	50:50 split; predrilled & topdressed early flowering	Control (no added N)	LSD (5%)
High	42.57	41.79	41.24	41.99	41.85	43.95	1.16
Moderate	44.05	42.52	42.10	43.06	42.36		
Low	42.95	43.22	44.01	43.99	44.21		

Oil content tended to follow yields inversely.

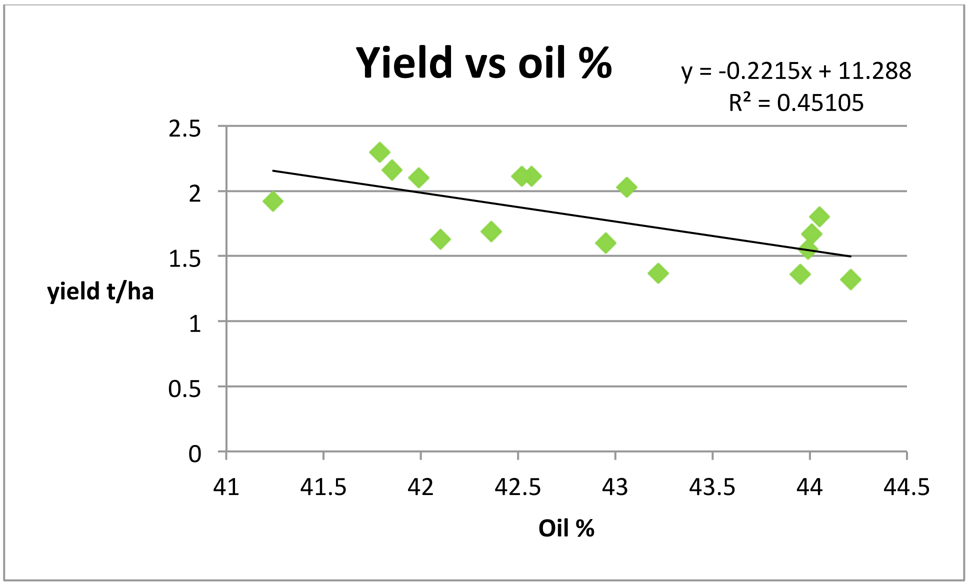

Figure 1: Yields and oil content were inversely related. Each dot represents the mean oil content and yield of each treatment, shown in Tables 2 and 3. Despite this, higher grain yields gave higher oil yields.

Discussion

Rates more important than timing

The results reinforce the importance of nitrogen for canola. It also reinforces previous recommendations that canola rate is more important than timing, provided the crop does not become nitrogen limited in its early growth stages.

While the trial found that 'rule of thumb' high rates (80kg N/ha/t) was the best rate, growers can achieve equal yields with lower (moderate) rates (60kg N/ha/t) so long as the fertiliser is supplied early enough during crop growth, including a topdress by early stem elongation.
A high yielding irrigated trial conducted by VICC under irrigation found yields of canola no different between the 80 kg/ha/t nitrogen 'rule of thumb' rate and a lower 60 kg/ha/t rate. It is possible that lateral movement of nitrogen between plots may have confounded that trial.

VICC canola variety trials under irrigation at Kerang have also yielded above their theoretical nitrogen-limited potential when based on the rule of thumb discussed in the introduction. One explanation may be higher growing season mineralisation rates under irrigation in the warm Mallee region than experienced in the dryland Wimmera. The calculation used to estimate in-crop mineralisation is very rough and needs to be researched further to be more useful to growers. *(that is, in-crop mineralised N in kg/ha = organic carbon % x 0.15 x GSR).*

Alternatively, or in combination with differences in mineralisation, the rooting depth of canola is assumed to be between 60 cm and 100 cm, with mineral N supply taken to the former and water supply to the latter depth. On these vertosols, roots of canola have been measured down to 1.8 m (Norton and Wachsmann, 2006) so that additional N and water could have been accessed during growth.

Topdressing nitrogen fertiliser during early flowering can still provide a yield response. In 2011, the efficiency of late topdressed fertiliser was lower than earlier applications. The late topdressing occurred before dry conditions. Research at wet sites by Central West Farming Systems in the 1990s showed that canola respond to nitrogen topdressed during flowering as long as the spring was wet.

Crop demand during the season

The site had about 40 kg nitrogen at sowing. The soil organic matter content suggests that around 40 kg nitrogen would be mineralised during the season, based on the rough calculation for estimating in-crop mineralisation.

By the four to six leaf stage, the crop would have extracted between 50 and 70 kg N/ha (about 1 t/ha biomass with 6% nitrogen content). At that stage the control would have been nitrogen stressed, and possibly also the low nitrogen rate at sowing.

By stem elongation, the canola would have around 2 t/ha biomass, with a lower nitrogen content of around 5%. This means the crop would have required around 100 kg N/ha. None of the low nitrogen treatments would have been able to meet this nitrogen demand and so would be nitrogen stressed.

The application of early 'splits' helped the moderate rate catch up a little, while the nitrogen applied at the higher rate would have kept the crop growing without nitrogen stress.

By first flower, the better growing crop is around 4 t/ha of biomass with around 4% nitrogen, so that it has demanded 160 kg nitrogen by now. If there was no additional nitrogen supplied, this would meet a 2 t/ha yield potential.

It seems that the predrilled treatment is using the N more efficiently – a placement effect largely, but all the high N treatments – even the late top dressing – still look pretty good. The late topdress recovered significantly compared with the control.

Some Rules of Thumb

Please treat these as guides only, the biggest variable is the efficiency of N use which is a culmination of many complex interactions between soil, plant and climate. The values below are largely taken from the PhD work of the co-author, Rob Norton, which was conducted in the Wimmera in the late 1980's:

· Read your crop –even at early flowering if the lower leaves are yellow and dropping – N supply is likely to be limiting.

· Each 25 mm of rainfall has the potential to add an extra 250 kg canola per hectare. To achieve this extra yield an additional 10-20 kg N would be required.

· Each added tonne of grain yield will reduce seed oil content by around 2%

· Response

  o With 50 kg N at seeding, and an extra 50 kg N will increase biomass at flowering by 50%.

  o With 50 kg N at seeding, and an extra 100 kg N will increase biomass at flowering by 100%.

  o With more than 120 kg N at seeding, then there will be little biomass at flowering response to extra N.

· Canola does manage to regulate its growth and yield so that harvest index (proportion of grain yield to total biomass) does not fall under moderate to high nitrogen supply. Frost and high temperatures can cause harvest index to fall though.

· Although N is important, other nutrients – especially S - should be considered.

Conclusion

- The original rule of thumb for nitrogen rates in canola of a total 80 kg N/ha/tonne of grain has stood up as the best treatment over a range of timings. However, results from this trial suggest a lower rate (60 kg) can provide similar yields as long as it is applied early.
- Canola can respond to late applied nitrogen (early flowering) but less efficiently than earlier applied nitrogen in a season with a dry spring.

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References

Norton RM and Wachsmann N, (2006). Nitrogen use and crop type affect the water use of annual crops in south-eastern Australia. Australian Journal of Agricultural Research, 57, 257-267.

Robertson M and Kirkegaard J (2005) Water use efficiency of dryland canola in an equi-seasonal rainfall environment. Australian Journal of Agricultural Research, 56, 1373-1386