CROP VARIETY, PERFORMANCE AND NUTRITION

YIELD PERFORMANCE OF NEW AND EXISTING BARLEY VARIETIES IN THE MALLEE AND NORTH CENTRAL NVT

Brooke Bennett (BCG)

TAKE HOME MESSAGES

- Three new barley varieties with suitability for the Mallee and North Central regions were released in 2021: Commodus CL Plus, Cyclops and Minotaur.
- New varieties lack long term data but are displaying encouraging yield potentials and useful physical traits that may lead to the replacement of existing lines in the future.
- Of the varieties with long term data available (five years), Leabrook, Rosalind and Compass have all performed above the Mallee average each year, placing them as consistent performers over a range of seasons.

BACKGROUND

The start to the 2021 season was quite a contrast to that of 2020. Where 2020 saw varying summer rainfall and a timely break in many areas, 2021 was dry for much of the first half of the year. The rain which arrived in spring was too late for many barley crops across the Mallee and some crops produced secondary tillers making maturing paddocks turn green again. This caused frustration over harvest as crops were slow to ripen. Some growers turned to desiccation options while others waited for the crops to ripen naturally. Around harvest time, when the straw of the barley was beginning to dry out, many growers observed brackling in some varieties—the stems of the plants buckled and lay on the ground making many heads impossible to harvest.

In the North Central region, the season was closer to an average year, with a timely break for many areas and average winter rainfall. Similar to growers in the Mallee, a handful of the National Variety Trials (NVT) re-tillered causing a delay to harvest. Some varieties also brackled, resulting in a slow and low harvest to collect all heads/grain.

There were six barley sites across the Mallee and two in the North Central in 2021. The North Central sites included trials at Charlton and Colbinabbin. It is however worth noting that these sites vary by soil type and seasons experienced. Colbinabbin experienced a typical season with a timely break and average winter rainfall whereas Charlton had a similar season to the Southern Mallee.

AIM

To compare the performance of new and existing barley varieties in the Mallee and North Central NVT.

TRIAL DETAILS AND INPUTS

Crop type: Barley

Target plant density: 130 plants/m^2

Seeding equipment: Knife points, press wheels, 30cm row spacing

Sowing date: Refer to Table 1

Nutrition, weeds, insects and disease were managed as per best practice.

Table 1. Sowing, germination dates and growing season rainfall (GSR) for the 2021 barley NVT sites across the Mallee and North Central regions.

Region	Location	Sowing date	Germination date	GSR (mm) number in bracket denotes decile
Mallee	Birchip (Watchupga)	7/05/21	10/05/21	172 (3)
	Manangatang	12/05/21	25/05/21	148 (3)
	Murrayville	11/05/21	11/05/21	149 (2)
	Rainbow	18/05/21	18/05/21	214 (4)
	Ultima	11/05/21	11/05/21	186 (4)
	Walpeup	12/05/21	25/05/21	184 (4)
North Central	Charlton	19/05/21	19/05/21	259 (5)
	Colbinabbin	20/05/21	20/05/21	306 (5)

METHOD

This research was conducted through the NVT program delivered by the Grains Research and Development Corporation (GRDC). The NVT program involves a series of replicated field trials that test varieties across many crop types. The data displayed in this article is a combination of NVT results; individual site reports and multi-environment trial analysis (MET) long term summaries. The MET analysis should be used by growers when comparing varieties as this encompasses more data over multiple seasons and is therefore more reliable. Both the MET analyses and single site summaries can be found at nvtonline.com.au. Grain yield data is represented as a percentage of the site mean for the past five years, which shows how a variety has performed in each season compared with the region's overall mean yield.

RESULTS AND INTERPRETATION

New varieties released in 2021

Commodus CL, bred by Grains Innovation Australia (GIA) and InterGrain and marketed by InterGrain, is a quick-mid maturing Clearfield® variety that is agronomically very similar to Compass. It is suited to lighter soils in the low rainfall zone and has similar lodging and head loss susceptibility to Compass. It is undergoing malt accreditation with a decision expected in 2023.

Cyclops is bred and marketed by Australian Grain Technologies (AGT). It is a quick–mid maturity that has Hindmarsh parentage, so has a short compact structure making it less susceptible to lodging. It is undergoing malt accreditation with the earliest decision expected in 2023. Cyclops has a provisional rating of susceptible (S) to CCN so would ideally need to be in a rotation with a CCN resistant wheat variety.

Minotaur, also bred and marketed by AGT, is a mid–slow maturity variety that is suited to the medium to high rainfall zone. It is bred from Hindmarsh as well as European genetics and is currently undergoing malt accreditation with the earliest decision expected in 2023.

More information on these and other varieties can be found in the Agriculture Victoria 2022 Victorian crop sowing guide.

YIELD RESULTS

Overall site averages of 2.6t/ha were recorded across the Mallee, ranging from an average of 1.34t/ha at Ultima on a vetch hay stubble to 3.3t/ha at Rainbow (lentil stubble) and Walpeup (lentil stubble). In the North Central, Charlton yielded 4.7t/ha on a lentil stubble and Colbinabbin yielded 5.9t/ha on a canola stubble (Table 2).

Commodus CL yielded within 0.3t/ha of Compass at every site and was in the top three yielding varieties at four of the six Mallee sites. This confirms Commodus CL's potential to perform as well as Compass with the added benefit of being a Clearfield ® barley. Commodus CL has yielded on average 9 per cent (%) higher than Spartacus CL or Maximus CL in the Mallee this season. These two varieties are quite different however and suit contrasting environments. For example: Spartacus CL would be the preferred option in high yielding environments as it has a short plant type and strong straw and peduncle strength, making it less likely to lodge and lose heads whereas Commodus CL has good early vigour and would be more suited to areas where early ground cover is required, such as sandy soils in lower yielding environments.

Cyclops has yielded well in the Mallee, topping three of the six trials, and hitting the site mean or above at all sites. It's outperformed La Trobe at every site achieving 4–30% more than La Trobe. This season Cyclops performed similarly to AGT's first released barley line, Beast, so it could be an option to replace Beast if susceptibility to lodging is an issue.

Minotaur yielded above the site average at four of the six Mallee trials and the same or higher than RGT Planet at five of the six Mallee sites, whereas in the North Central, Minotaur and RGT Planet yielded the same at Charlton and RGT Planet yielded higher than Minotaur at Colbinabbin. This suggests Minotaur may have broader adaptation to the low rainfall zone than RGT Planet, which performs extremely well in reliable rainfall environments, but yields drop back in below average years such as the 2021 Mallee season.

Several varieties released in the past few years are awaiting malt accreditation, so the highest quality they can achieve when sold currently is BAR1. How this affects decisions around variety selection depends on how regularly malt quality is achieved and the grain price when selling. The premium for malt on 22 December was $33/t, compared to the previous year when there was no price difference.

Of the varieties with long term data available (five years of data), Leabrook, Rosalind and Compass have all performed above the Mallee average each year, making them consistent performers over a range of seasons. However, Rosalind is non-malting quality, Compass has high lodging susceptibility and Leabrook has medium lodging susceptibility and is SVS for leaf rust. The decision to grow these varieties cannot be based on yield alone, but must include consideration of agronomic characteristics.

Table 2. Yield results of the 2021 NVT barley sites across the Mallee and North Central regions.

Region	Location	Average trial yield (t/ha)
Mallee	Birchip (Watchupga)	2.4
	Manangatang	3.2
	Murrayville	2.0
	Rainbow	3.3
	Ultima	1.3
	Walpeup	3.3
North Central	Charlton	4.7
	Colbinabbin	5.9

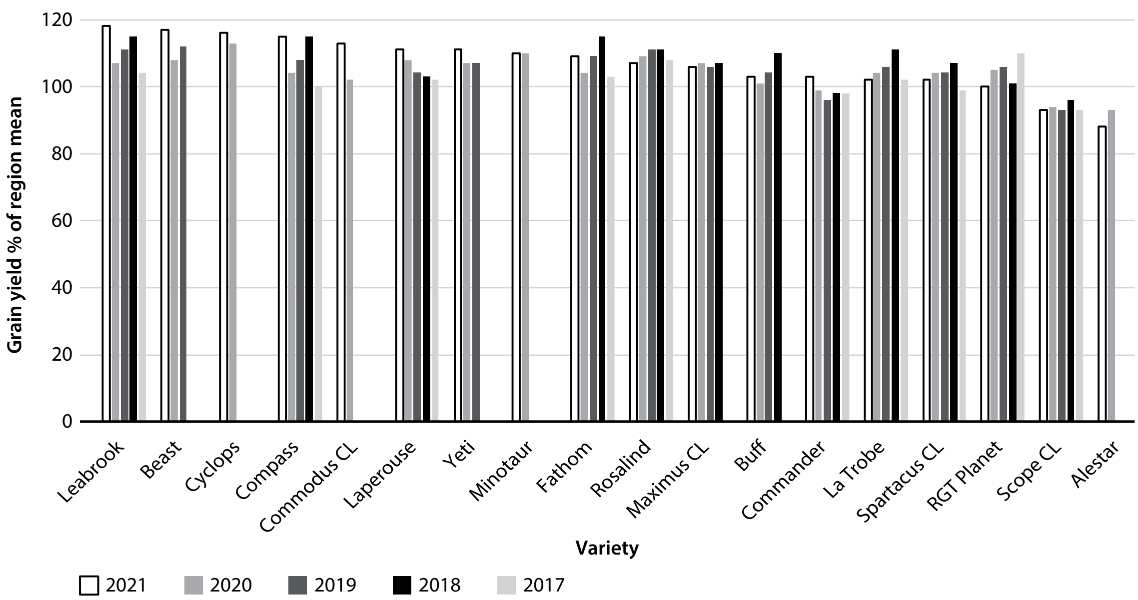

Figure 1. Mallee barley NVT average yield as a percentage (%) of region mean from 2017-2021. Includes data from six sites.

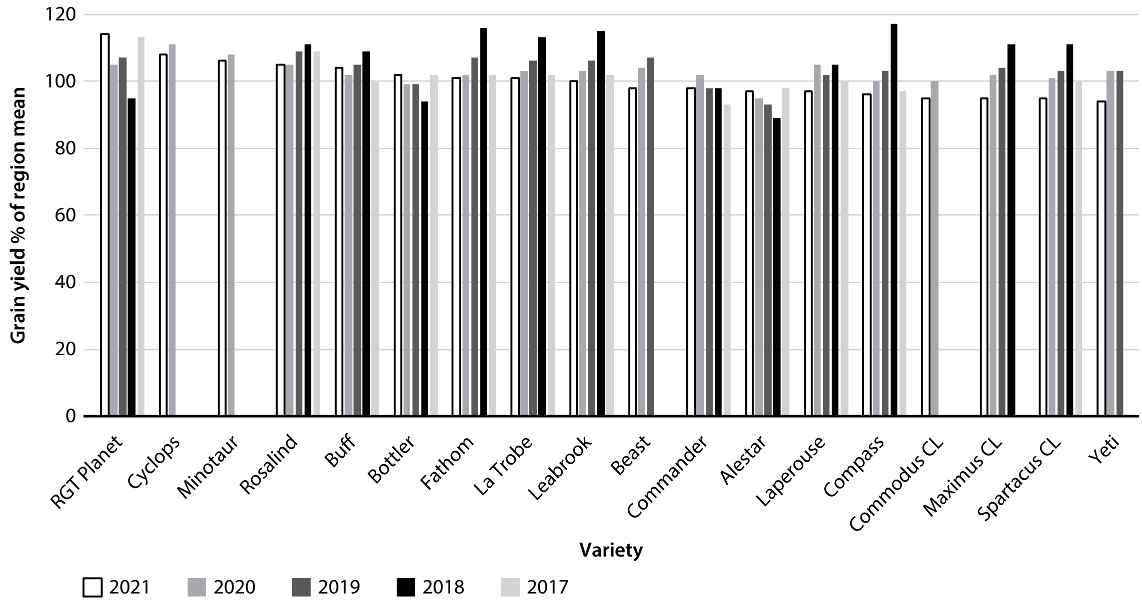

Figure 2. North Central barley NVT average yield as a percentage (%) of region mean from 2017–2021. Includes data from two sites.

DISEASE RATINGS

Cyclops has high yielding potential however it has a provisional rating of S for CCN (Table 3) so would ideally need to be in the cropping rotation with a resistant wheat variety. Commodus CL has a very similar disease package to Compass; it is resistant to CCN and has a provisional rating of MS for spot form of net blotch (SFNB) and net form of net blotch (NFNB).

Minotaur has improvements over RGT Planet's ratings for SFNB and NFNB but is SVS for leaf rust. Of all the released barley varieties, Maximus CL has the overall best disease package.

Table 3. Disease ratings of select barley varieties and select diseases (newly released varieties in bold text).

Variety	Disease			
	SFNB	**NFNB**	**Leaf rust**	**CCN resistance**
Commodus CL	MS*p*	MS*p*	SVS	R
Compass	MS	MS	SVS	R
Cyclops	S	MS*p*	SVS*p*	S*p*
Spartacus CL	SVS	S	S	R
Maximus CL	MRMS	MS	S	R
Minotaur	S	MS*p*	SVS	R*p*
RGT Planet	SVS	SVS	MS	R*p*

p = provisional rating. R = Resistant RMR = Resistant to moderately resistant, MR = Moderately resistant, MRMS = Moderately resistant to moderately susceptible, MS = Moderately susceptible, MSS = Moderately susceptible to susceptible, S = Susceptible, SVS = Susceptible to very susceptible, VS = Very susceptible.

SUMMARY

The number of varieties available to growers is continuing to increase, so choosing a suitable variety can be challenging. Spartacus CL and RGT Planet are commonly grown in the Mallee and North Central, however newer varieties are becoming competitive and the NVT data offers the opportunity to see how the yield of varieties stacks up against each other in varying environments, and in different seasons. Growers should combine this knowledge of the genetic potential of varieties with their own understanding of the management required in the farming system e.g. rotation, weed pressure, disease, soil constraints, nutrition, lodging/shattering susceptibility and sowing windows. Grain quality results were not available at the time of writing, but a variety's quality grade and consequent prices should also be considered when choosing a suitable variety. New varieties may lack long term data but many are displaying encouraging yield potentials and useful physical traits that may lead to the possible replacement of existing lines in the future.

REFERENCES

Victorian Crop Sowing Guide, 2022, Agriculture Victoria.

GRDC National Variety Trials yield data, 2021, <https://www.nvtonline.com.au/>.

ACKNOWLEDGEMENTS

This research was funded by the GRDC as part of the National Variety Trials project (BWD00029).
This summary has been funded by BCG members through their membership.

YIELD PERFORMANCE OF NEW AND EXISTING WHEAT VARIETIES IN THE MALLEE AND NORTH CENTRAL NVT

Brooke Bennett (BCG)

TAKE HOME MESSAGES

- Four new wheat varieties with suitability for the Mallee and North Central regions, were released in 2021: Calibre, LRPB Bale, LRPB Dual and Valiant CL Plus.
- Calibre topped the yield results in 2021 at five of the eight Mallee sites and yielded 8% or higher than Scepter at seven out of the eight sites but there isn't sufficient long-term data on this variety.
- Both quick and mid–slow maturing varieties yielded well this season.

BACKGROUND

The start to the 2021 season in the Mallee was quite a contrast to that of 2020. Where 2020 brought varying summer rainfall and a timely break in many areas, 2021 was dry for much of the first half of the year. A very late break to the 2021 season forced growers to make decisions about how to tackle their sowing program. Some removed canola from the rotation and replaced it with more wheat, others took out wheat altogether and fallowed paddocks, while growers with quick maturing varieties on hand, such as Vixen, inserted them into the sowing program to replace the traditional mid-maturing varieties, such as Scepter. Other growers continued business as usual. Winter continued to be dry. Welcome rain came late in spring, almost too late for growers further north, but providing welcome relief to wheat growers in the southern Mallee and North Central regions. With this rain however came paddock observations of leaf rust and Septoria in crops but, with limited biomass from the late start, no significant yield losses were observed.

Like many growers across the region, dry sowing some or all of their programs, many of the National Variety Trials (NVT) were also dry sown. The 'early break' trial that was irrigated at Watchupga was an exception and germinated before the end of April. While not reflective of the 2021 season, it was designed to imitate how the varieties might have performed under an early break scenario.

Eight sites across the Mallee and two sites in the North Central region were established and harvested in 2021, with 40 per cent of the trialled varieties consisting of breeding lines for potential release in years to come.

AIM

To compare the performance of new and existing wheat varieties in the Mallee and North Central NVT.

TRIAL DETAILS AND INPUTS

Crop type: Wheat

Target plant density: 130 plants/m^2

Seeding equipment: Knife points, press wheels, 30cm row spacing

Sowing date: Refer to Table 1

Nutrition, weeds, insects and disease were managed as per best practice.

METHOD

This research was conducted through the NVT program delivered by the Grains Research and Development Corporation (GRDC). The NVT program involves a series of replicated field trials that test varieties across many crop types. The data displayed in this article is a combination of NVT results; individual site reports and multi-environment trial (MET) long term summaries. The MET analysis should be used by growers when comparing varieties as it encompasses more data over multiple seasons and is therefore more reliable. Both the MET analyses and single site summaries can be found at nvtonline.com.au. Grain yield data is represented as percentage of the site mean for the past five years, which shows how a variety has performed in a given season compared with the region's overall mean yield.

Table 1. Sowing and germination dates as well as growing season rainfall (GSR) for the 2021 wheat NVT sites across the Mallee and North Central regions.

Region	Location	Sowing date	Germination date	GSR (mm) number in bracket denotes decile
Mallee	Balranald	12/05/21	25/05/21	161 (4)
	Birchip (Watchupga)	7/05/21	10/05/21	172 (3)
	Birchip (Watchupga) 'early break'	19/04/21	19/04/21 (irrigated with 15mm)	172 + 15 (3)
	Hopetoun	13/05/21	13/05/21	168 (2)
	Manangatang	12/05/21	25/05/21	148 (3)
	Merrinee	12/05/21	25/05/21	135 (3)
	Quambatook	6/05/21	6/05/21	208 (4)
	Ultima	11/05/21	11/05/21	186 (4)
	Walpeup	12/05/21	25/05/21	184 (4)
North Central	Charlton	19/5/21	19/5/21	259 (5)
	Diggora	21/5/21	21/5/21	255 (5)

RESULTS AND INTERPRETATION

New varieties released in 2021

Calibre, bred and marketed by Australian Grain Technologies (AGT), is a variety derived from Scepter with AH quality. In comparison to Scepter, it is three days quicker maturing and has a similar disease package, with slightly improved powdery mildew resistance. A key feature of Calibre is its longer coleoptile length compared to many commonly grown varieties, including Scepter, making it more suited to deeper sowing.

LRPB Bale and LRPB Dual are both bred by CSIRO and marketed by LongReach. LRPB Bale is APW quality and slow maturing with a long coleoptile length. LRPB Dual is AH quality, mid to slow maturing and has a long coleoptile length. A distinguishing characteristic of these two varieties is they are awnless, making them suited for both grain or hay markets. These varieties however, are lower yielding than available awned varieties but, with the hay option, may have a fit in frost-prone areas.

Valiant CL Plus, bred and marketed by InterGrain, is a slow season Clearfield ® Plus spring wheat suited to early sowing. In 2021 it hit flowering almost two weeks later than Scepter when sown on the 7 May at Birchip. Valiant CL Plus also has a long coleoptile length and is suited to deeper sowing.

More information on these and other varieties can be found in the Agriculture Victoria 2022 Victorian crop sowing guide.

Yield results

Overall site averages of 3.2t/ha were recorded across the Mallee, ranging from 1.5t/ha at Balranald on vetch hay stubble and 2.9t/ha at Hopetoun, to 3.9t/ha at Quambatook on lentil stubble. In the North Central, the Charlton trial averaged 4.3t/ha on lentil stubble and the Diggora site 5.8t/ha on field pea stubble (Table 2).

Calibre topped the yield results at five of the eight Mallee sites and yielded 8% or higher than Scepter at seven of the eight sites. In the North Central trials, Calibre performed above the site mean but wasn't the top performing line (Figure 3). While impressive results are being seen in the Mallee, it has only been part of NVT for two seasons and therefore should be considered one to watch before replacing Scepter (Figure 1). Vixen performed consistently well again this season, achieving above the site average at both the NC sites and seven of the eight Mallee sites.

LRPB Dual only achieved above the site average at two of the 10 sites, suggesting it doesn't have a huge yield potential but may be a beneficial variety to have in the farming system for its other characteristics. These include long coleoptile length and being awnless, making it more suitable for hay in environments or under conditions where this would be beneficial.

LRPB Bale was in the early sown wheat trial located at Birchip. This site was sown on 19 April and received 15mm of irrigation through dripper tape to ensure the trial emerged before the end of April to imitate an early break, it was rain fed for the remainder of the season. LRPB Bale yielded 95% of the trial average (Figure 3), however as with LRPB Dual, the yield deficit may be less of a concern when its other qualities are assessed in the farming system (awnless for hay option). Rockstar topped the early sown trial, yielding 121% of the trial average. The trial mean was 3.8t/ha.

The Clearfield varieties continue to consistently perform lower than the top non-herbicide tolerant lines. However, it is important to remember that these trials are focused on identifying varieties with the greatest yield potential and don't consider the additional benefits of the herbicide tolerance options in weed management on-farm. When comparing Clearfield varieties, Razor CL Plus is a consistently high yielding line but only has a maximum quality grade of ASW. Growers need to decide whether a high yielding ASW variety is more profitable over a lower yielding AH variety, and this will depend on how often the grower can produce H1 quality grain as well as prices when selling the grain. Looking at prices from the 10 December, an ASW variety had to yield 15% more than an AH variety at H1 quality to be as profitable (ASW price $355.25/t, H1 price $408.25/t). At the same time the previous year, the ASW variety only needed to yield 5% more. Valiant CL Plus reached above the site average at two of the eight sites but this is a slow maturing variety and would benefit from being sown earlier than the sowing dates in these trials. This characteristic may prove beneficial in its ability to increase the sowing window for some growers.

All maturity groups yielded well this season, with maturities ranging from Quick (Vixen) to Mid-Slows (RockStar) all appearing in the top five yielding varieties for 2021 in the Mallee (Figure 1). This was most likely due to the changing conditions throughout the season. The late break benefited the quicker maturing varieties due to later sowing, but the mild finish and spring rain allowed the mid-slow season varieties to catch up. It clearly highlights how a mix of varieties based on maturity can help spread risk and capitalise on seasonal variations.

Table 2. Yield results of the 2021 NVT wheat sites across the Mallee and North Central regions.

Region	Location	Trial average yield (t/ha)
Mallee	Balranald	1.5
	Birchip (Watchupga)	2.5
	Birchip (Watchupga) 'early break'	3.8
	Hopetoun	2.9
	Manangatang	2.4
	Merrinee	1.5
	Quambatook	3.9
	Ultima	1.5
	Walpeup	2.4
North Central	Charlton	4.3
	Diggora	5.8

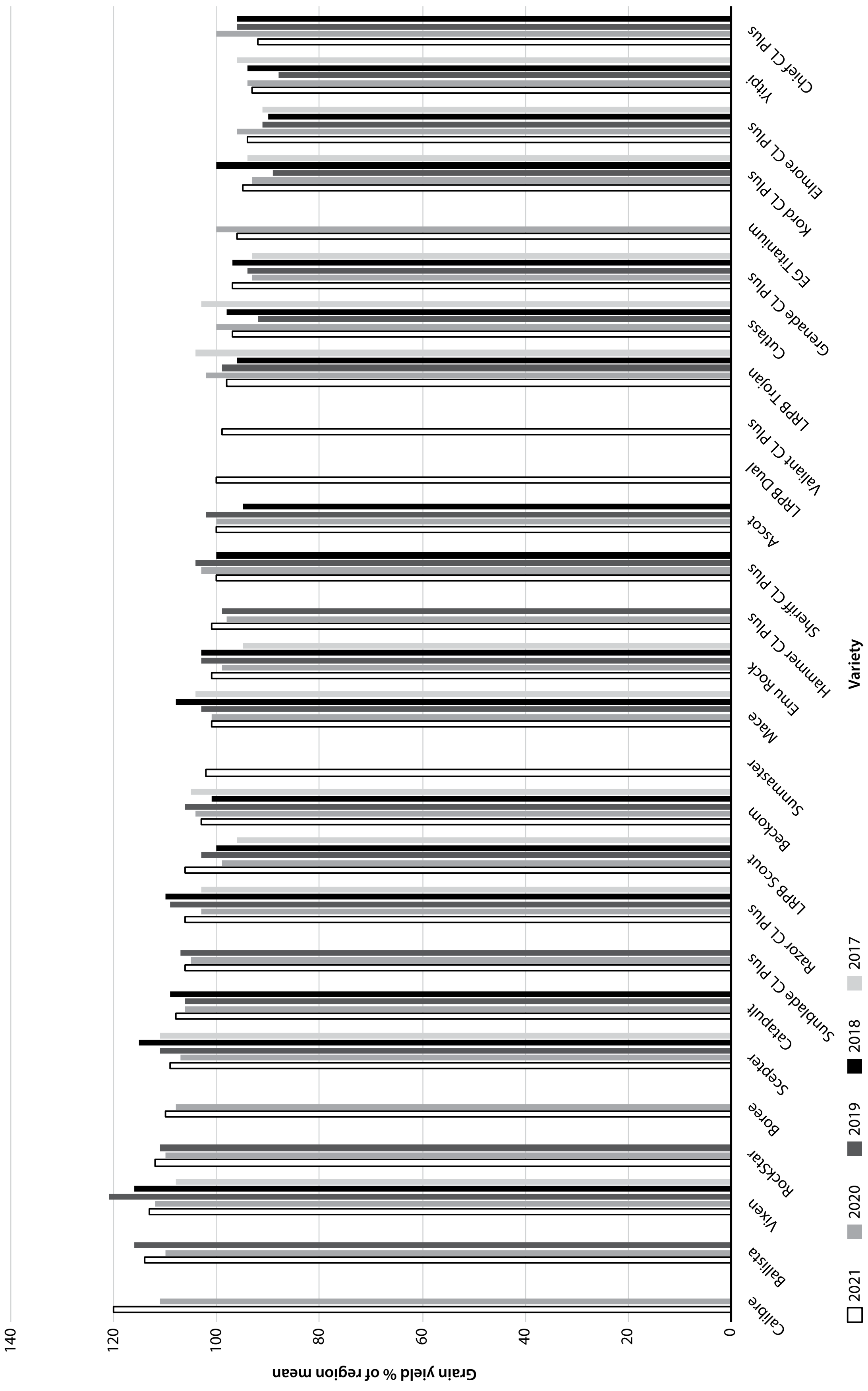

Figure 1. Mallee Wheat NVT average yield as a percentage (%) of region mean from 2017–2021. Includes data from eight sites.

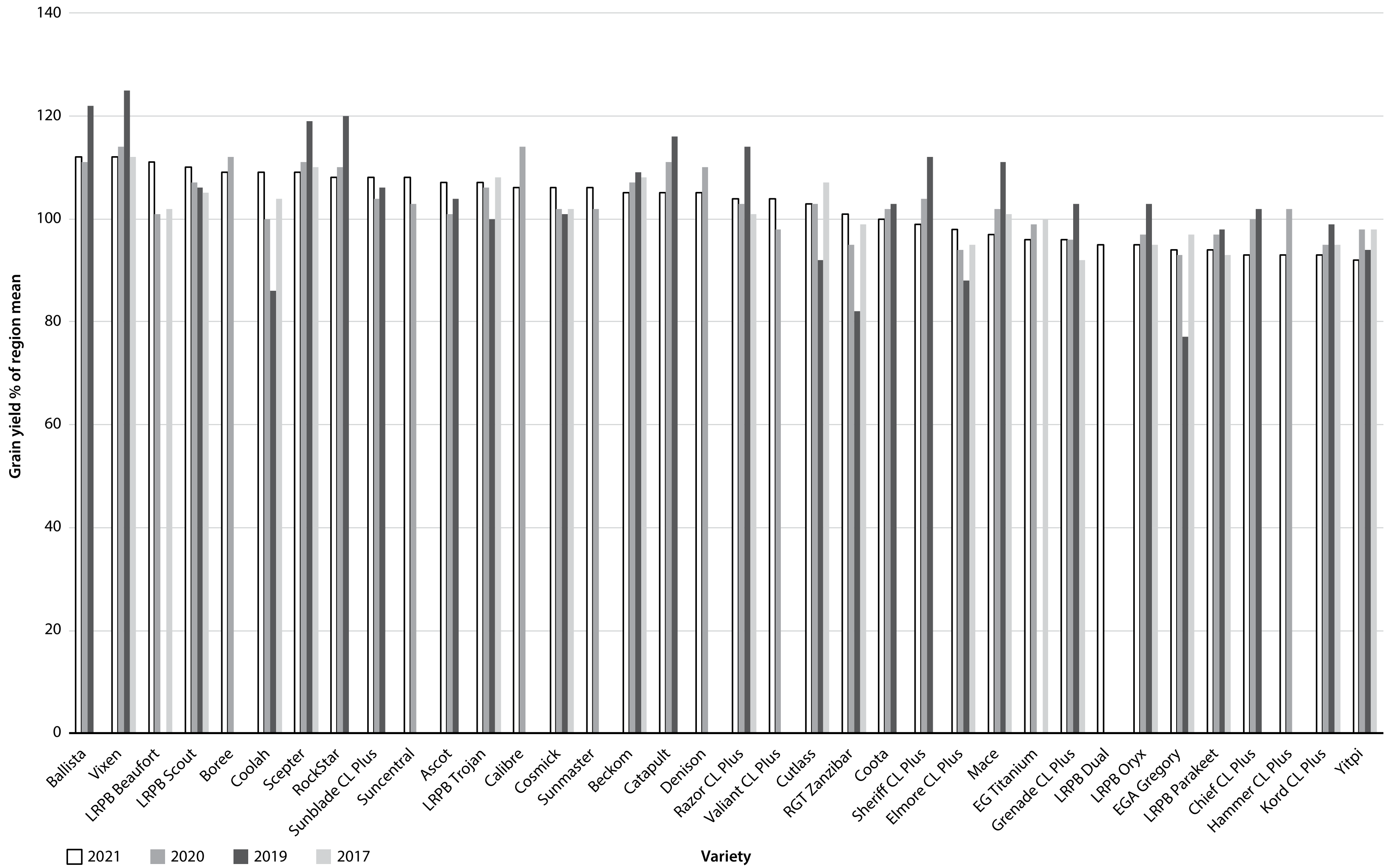

Figure 2. North Central Wheat NVT average yield as a per cent (%) region mean from 2017–2021 (no data for 2018). Includes data from two sites.

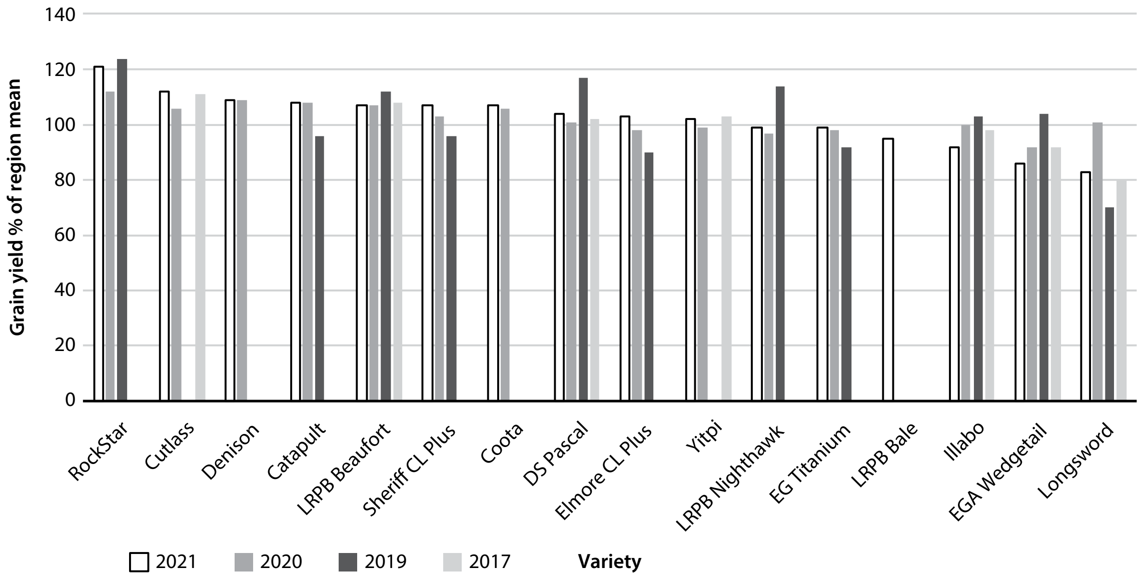

Figure 3. Mallee 'early break' Wheat NVT average yield as a percentage (%) of region mean from 2017–2021 (no data for 2018). Includes data from one site.

Disease ratings

Disease ratings of existing lines and recently released lines can be found in the 2022 Victorian crop sowing guide. Calibre has a similar disease package to Scepter with one improvement being S for powdery mildew compared to SVS (Table 3). Valiant CL Plus has a solid disease package overall, with provisional rating of MRMS for yellow leaf spot (YLS) which is an improvement on Grenade CL Plus (S), Kord CL Plus (MSS) and Razor CL Plus (MSS). Hammer CL Plus is also MRMS for YLS. This may make those varieties more suitable for rotations with a higher presence of wheat. NVT disease ratings for LRPB Bale and LRPB Dual were not available at the time of writing, however Longreach disease screening showed ratings similar to many widely grown varieties. Worth noting is the rating of S-VS for YLS, so if these varieties are chosen, they should not be grown in a wheat-on-wheat rotation. The varieties are MR for CCN.

Table 3. Disease ratings of select wheat varieties and select diseases (newly released varieties in bold text).

	Disease				
Variety	**Stripe rust**	**Leaf rust**	**Yellow leaf spot**	**Septoria tritici**	**CCN**
Calibre	MS*p*	S*p*	MS*p*	-	-
Scepter	MSS	MS	MRMS	S	MRMS
Valiant CL Plus	MSS*p*	MRMS*p*	MRMS*p*	-	-
Razor CL Plus	MS	S	MSS	SVS	MR
Hammer CL Plus	MS	S	MRMS	MSS	MRMS
LRPB Dual	MS*p**	MSS-S*p**	S-VS*p**	MS-S*p**	MR*p**
LRPB Bale	MS*p**	MS-S*p**	S-VS*p**	S*p**	MR*p**

p = provisional rating. * = Preliminary Longreach disease screening results.
R = Resistant, RMR = Resistant to moderately resistant, MR = Moderately resistant, MRMS = Moderately resistant to moderately susceptible, MS = Moderately susceptible, MSS = Moderately susceptible to susceptible, S = Susceptible, SVS = Susceptible to very susceptible, VS = Very susceptible.

Summary

The number of varieties available to growers is continuing to increase, so choosing a suitable variety can be challenging. Scepter remains the most popular wheat variety grown in the Mallee and North Central, however newer varieties are becoming competitive and the NVT data offers the opportunity to see how yields stack up against each other in varying environments, and in different seasons. Growers should combine this knowledge of the genetic potential of varieties with their own understanding of the management required in the farming system e.g. rotation, weed pressure, disease, soil constraints, nutrition, and sowing windows. Grain quality results were not available at the time of writing, but consideration around a variety's quality grade and consequent prices should also be reflected on when choosing a suitable variety. The 2021 season has shown us a mix of varieties based on maturity can help spread risk and capitalise on seasonal variations.

REFERENCES

Victorian Crop Sowing Guide, 2022, Agriculture Victoria

GRDC National Variety Trials yield data, 2021, <https://www.nvtonline.com.au/>.

ACKNOWLEDGEMENTS

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MANAGING N FERTILISER TO PROFITABLY CLOSE YIELD GAPS

James Hunt (University of Melbourne), James Murray (BCG), Kate Maddern (BCG)

TAKE HOME MESSAGES

- Making N fertiliser decisions based on Yield Prophet® Lite or an environmentally appropriate N Bank target maximises profit, stops soil organic N decline and prevents accumulation of excessive mineral N.
- N decisions based on 50% Yield Prophet® or 125kg/ha N bank strategy apply more N (60–80kg/ha) and are over $100/ha per year more profitable than the district average N rate (21–30kg/ha N).
- The most profitable strategies all have neutral to positive N balances (more N applied in fertiliser than removed in grain) indicating soil organic N is not being mined.
- High urea prices in 2022 will reduce profit and optimal N rates. Growers can offset this by planting a higher area of legumes (grain, hay, pasture, brown manure) and using organic wastes (manure, compost, biosolids) where available and cost effective.

BACKGROUND

Australian wheat yields are only half what they could be for the rainfall received (Hochman et al. 2017). Nitrogen (N) deficiency is the single biggest factor contributing to this yield gap. This is also likely to be true for other non-legume crops (barley, canola and oats) and this reduces farm profitability. Alleviating N deficiency would increase national wheat yields by 40 per cent (%) (Hochman and Horan 2018).

On farms with no legume pastures, most of the crop N supply must come from N fertiliser. Grain legumes do not provide enough N to support yield of subsequent crops at the intensity at which they are currently grown. N fertiliser is a costly input and its use increases the cost of production and value-at-risk for growers. Growers fear over-fertilisation will result in 'haying off', which reduces both yield and quality. There is also concern that overapplied fertiliser not used by crops is lost to the environment by leaching, volatilisation and denitrification. Consequently, efforts are made to match N fertiliser inputs to seasonal yield potential. This is difficult in southern Australia due to the lack of accurate seasonal forecasts for rainfall. The difficulty in matching N supply to crop demand and a tendency for growers to be conservative in their N inputs is the cause of the large proportion of the yield gap that can be explained by N deficiency.

In 2018, BCG and La Trobe University commenced a multi-year experiment to evaluate the potential for different N management systems to profitably close the yield gap and slow organic matter decline; 2021 was the fourth season of the experiment.

AIM

To evaluate different N management systems designed to profitably close the yield gap due to N deficiency and slow soil organic matter decline.

PADDOCK DETAILS

Location:	Curyo
Crop year rainfall (Nov–Oct):	2018: 200mm 2019: 368mm 2020: 358mm 2021: 241mm
GSR (Apr–Oct):	2018: 138mm 2019: 149mm 2020: 221mm 2021: 197mm
Soil type:	Sandy loam top-soil with clay content and calcium carbonate increasing with depth
Paddock history:	2017: Lentil

TRIAL DETAILS

Crop type/s:	2018: wheat cv. Scepter 2019: canola cv. Hyola 350 TT 2020: wheat cv. Scepter 2021: barley cv. Spartacus CL
Treatments:	Refer to Table 1
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	2018: 14 May 2019: 29 April 2020: 16 May 2021: 14 May
Replicates:	Four
Harvest date:	2018: 15 November 2019: 15 November 2020: 21 November 2021: 25 November

TRIAL INPUTS

N fertiliser:	Refer to Table 2 for nitrogen fertiliser applications in 2020 and 2020 BCG Season Research Results (pages 122 to 128) for results from 2018, 2019 and 2020. All nitrogen fertiliser has been top-dressed as a single application of urea during winter.
Starter fertiliser:	2018: Urea @ 35kg/ha at sowing (host farmer management) 2019: Granulock®Z @ 60kg/ha at sowing 2020: Granulock®Z @ 60kg/ha at sowing 2021: Granulock®Z @ 60kg/ha + triple superphosphate @ 35kg/ha at sowing

The experiment was kept free of weeds and disease as per current best practice management.

METHOD

A multi-year experiment using a randomised complete block design was established in 2018 to evaluate the performance of different N management systems. There were four different systems being tested:

- Matching N fertiliser to seasonal yield potential (Yield Prophet® and Yield Prophet® Lite, YP)
- Maintaining a base level of fertility using N fertiliser (N banks (NB))
- Replacing the amount of N removed in grain each year with fertiliser in the next season (replacement)
- Applying national average N fertiliser rate (45kg/ha) each season (national average, NA)

All systems were compared to a nil control to which only starter fertiliser was applied (7kg N/ha per year). Within the Yield Prophet® and N bank systems there were different treatments targeting different yield potentials (Table 1). In the Yield Prophet® treatment prior to 2021, water limited potential yield was determined at different levels of probability; the amount of N required to achieve these yields was applied, assuming a requirement of 40kg/ha N per t/ha wheat yield and 80kg/ha N per t/ha canola yield (Figure 1). From 2021 onward, Yield Prophet® Lite was used in a similar way. For the N bank treatments there were different target levels of N fertility (N banks). N fertiliser rates in these treatments were calculated as the N bank value minus soil mineral N (kg/ha) measured prior to sowing.

All gross margins were calculated using values from the 2021 SAGIT Gross Margin Guide, assuming medium rainfall and five-year average prices (SAGIT 2021).

Table 1. Nitrogen management systems and treatments used in the experiments.

System	Treatment	Description
Nil	Nil	No nitrogen applied other than in starter fertiliser
Replacement (R)	-	Amount of N removed in grain applied as fertiliser N in the following season
National average (NA)	-	National average N fertiliser (45kg/ha N) applied each season
Nitrogen banks (kg/ha N)	100	Soil mineral N + fertiliser = 100kg/ha N
	125	Soil mineral N + fertiliser = 125kg/ha N
	150	Soil mineral N + fertiliser = 150kg/ha N
Yield Prophet® probabilities	100%	Yield with lowest yielding season finish on record (decile 1 in Yield Prophet® Lite)
	75%	Yield with lower yielding quartile season finish (decile 2–3 in Yield Prophet® Lite)
	50%	Yield with median season finish (decile 4–7 in Yield Prophet® Lite)
	25%	Yield with higher yielding quartile season finish (decile 8–9 in Yield Prophet® Lite)

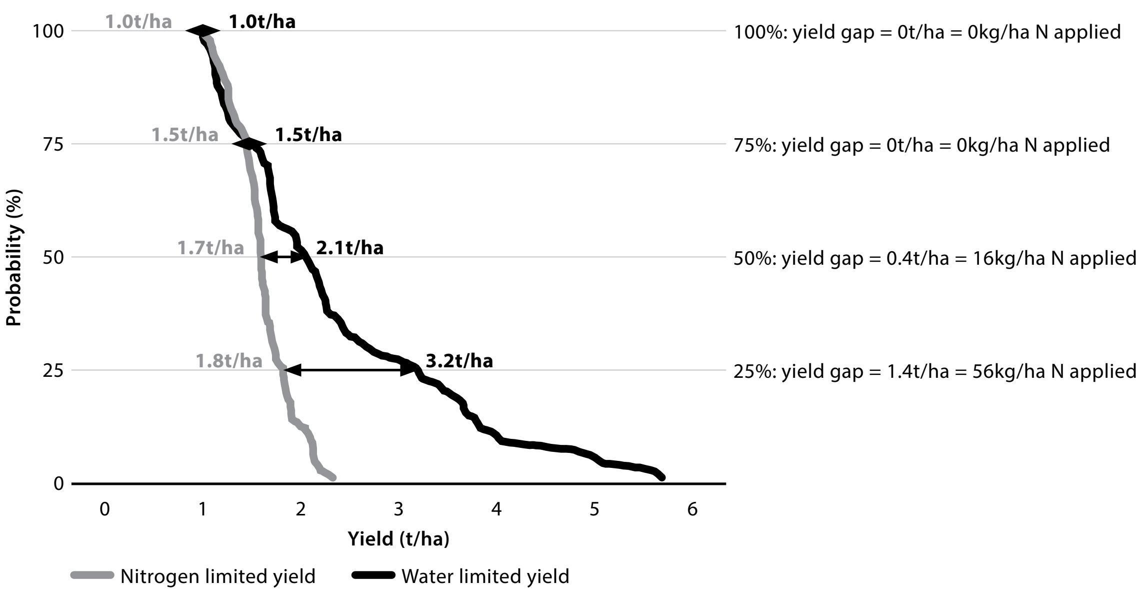

Figure 1. An example from 2018 of how Yield Prophet® is used to determine water limited potential yield given probabilities of different season outcomes and how this is used to calculate a yield gap and N fertiliser rate required to close the yield gap.

RESULTS AND INTERPRETATION

2018–2020 results

Please see 2020 BCG Season Research Results (pages 122–129) for results from the 2018–2020 growing seasons.

2021 results

There were large differences between treatments in soil mineral N measured before sowing in 2021 (Table 2). There was a strong positive relationship between three-year N balance (fertiliser applied minus N removed in grain in 2018–2020) and soil mineral N measured before sowing in 2021 (Figure 2). On average 76% of fertiliser N applied 2018–2020 that exceeded grain removal was available as mineral N before sowing in 2021. This is consistent with 2019 and 2020 season results. Yield Prophet® 50% and 25% treatments had the highest mineral N, reflecting the very high fertiliser N applications made in 2020. These treatments would have been most susceptible to N losses over summer. All N bank treatments had comparatively low mineral N.

Despite the relatively dry growing season (only 129mm of rain to 28 September), grain yield, protein and gross margin responded positively to N supply (Table 2). The highest yielding treatment was the 150kg/ha N Bank treatment which applied the most fertiliser N in 2021. The most profitable treatment was the Yield Prophet® 25% treatment which had applied high rates of N in 2020 (128kg N/ha), a lot of which was carried over as mineral N in 2021, so only 8kg N/ha fertiliser N was applied.

Table 2. Soil mineral N measured prior to sowing, top-dressed N, crop N supply, grain yield, protein and gross margin for different treatments in the experiment in 2021.

System	Treatment	Soil mineral N (kg/ha)	Top dressed N (kg/ha)	N supply (kg/ha)	Yield (t/ha)	Protein (%)	Gross margin ($/ha)
Nil	Nil	26	0	33	1.1	10.0	-$113
Replacement	-	48	50	105	2.3	10.7	$77
National average	-	41	45	93	2.2	10.4	$62
Nitrogen banks (kg/ha N)	100	34	59	100	2.3	10.8	$64
	125	57	61	125	2.4	11.6	$83
	150	67	76	150	2.6	12.2	$105
Yield Prophet® probability	100%	38	0	45	1.1	10.3	-$113
	75%	46	0	53	1.7	10.7	$17
	50%	131	0	138	2.1	11.0	$104
	25%	108	8	123	2.4	12.2	$158
Sig. diff.		**<0.001**		**<0.001**	**<0.001**	**<0.001**	
LSD (P=0.05)		**24**	**-**	**20**	**0.2**	**0.7**	

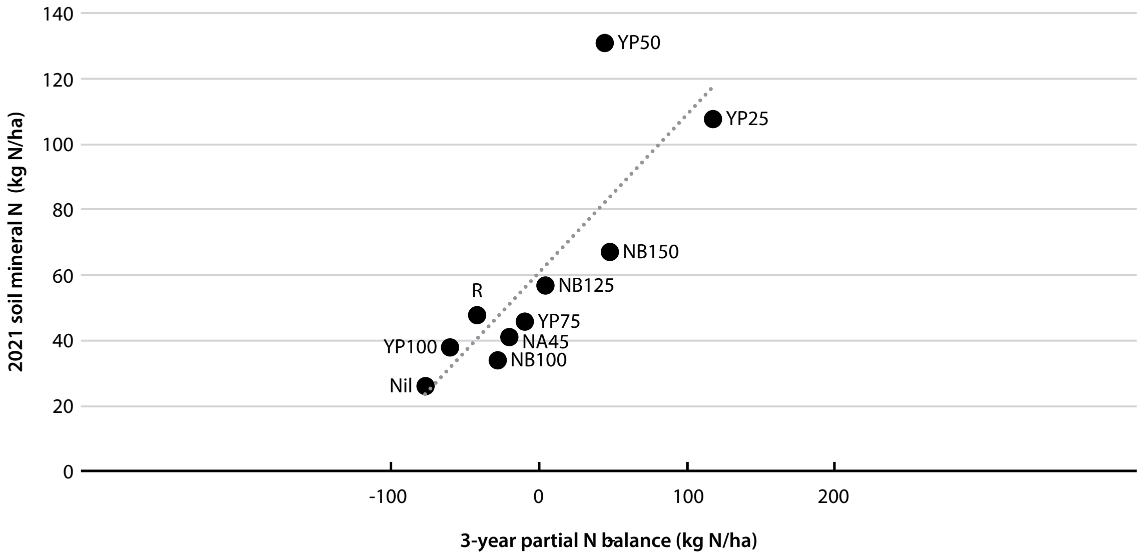

Figure 2. The relationship between three-year N balance (2018–2020) and soil mineral N measured before sowing in 2021. The linear regression is fitted by least-squares regression to the positive N balance values only and is of the form y = 0.48x + 60.60, R^2 = 0.69.

Four-year averages

Comparison of the different systems over the four years of the experiment shows the Yield Prophet 50% and N Bank 125kg/ha N treatments were most profitable, with several other treatments not far behind. All these treatments on average applied more fertiliser N than the district average of 21–30kg N/ha (Norton 2016) or the national average of 45kg/ha (Figure 3). Assuming the district average N application is 30kg N/ha, the fitted quadratic function suggests the Yield Prophet® 50% and Nitrogen Bank 125kg/ha treatments have on average returned ~$100/ha per year more profit than the district average.

The two most profitable treatments also had a neutral to slightly positive four-year N balance (Figure 4), indicating soil organic N was not being mined and soil organic matter was likely being maintained. This contrasts to the Nil control which had a four-year N balance of -89kg/ha N. Based on the soil C:N ratio at the site of 9.7, this suggests ~863kg/ha of soil organic carbon has been lost.

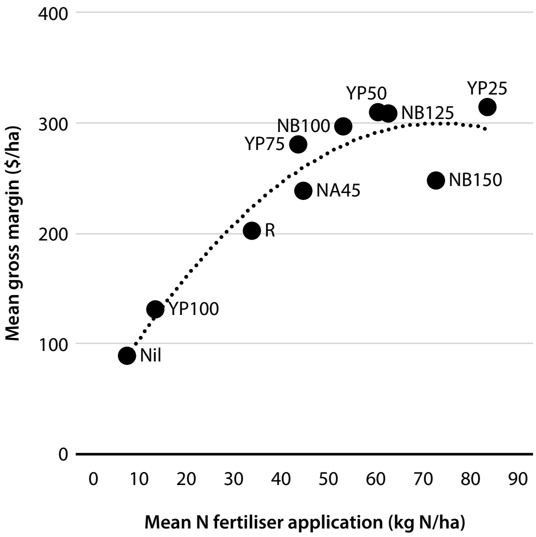

Figure 3. The relationship between mean four-year fertiliser application and mean four-year gross margin for the different treatments. The quadratic function fitted by least-squares regression is of the form $y = -0.05x^2 + 7.16x + 37.51$, $R^2 = 0.90$.

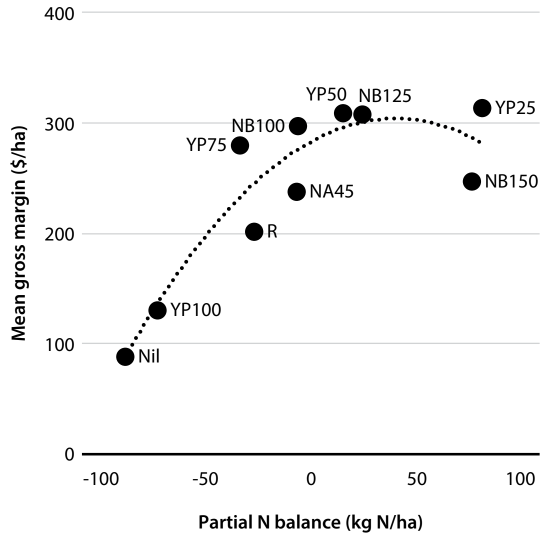

Figure 4. The relationship between four-year N balance and four-year mean gross margin for the different treatments. The quadratic function fitted by least-squares regression is of the form $y = -0.01x^2 + 1.05x + 282.74$, $R^2 = 0.84$.

The grains industry is understandably concerned about what high urea prices will mean for farm profitability and N strategies in 2022. Figure 5 shows the four-year average N rate and gross margin for this experiment assuming either a urea price of $550/t (same as Figure 3) or $1100/t with all other costs and prices held constant. Profit will be reduced at high urea prices and the most profitable urea rate in this example reduces from 73kg N/ha to 61kg N/ha.

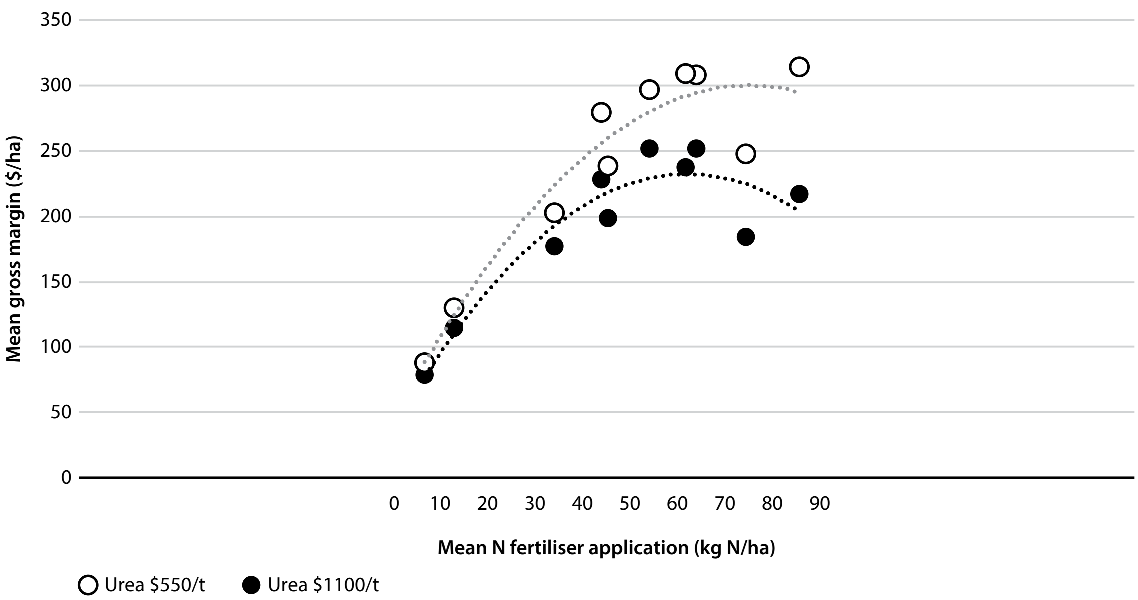

Figure 5. The relationship between mean four-year fertiliser application and mean four-year gross margin for the different treatments assuming a urea price of either $550/t or $1100/t. The quadratic functions fitted by least-squares regression are of the form $y = -0.05x^2 + 7.16x + 37.51$, $R^2 = 0.90$ for $550/t and $y = -0.05x^2 + 6.61x + 31.64$, $R^2 = 0.88$ for $1100/t.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Growers should soil test and use an environmentally appropriate fertiliser N management strategy such as Yield Prophet® Lite or N Banks to maximise profits. In this experiment, profit has been maximised at much higher rates of fertiliser N (60–80kg N/ha N or 130–174kg/ha urea per year) than is usually applied in the district (21–30kg N/ha or 46–65kg/ha urea). Long term profitability is likely to be increased by growers being less conservative with N fertiliser applications, particularly for those consistently achieving cereal grain proteins of less than 11.5% (ie. APW or ASW wheat). Growers in low rainfall regions with heavy textured soils can be confident the majority of applied N not used in year of application will remain in the soil for use in subsequent seasons and is not a lost cost.

The most profitable treatments in this experiment have neutral to slightly positive N balances, indicating a 'win-win-win' where profits are maximised, soil organic N is not mined and excessive mineral N is not accumulated that is then susceptible to losses. Growers should check the long-term N balances of their paddocks to ensure soil organic N is not being mined. A spreadsheet to do this is available here: <https://www.bcg.org.au/understanding-crop-potential-and-calculating-nitrogen-to-improve-crop-biomass-workshop-recording/>.

High urea prices in 2022 are a legitimate concern, given the strong reliance of continuous cropping systems on synthetic N fertiliser for high yields and profits. Growers can offset this price rise by increasing the planted area of legumes (grain, hay, brown manure or pastures—whatever fits), particularly in paddocks that return a low soil N test and would require substantial fertiliser N inputs if planted to non-legume crops. Growers with good access to organic wastes (manures, composts, biosolids) can substitute these for N fertiliser. Always test N content of organic wastes before application to ensure they are cost effective in comparison to synthetic fertilisers and that an agronomically appropriate rate of N (and other nutrients) is being applied.

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FODDER FOR THE FUTURE: CEREAL HAY, MITIAMO

James Taylor (BCG)

TAKE HOME MESSAGES

- Hay yield was highest for Kingbale, Mulgara, Brusher, Yallara and Wintaroo oat varieties.
- Achieving the optimum cutting time of GS71 increased profitability.
- Soil test to manage nutrient inputs appropriately. 60kg of urea was the most economical, higher rates of nitrogen were not needed. Applying additional P and K was not rewarded at Mitiamo in 2021.
- RGT Planet can be a good dual-purpose option (grain or hay).

BACKGROUND

Oaten hay can be a valuable inclusion in rotations. It's a profitable crop and brings benefits to a cropping system including weed management, moisture conservation and commodity diversification.

The dairy industry accounts for 52 per cent (%) of the total hay demand in Australia. Many dairy enterprises in Northern Victoria and the Riverina are shifting from perennial pastures towards more intensive mixed ration systems. This is in response to the cost of irrigation water and bigger but fewer herds. In other dairy regions of Victoria, tough seasons require bought-in fodder.

Compared to other feeds such as grain, silage and legume hay, oaten hay is lower in energy and protein and higher in fibre. This affects how much cattle are willing to eat and how well they perform on it. Hence, oaten hay is mostly used for the maintenance of dry stock.

Murray Dairy has collaborated with a range of organisations, including BCG, for the Fodder for the Future project. The project outcomes will help both broadacre and dairy farmers to meet the growing conserved fodder requirements of the dairy herd.

AIMS

To investigate how the yield and quality of oaten hay are impacted by:

- Variety and time of sowing
- Nutrient inputs of nitrogen, phosphorous and potassium
- Sowing rate and cutting time.

PADDOCK DETAILS

Location:	Mitiamo
Crop year rainfall (Nov–Oct):	351mm
GSR (Apr–Oct):	229mm
Soil type:	Silty clay
Paddock history:	Wheat

TRIAL DETAILS

Crop type:	Oats and barley
Treatments:	Variety and TOS
Nutrition management:	Refer to Table 1b
Target plant density:	320 plants/m^2, except for sowing rate treatments, refer to Table 1a.
Seeding equipment:	Knife points + splitter boot (70mm split), press wheels, 30cm row spacing
Sowing date:	19 April 2021 for all treatments except TOS 2: 2 June 2021
Replicates:	Four
Harvest dates:	Refer to Table 2 and Table 4.
Trial average yield:	4.8t/ha

TRIAL INPUTS

Fertiliser:

Variety and TOS, and Sowing rate and Time of cutting treatments:

- Sown with Granulock® Supreme Z @ 60kg/ha and 120kg/ha of urea broadcast at GS31.

Nutrition management:

- Nitrogen (N) treatments: sown with Granulock® Z Supreme @ 60kg/ha. Additional N was broadcast in-season as urea, according to Nitrogen treatment rate, refer to Table 1b.
- Phosphorous (P) treatments: sown with triple super phosphate according to treatment, refer to Table 1b. Urea was broadcast @ 120kg/ha at GS31.
- Potassium (K) treatments: sown with Granulock® Z Supreme @ 60kg/ha. Potassium treatments were applied at sowing as sulphate of potash according to Potassium treatment rate, refer to Table 1b. Urea was broadcast @ 120kg/ha at GS31.

Trial was managed as per best practice for weeds, pests and diseases.

METHOD

A replicated field trial was sown using a randomised complete block design. Assessments included establishment scores, NDVI, hay biomass cuts at GS71, stem diameter and feed test quality for energy, protein and fibre metrics.

Table 1a. Cereal variety, plant density, cut time and time of sowing treatments, Mitiamo 2021.

Variety	Variety characteristics			Target plant density (plants/m²)	Cut timing (growth stage)	Time of Sowing
	Notes, end use[1]	Height[1]	Maturity[1]			
Bannister	Milling	Tall dwarf	Quick	High: 320	GS71	TOS1: 19 April 2021 TOS2: 2 June 2021
Brusher	Hay/grazing/ feed grain	Tall	Quick	High: 320	GS71	
Kingbale	Imi tolerance[2], Hay	Tall	Mid–slow	High: 320	GS71	
Mulgara	Hay/feed	Tall	Quick	High: 320	GS71	
Wintaroo	Hay/grazing	Tall	Mid	Low: 120 Med: 220 High: 320	GS65 & GS71	
Yallara	Milling/hay	Mod tall	Quick	High: 320	GS65 & GS71	
RGT Planet	Malt/feed	Medium	Quick	Low: 90 Med: 130 High: 160	GS71	
Spartacus CL	Clearfield barley, Malt/feed	Mod short	Very quick	Med: 130	GS71	

[1] Brown S (AgVic), 2021, 2021 Victorian crop sowing guide.
[2] Sentry® is the only IMI herbicide registered for use on Kingbale hay.

Table 1b. Nutrient management treatments, Mitiamo 2021.

Nitrogen (as starting fertiliser and urea)		Phosphorous (as triple superphosphate)		Potassium (as sulphate of potash)	
Treatment name	Applied N (kg/ha)	Treatment name	Applied P (kg/ha)	Treatment name	Applied K (kg/ha)
N1	6	P1	0	K1	0
N2	22	P2	8	K2	30
N3	52	P3	16	K3	60
N4	82	P4	24	K4	90

RESULTS AND INTERPRETATION

2021 seasonal conditions

Growing season rainfall for April to October was 229mm, which is just below average for Mitiamo. The timing of rainfall was not ideal for hay growing—a late break followed by a dry August and spring falls too late to influence biomass growth.

VARIETIES AND TIME OF SOWING

The Variety x Time of sowing trial was cut at GS71-watery ripe, and had an average yield of 4.9t/ha. Hay yield was not affected by time of sowing at Mitiamo in 2021. TOS1 was dry sown and emerged slowly after small showers and had lower plant establishment than TOS2 ($p=0.003$). Despite this, TOS1 was observed to have higher early biomass, but the dry August conditions limited that advantage. Moisture would have become limiting as the crop's ability to use water deeper in the soil profile was halted by high salinity below 40cm. Given lower early biomass (observed only), TOS2 was better able to cope with the dry August and yielded the same as TOS1.

The highest yielding varieties were Kingbale, Mulgara, Brusher, Yallara and Wintaroo (Table 2). These are oat varieties specifically bred for hay production. Bannister, a milling oat, was the lowest yielding oat variety. Barley variety RGT Planet yielded similar to Brusher, Yallara, Wintaroo and Bannister oats, and yielded 0.7t/ha more than Spartacus CL.

Stem diameter for all varieties in 2021 averaged 4.1mm. Export markets typically specify a stem diameter of less than 6mm as thicker stems are associated with lower quality. Time of sowing influenced stem diameter, with TOS1 averaging 4.4mm and TOS2 averaging 3.9mm.

Feed test analysis showed difference in quality measures between varieties.

There were varietal differences in crude protein, with Brusher at 11.2% closely followed by Bannister at 10.7%, which was above the average of 10.3%. There was no relationship between yield and crude protein. Higher protein levels are valued by dairy farmers but cereal hay is not expected to be high in crude protein. Crude protein of 10–12% for cereal hay is considered good (FeedCentral 2017).

Fibre is measured as both neutral detergent fibre (NDF)—the indigestible fibre, and acid detergent fibre (ADF)—the digestible fibre (Dairyland Laboratories Inc., 2022). Lower NDF and ADF levels are more desirable because those feeds are more digestible. NDF averaged 50.6% in this trial, with no difference between varieties or TOS. ADF measured 25.8–29.7% across varieties (Table 2). It was highest in Kingbale and Wintaroo, and lowest in Bannister oats, RGT Planet and Spartacus CL barley.

There are several measures for energy. The two focused on here are: metabolisable energy (ME)—gross energy available for use by the cow; and water-soluble carbohydrates (WSC)—a specific subset of simple carbohydrates. ME did not differ between varieites or TOS, and averaged 10.7MJ/kgDM. RGT Planet had the highest WSC of all cereals at 36.1%, and the lowest was Bannister at 27.5% (Table 2).

Table 2. The effect of variety and time of sowing on yield and quality measures.

Variety	Cutting date TOS1	Cutting date TOS2	Yield (t/ha)	Stem diameter (mm) TOS1	Stem diameter (mm) TOS2	Crude protein (%)	ADF (%)	WSC (%)
Kingbale	5 Oct	18 Oct	5.5^{a}	4.4	3.6	10.1^{bc}	29.7^{a}	28.5^{cd}
Mulgara	5 Oct	8 Oct	5.3^{a}	5.1	4.1	10.1^{bc}	28.7^{ab}	27.9^{d}
Brusher	23 Sep	8 Oct	5.1^{ab}	4.2	3.6	11.2^{a}	27.3^{bcd}	30.0^{c}
Yallara	21 Sep	1 Oct	5.1^{abc}	4.1	3.4	9.7^{c}	27.6^{bc}	33.5^{b}
Wintaroo	27 Sep	5 oct	5.1^{abc}	4.1	4.6	9.8^{c}	29.5^{a}	28.2^{d}
RGT Planet	23 Sep	5 Oct	4.7^{bc}	4.3	4.1	10.3^{bc}	25.8^{d}	36.1^{a}
Bannister	27 Sep	8 Oct	4.5^{cd}	4.7	4.0	10.7^{ab}	26.9^{cd}	27.5^{d}
Spartacus CL	21 Sep	27 Sep	4.0^{d}	4.2	3.8	10.3^{bc}	26.2^{cd}	33.3^{b}
Sig. diff.								
Variety			**<0.001**	**NS**		**0.018**	**<0.001**	**<0.001**
TOS			**NS**	**0.001**		**NS**	**NS**	**NS**
Variety x TOS			**NS**	**NS**		**NS**	**NS**	**NS**
LSD (P=0.05)	**Variety**		**0.6**	**NS**		**0.8**	**1.6**	**1.8**
	TOS		**NS**	**0.3**		**NS**	**NS**	**NS**
	Variety x TOS		**NS**	**NS**		**NS**	**NS**	**NS**
CV%			**11**	**12**		**6.5**	**5.0**	**4.8**

NUTRIENT MANAGEMENT

Soil nitrogen at sowing measured 71kg/ha to a depth of 100cm, but given the high salinity below 40cm (Cl >1000mg/kg) the available N was probably restricted to 52kg/ha.

Nitrogen: Hay yield increased as applied N increased from 6 to 22kg/ha, but the response plateaued at further N (Figure 1).

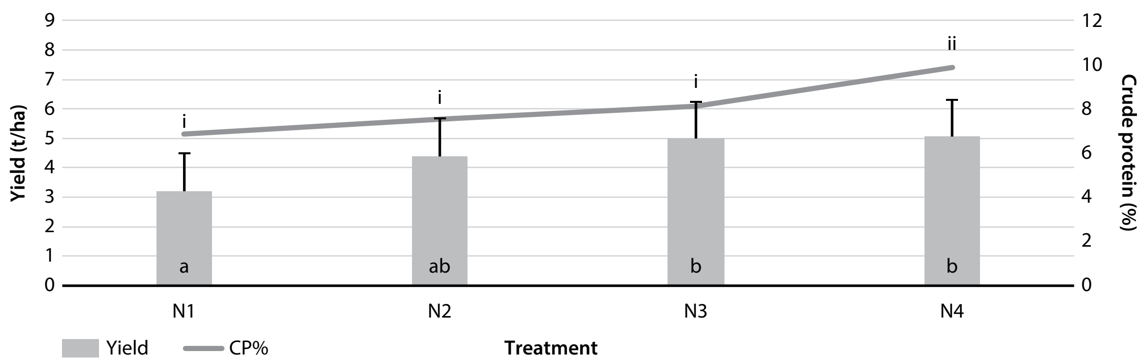

Figure 1. Oaten hay yield and protein response to N treatments, Mitiamo 2021.
Stats: Yield: P=0.042, LSD 1.3t/ha, CV 14.7%, Protein: P=0.002, LSD 1.2%, CV 8.7%.

Stem diameter did not respond to N rate. Crude protein only responded to the highest N rate of 82kg/ha, increasing CP from 8.1 to 9.9%. ME and WSC did not respond to increasing N rate.

Phosphorous: Neither hay yield or stem diameter responded to P rate.
Potassium: Neither hay yield or stem diameter responded to K rate.

CUT TIMING

Wintaroo and Yallara oats were cut at GS65-mid flowering and GS71-watery ripe for both TOS. Yallara is a quick variety so had very close cutting dates between growth stages and cutting time whereas mid-maturing Wintaroo had longer intervals (Table 4).

Table 4. Cutting dates for cut timing, Mitiamo 2021.

Variety	TOS1			TOS2		
	GS65	GS71	Interval (days)	GS65	GS71	Interval (days)
Wintaroo	27 Sep	5 Oct	8	5 Oct	12 Oct	7
Yallara	21 Sep*	23 Sep	2	1 Oct	Oct	4

* Yallara TOS1 cut closer to GS67, late flowering, than the target of GS65, mid flowering.

Across all eight cereal varieties TOS didn't impact yield. However, focusing just on Wintaroo and Yallara oats, hay yield was influenced by time of sowing and cutting times. Sowing on 19 April yielded 5.1t/ha while sowing on 2 June yielded 4.7t/ha. Early cutting at flowering resulted in a yield penalty of 0.45t/ha and reduced metabolisable energy by 0.5MJ/kgDM. NDF averaged 52% and was not improved by cutting earlier but there were differences in ADF (Table 5).

Stem diameter averaged 4mm and was not affected by variety, TOS or time of cutting.

There was an interaction between TOS and variety for crude protein. Wintaroo crude protein increased from 9.8% to 11.4% between TOS1 and TOS2 while Yallara remained stable. There tended to be a similar relationship between TOS and variety for WSC (p=0.07). Wintaroo WSC decreased from 30.6% at flowering to 27.6% at watery ripe while Yallara remained more stable going from 33.7% to 33.5%. While this may reflect the difference in maturity of varieties, Yallara TOS1 was cut later than intended, closer to later flowering rather than at mid-flowering.

Table 5. The effect of time of sowing and cutting date on yield and quality of Wintaroo and Yallara oats, Mitiamo 2021.

Treatment	Yield (t/ha)		ME (MJ/kg)		ADF (%)	
	GS65	GS71	GS65	GS71	GS65	GS71
TOS1	5.0	5.2	10.2	10.7	28.6	28.1
TOS2	4.3	5.0			27.9	29.6
Sig. diff	**<0.01**		**0.01**		**0.04**	
LSD (P=0.05)	**0.3**		**0.4**		**1.1**	
CV%	**7.5**		**4.3**		**4.4**	

SOWING RATE

Sowing rate treatments were included in Wintaroo oat and RGT Planet barley for both TOS (Table 6). The best practice target plant densities for hay oats is 320 plants/m^2 and 130 plants/m^2 for grain barley.

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Table 6. Sowing rates of Wintaroo oat and RGT Planet barley according to target plant density and thousand grain weight at Mitiamo 2021.

Variety	Thousand grain weight (g)	Target plant density (plants/m²)	Sowing rate (kg/ha)
Wintaroo	33	320	127
		220	87
		120	47
RGT Planet	43	160	80
		130	66
		90	45

Establishment counts showed sowing rate made a difference to the number of plants per square metre (Figure 2). TOS2 established better than TOS1 given kinder seasonal conditions.

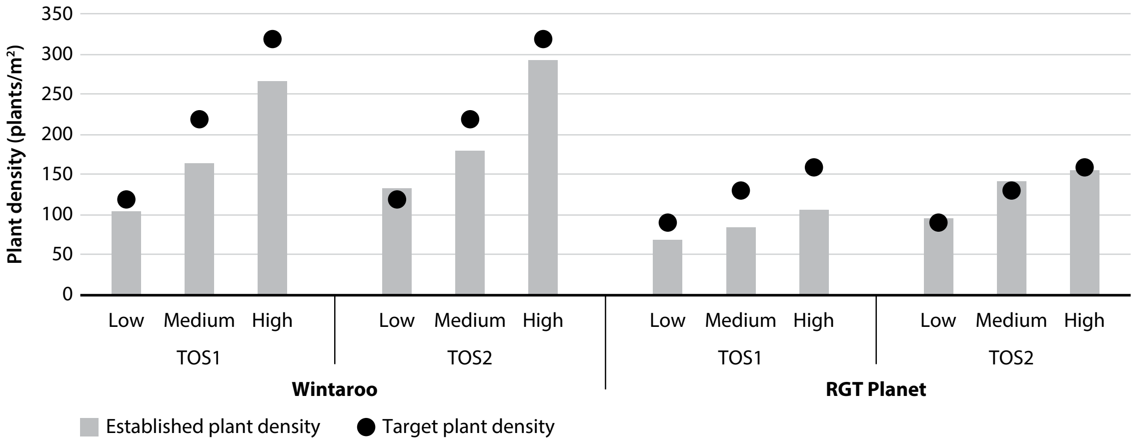

Figure 2. Established plant densities and target plant densities for Wintaroo oat and RGT Planet barley at Mitiamo 2021.

The plants compensated for lower plant densities with no increase in yield in either Wintaroo or RGT Planet. Stem diameter also remained unaffected by sowing rate, most likely because of seasonal conditions at Mitiamo in 2021. All feed test quality parameters were unaffected.

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Sowing on 19 April made no difference in yield compared to 2 June in 2021. This is not normal and reflects the season and varieties sown. The trial included some barley and quick oat varieties that reduced the average response to TOS. Wintaroo, with mid maturity, did respond to time of sowing.

Across previous BCG oaten hay trials, the quick-mid and mid maturity oat varieties performed consistently better at earlier sowing dates, such as the last week of April or first week of May. At Curyo and Rupanyup in 2020, earlier sowing increased oat hay yields by 1.2t/ha and 1.3t/ha respectively. At Kalkee North in 2019, sowing in early May rather than June increased yields by 1.5t/ha. Delaying sowing of oat crops is a higher risk strategy that "locks in" lower yield. Sowing later would have had large penalties if the season was more favourable for hay growing.

All oat varieties bred for hay yielded similarly at Mitiamo in 2021. The trial only included varieties that are suited to the region. Over the long term, Wintaroo has yielded consistently across seasons and environments in north-west Victoria. Kingbale is a newer variety derived from Wintaroo with a imi-tolerance gene. It yielded well at Mitiamo in 2021 so will be one to watch. Kingbale is slightly slower maturing than Wintaroo by about three days.

RGT Planet provides a good option for grain or hay. Yield was slightly below oat varieties at Mitiamo in 2021 and WSC content was higher. As a grain variety in the National Variety Trials, it performs better in the North Central than the Mallee, requiring spring moisture to fill its yield potential.

Hay quality is often better in drier to average seasons. This theory was upheld at Mitiamo in 2021. The site had a slow start to the growing season and lower than average growing season rainfall. These seasonal conditions limited growth and reduced the differences between treatments.

While the season took care of quality to a large extent in 2021, cut timing remained important. Cutting earlier at Mitiamo in 2021 had a yield penalty of 0.45t/ha and would have cost $77/ha (oaten hay $170/t) without any commercially relevant change in quality.

Watery ripe, GS71 is considered the ideal cutting time for optimising yield and quality for cereal hay. In reality, considering logistics and weather, it can be challenging to cut hay at exactly GS71 so aim for after full head emergence GS59 and before early milk, GS73. Cutting in this window helps minimise curing time before quality starts to rapidly decline.

Hay removes large amounts of nutrients from the soil. The Mitiamo site had sufficient phosphorus and potassium for oats so there was no response to treatments. Soil testing should be used to inform fertiliser decisions and monitor soil fertility.

The industry target for nitrogen supply in oat hay suggests that up to 80kg/ha of nitrogen at sowing is enough (AEXCO, 2016). The Mitiamo 2021 results are consistent with this rule-of-thumb with yield responses between no applied urea and some applied urea. The only quality factor that changed was crude protein at highest rate of nitrogen.

What do dairy farmers want?

Dairy feeding systems are as diverse as the environments they operate in. In Northern Victoria and the Riverina, there is an increasing number of dairy herds being housed and fed total mixed rations. While dairy farmers try to grow most of their own feed, they usually focus on growing cereals and maize for silage and to a lesser extent, grain and vetch.

Oaten hay has a role in feeding dry stock, heifers and pre calving cows. Other forages such as silage and legume hay are preferred in a lactating cow's diet because of energy content and lower NDF.

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ACKNOWLEDGEMENTS

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DRYLAND LEGUME PASTURE SYSTEMS: LEGUME ADAPTATION 2021

Alison Frischke (BCG), Ross Ballard and David Peck (SARDI)

TAKE HOME MESSAGES

- Soft seeded common vetch varieties Studenica and Morava performed well as short-term legume options at Watchupga and Mitiamo.
- Hard seeded legume pasture cultivars Seraph strand medic and Bartolo bladder clover consistently provided good biomass production, making them suitable options where regeneration after a crop phase is preferred.
- Frano French serradella and Cefalu arrowleaf clover had variable performance between sites, reflecting their pH preferences and ability to respond to late season rainfall.
- Dry seasonal conditions at sowing lessened the impact of time of sowing and sowing rate in 2021.
- The main benefit of increased sowing rate was on early production.

BACKGROUND

The area under traditional annual legume pastures has generally declined due to intensified cropping rotations, less reliable seasons and a changing climate, making conditions for persistence of those pastures less than ideal.

Legume pastures are also often sown later, after crops. This limits biomass production in the year of establishment. These factors, coupled with periods of drought, have resulted in eroded seedbanks of legume pastures on many farms. Despite a continuing positive outlook for livestock and legume pasture benefits, pasture renovation rates remain low.

The opportunity exists to improve the quality of the pasture base on many low to medium rainfall mixed farms across southern Australia, especially on soils where it is too risky to grow grain legumes. The Dryland Legume Pasture Systems (DLPS) project is evaluating the regional performance of commonly grown legumes, including medics and vetch, as well as recently developed pasture cultivars of serradella, biserrula and bladder clover. The final growing season of field evaluation was in 2021.

AIM

To evaluate the establishment, production and persistence of a range of pasture legumes grown on sandy loam, southern Mallee and silty clay, North Central soils.

- Species adaptation: To compare establishment, growth and regeneration of eight pasture legume species, sown at high rates to simulate regeneration from seedbanks.
- Sowing rate: To compare establishment of Seraph medic sown at 2.5, 5 and 10kg/ha and 20kg/ha.
- Time of sowing (TOS): Evaluate the effect of sowing Seraph medic and Frano French serradella on the break of the season (late April) compared with after the seeding program (late May).

PADDOCK DETAILS

Location:	Watchupga	Mitiamo
Crop year rainfall (Nov–Oct):	234mm	302mm
GSR (Apr–Oct):	172mm	180mm
Soil type:	Sandy loam	Silty clay
pH($CaCl_2$):	0–10cm: 7.5 10–40cm: 8.2 >40cm: >8.5	0–10cm: 5.0 10–40cm: 7.4 >40cm: toxic to plant roots
Paddock history:	2020 Barley	2020 Oats

TRIAL DETAILS

Crop type/s:	Legume pastures
Treatments:	Refer to Table 1
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	TOS1: 27 April 2021 TOS2: 31 May 2021
Replicates:	Three

TRIAL INPUTS

Fertiliser:	Granulock® Supreme Z + Flutriafol (200mL/100kg) @ 60kg/ha at sowing 17 May – Roundup® @ 2L/ha applied IBS
Herbicide:	27 April and 31 May (TOS2 only) - Roundup® @ 2L/ha applied IBS 21 June – Liase @ 2% + Haloxyfop @ 0.075L/ha + Clethodim @ 0.3L/ha + Uptake @ 0.5% 9 August – Liase @ 2% + Haloxyfop @ 0.075L/ha + Clethodim @ 0.3L/ha + Uptake @ 0.5%

The trial was kept pest and disease free.

METHOD

A replicated field trial was sown using a complete randomised block design on a sandy loam soil at Watchupga. Pasture variety descriptions and sowing rates are given in Table 1. Treatments evaluated species adaptation, sowing rate and time of sowing.

Assessments included plant establishment counts, legume biomass production at flowering and seed production. Seed counts were not available at the time of writing.

Table 1. Pasture species descriptions and treatments, Watchupga South, 2021.

Variety and species	Inoculant group	Maturity	Preferred soil types & pH ($CaCl_2$)	Release year, traits* and notes	Trial sowing rate (kg/ha)		Time of sowing
					TOS 1	TOS 2	
Seraph strand medic	AL (strain RRI-128)	Early	Sandy loams & loams pH>5.8	2021, PM, HT, BGA, HS70 Was PM250, developed for SA Mallee regions	2.5, 5, 10, 20**	10	TOS 1: 27 April 2021 TOS 2: 31 May 2021 (Seraph strand medic and Frano French serradella only)
Frano French serradella	S or G (strain WU425 or WSM471)	Mid–late	Deep sands & sandy loams pH 4.0–7.0	2021, PH, Early maturity hard seeded = WA cultivar, replaced Margurita	10, 20**	10	
SARDI rose clover	C (strain WSM1325)	Mid	Sandy loams & loams pH 4.5–7.0	2005, SH, HS80 Developed in mid-north SA, not widely sown in Mallee but performs well	20**		
Bartolo bladder clover	C (strain WSM1325)	Mid	Sandy loams & clay loams pH 5.0–8.0	2007, SH, HS80 WA cultivar, aerial seeded, limited testing in the southern region	20**		
Trigonella balansae	AL (strain RRI-128)	Mid–early	Loams	Potential release 2024 New species, aerial seeded	10**		
Cefalu arrowleaf clover	C (strain WSM1325)	Mid–late	Sand-loam pH 4.5–7.5	1999, SH Deep rooted, adapted to deep well-drained soils	10**		
Morava common vetch	E or F (strain SU303 or WSM1455)	Late	Sandy loams & clay loams pH 5.5–8.5	1998, HS<1% Old cultivar	40		
Studenica common vetch	E or F (strain SU303 or WSM1455)	Early	Sandy loams & clay loams pH 5.5–8.5	2021, SH, HS<1% Specifically developed for drier areas	40		

* PM: powdery mildew resistant, PH or SH: pod holding or seed harvestable, HT: is tolerant of Intervix® residues, BGA: tolerant to blue green aphids, HS%: approximate level of hard seed remaining at break of the season.

** Sowing rates were double the recommended rate to simulate a seedbank situation. Other rates are recommended or sometimes used grower rates (2.5 and 5kg/ha for Seraph strand medic).

RESULTS AND INTERPRETATION

WATCHUPGA

After 29mm of rain in January, there was little rain at Watchupga in the lead up to sowing at the end of April. The season began slowly towards the end of May, then rain fell regularly until early August which had below average rainfall. Early rain in September broke the dry spell. Spring rains into November finished the season, extending the growing season for later flowering legumes (see page 16).

Species adaptation

All legume pasture lines established, with plant counts ranging from 75 to 276 plants/m^2 (Table 2) when sown at the higher rates to simulate pastures regenerating from a seedbank and provide a better estimate of growth potential.

Table 2. Plant establishment, flowering and maturity biomass of pastures, Watchupga 2021.

Treatment	Sowing rate (kg/ha)	Establishment (plants/m^2)	Flowering biomass (t/ha) 2 September	Total biomass (t/ha) 7 December
Arrowleaf clover	10	136^{cd}	0.41^{e}	5.6^{a}
Morava vetch	40	77de	1.5^{b}	5.2^{a}
Seraph strand medic	20	227^{ab}	1.0^{c}	3.8^{b}
Bartolo bladder clover	20	253^{a}	1.0^{c}	3.8^{b}
Studenica vetch	40	75^{e}	2.5^{a}	3.5^{bc}
Trigonella balansae	10	108^{cde}	0.31^{e}	3.2^{bc}
Rose clover	20	167^{bc}	0.58^{de}	3.1^{bc}
Frano French serradella	20	276^{a}	0.83^{cd}	2.8^{c}
Sig. diff.		**<0.001**	**<0.001**	**<0.001**
LSD (P=0.05)		**60**	**0.40**	**0.96**
CV%		**21**	**22**	**14**

While all legumes were inoculated at sowing, when plants were examined for nodulation, only Studenica vetch achieved adequate levels, with 70 per cent (%) of plants having active nodules. Morava vetch, Frano French serradella, rose clover and Trigonella had borderline levels (50–70% of plants with active nodules) and the remainder had poor nodulation (<50% with active nodules); likely due to dry conditions after sowing.

Pasture production had been generally slow when plants began flowering in September, with biomass ranging from 0.3–2.5t/ha. The highest biomass at flowering was produced by early maturing Studenica vetch, followed by Morava vetch at 1.5t/ha, then cultivars Seraph strand medic, Bartolo bladder clover and Frano French serradella all producing 0.8–1.0t/ha.

With ongoing spring rain, pastures continued to accumulate biomass into November, changing the order of production. Cefalu arrowleaf clover and Morava vetch produced an impressive 3.5–5t/ha more biomass to yield above 5t/ha. Seraph strand medic and Bartolo bladder clover (3.8t/ha) caught up to early maturing Studenica vetch (3.5t/ha), which was limited by its early maturity this year.

Interestingly, while Frano French serradella has a later maturity, it didn't keep growing as vigorously as other cultivars. At Jil Jil in 2019, it had the highest biomass despite a dry spring, on a deep sand (0–10cm pH 6.8, >10cm pH 8.0). Watchupga was slightly more alkaline with pH$_{CaCl2}$ 0–10cm: 7.2 and 10–100cm: 7.2–8.6.

Seed yield samples have been collected and are being processed. Re-establishment of pastures from the seedbank will be measured in 2022.

Sowing rate

Plant establishment improved as sowing rates increased, nearly doubling as sowing rate increased from 5 to 10kg/ha and tripling when sowing rate was 20kg/ha (Table 3).

Table 3. Plant establishment, flowering and maturity biomass of Seraph medic sown at different sowing rates, Watchupga 2021.

Sowing rate (kg/ha)	Establishment (plants/m²)	Flowering biomass (t/ha) 2/09/2021	Total biomass (t/ha) 7/12/2021
2.5	66^{c}	0.31^{b}	3.4
5	86^{c}	0.52^{b}	3.0
10	154^{b}	0.67^{ab}	3.5
20	227^{a}	1.00^{a}	3.8
Sig. diff.	**<0.001**	**0.03**	
LSD (P=0.05)	**52**	**0.42**	**NS**
CV%	**20**	**34**	

Biomass at flowering doubled with higher sowing rates and plant density for medic sown at 20kg/ha—the simulated seedbank rate.

However, with the occurrence of good spring rainfall, legume biomass in the lower sowing rate treatments caught up to the extent that biomass at maturity was similar for all sowing rate treatments.

Time of sowing

Plant establishment density of Seraph strand medic and Frano French serradella was not affected by species or TOS (Table 4).

Table 4. Plant establishment, flowering and total biomass of Seraph strand medic and Frano French serradella sown at difference sowing times, TOS1: 27 April and TOS2: 31 May, Watchupga 2021.

Cultivar	Establishment (plants/m²)	Flowering biomass (t/ha) 2/09/2021		Maturity biomass (t/ha) 7/12/2021
		TOS1	**TOS2**	
Seraph strand medic	148	0.67	0.31	3.2
Frano French serradella	191	0.66	0.25	2.5
Sig. diff.	**NS**	**P=0.005 (TOS)**		**P=0.048 (cultivar)**
LSD (P=0.05)		**0.42**		**0.68**
CV%		**34**		**17**

At flowering, Seraph strand medic and Frano French serradella sown at the end of April had double the biomass of pastures sown at the end of May. By maturity however, TOS differences had disappeared, and cultivar became more important, with Seraph yielding highest biomass of 3.2t/ha. Cultivar biomass likely reflects how well cultivars were adapted to the soil type.

MITIAMO

A similar species evaluation and sowing rate trial was sown at Mitiamo into an acidic (pH_{CaCl2} 0–10cm: 5.0, 0–40cm: 7.4) silty clay soil on 25 May 2021.

April to October growing season rainfall at Mitiamo was 180mm. Despite an average GSR, the distribution of rain was challenging for establishing pastures, with a late break resulting in poor winter growth due to cold conditions. This was followed by a dry August and spring falls too late to influence biomass growth (see page 18).

Species adaptation

At Mitiamo, plant establishment density was greatest for Bartolo bladder clover, Seraph strand medic and Frano French serradella.

Studenica vetch and Morava vetch both achieved adequate levels of nodulation. Bartolo bladder clover and Rose clover had borderline nodulation and remaining varieties had poor nodulation, again likely affected by dry conditions after sowing.

After the wet June and July, NDVI readings indicated higher biomass for Studenica vetch, followed by Morava vetch. Seraph strand medic, Bartolo bladder clover and Frano French serradella produced lower but similar levels of biomass (Table 5). Cefalu arrowleaf clover and Trigonella produced the lowest biomass.

This trend followed through to flowering biomass.

At Mitiamo, chloride exceeded 1000mg/kg below 40cm deep, so it's unlikely that these pastures could access water or nutrients further down the profile which would have affected later season biomass production.

Table 5. Plant establishment, NDVI and flowering biomass of pastures, Mitiamo 2021.

Treatment	Sowing rate (kg/ha)	Establishment (plants/m²)*	NDVI (expressed as a % of Seraph strand medic sown @ 20kg/ha) 6 August	Flowering biomass (t/ha) 5 October
Studenica vetch	40	45	194^{a}	3.2^{a}
Morava vetch	40	48	171^{b}	1.9^{b}
Seraph strand medic	20	105	100^{c}	1.4^{bc}
Bartolo bladder clover	20	117	92^{cd}	1.3^{c}
Frano French serradella	20	97	92^{cd}	1.3^{c}
Rose clover	20	22	94^{cd}	0.91^{cd}
Cefalu arrowleaf clover	10	42	80^{d}	0.68^{de}
Trigonella	10	22	80^{d}	0.23^{e}
		Sig. diff.	**<0.001**	**<0.001**
		LSD (P=0.05)	**15**	**0.54**
		CV%	**7.6**	**22**

*Only measured in one replicate.

Sowing rate

Plant establishment was highest when Seraph strand medic was sown at 20kg/ha—the rate simulating a regenerating pasture. The biomass measure of NDVI in August was greater for the higher sowing rate, and although not significant (low replicates, high variation), the trend was still present at flowering (Table 6).

Table 6. Plant establishment, flowering and total biomass of Seraph strand medic sown at different rates, Mitiamo 2021.

Sowing rate (kg/ha)	**Establishment (plants/m²)**	**NDVI** (expressed as a % of Seraph strand medic sown @ 10kg/ha) 6 August	**Flowering biomass (t/ha)** 7 December
2.5	15	98^{b}	0.74
5	20	98^{b}	0.81
10	15	100^{b}	0.95
20	105	117^{a}	1.4
	Sig. diff.	**0.03**	
	LSD (P=0.05)	**0.42**	**NS**
	CV%	**34**	

COMMERCIAL PRACTICE AND ON-FARM PROFITABILITY

Legume pastures grew well at Watchupga in 2021. Despite the late start, once established the pastures were able to survive and capitalise on a mild spring with above average rains.

At Mitiamo, water extraction was limited by subsoil constraints below 40cm so, despite adequate seasonal rainfall, the dry spells affected plant performance.

Evaluation of new and novel pastures has shown promise for hard seeded medic, clover and serradella varieties that could be included in pasture mixes for a phase of several years of pasture production.

Soil adaptation is an important consideration in choosing pasture species. Vetch performed well at both sites and was the best legume option where regeneration was not needed. At the higher pH site, Seraph and Bartolo performed best, considering both early and late biomass production. At this site, Cefalu arrowleaf clover responded well to late rains. At the lower pH site Seraph, Bartolo, Frano and Rose clover were the better options.

Cultivar and management information generated from field trials and demonstrations for the *Boosting profit and reducing risk of mixed farms in low and medium rainfall areas with newly discovered legume pastures enabled by innovative management methods* project, will be made available in time for the new season in 2022.

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COMMON VETCH TRIAL RESULTS FROM WATCHUPGA

Stuart Nagel, Angus Kennedy, Gregg Kirby (SARDI) and Brooke Bennett (BCG)

TAKE HOME MESSAGES

- Choose vetch varieties on initial end use targets, with flowering time/maturity a key selection tool, particularly in the Mallee.
- Time of sowing can dictate when cutting for hay is best, so choose maturity and sowing time based on when cutting/drying is best, if focusing on hay production.
- Vetch performs best when treated as a crop, not a break, to achieve maximum outputs, be it for hay, grain or nitrogen fixation—elite varieties require elite management.

BACKGROUND

The National Vetch Breeding Program at SARDI (South Australian Research and Development Institute) has been conducting advanced breeding (S4) trials with BCG for a number of years, as part of the GRDC-funded national program. This is to demonstrate the potential of vetch in the Victorian Mallee as well as to get a broader assessment of advanced breeding lines. 2021 was a challenging year logistically for programs with a national focus, resulting in fewer Victorian trials, compared to 2020.

Common vetch has become an integral component of many modern farming systems in Mallee areas. These trials are demonstrating which varieties perform best for different end uses in different areas, and show the influence of flowering and maturity time on dry matter and grain yields in different environments.

AIM

With more vetch being used in a variety of ways, particularly across the Mallee, this joint trial with BCG was run in conjunction with a series of trials across Southern Australian cropping regions to assess the performance of existing varieties and advanced lines. The aim is to give a better understanding of, and local examples of, varietal performance across the regions and how seasonal conditions and different flowering/maturity characteristics can affect yield.

PADDOCK DETAILS

Location:	Watchupga South
Crop year rainfall (Nov-Oct):	234mm
GSR (Apr-Oct):	172mm
Soil type:	Sandy loam
Paddock history:	Barley 2020

TRIAL DETAILS

Crop type:	Vetch
Target plant density:	60 plants/m^2
Seeding equipment:	knife point, press wheels, 30cm row spacing
Sowing date:	27 April
Replicates:	Four
Fodder harvest date:	6 September – 17 September
Grain harvest date:	29 November

TRIAL INPUTS

Fertiliser:	Granulock® Supreme Z + Flutriafol (200mL/100kg) @ 60kg/ha at sowing. Seed inoculated with Group E rhizobia.

Weeds, pests and disease were controlled according to best management practice.

METHOD

These trials were designed to include four varieties and eight advanced lines to demonstrate varietal performance and assess the potential of the advanced lines in specific regions. The trial was designed as a randomised complete block design. It was assessed for emergence, vigour, time to flowering, dry matter production and grain yield. For the fodder cuts, each line was cut at 50 per cent (%) flower – 50% flat pod, to reflect the ideal hay cutting time. 1m^2 was cut and dried to establish comparative tonnes/hectare of dry matter for each line.

RESULTS AND INTERPRETATION

The results below give an excellent example of the regional potential of the released varieties and how different maturities affect end use potential in a season like 2021.

Studenica demonstrated early growth and vigour, showing its potential for early fodder production/ grazing, but the more traditional hay timing showed the mid maturity varieties have the ability to grow on through September and significantly increase production. The later maturity Morava struggled with dry matter production but was able to make the most of later spring rain to give good grain yields.

The grain yields show Studenica does not out yield other varieties unless rainfall cuts off early. The mid and later maturing varieties make the most of spring rainfall and growth to produce higher grain yields, with Timok and Morava out yielding the other varieties.

The advanced line, SA 37107, is a likely candidate for future release. It flowers at a similar time to Timok, and as a mid-maturing line, it showed a good balance between hay and grain yields in a season like 2021.

Of the other advanced lines, 38819 was the best performing line. It has a later flowering/maturity time and was able to make the most of the spring rainfall. An interesting demonstration of the importance of different maturities was shown with two lines, 38179 and 38397, swapping ranking for the different end uses. A later maturing line, 38179 had excellent grain yields but a lesser hay yield. By contrast, the earlier to mid-maturing line 38397 showed excellent hay production but a more modest grain yield.

Table 1. Grain yield (t/ha) and biomass yield (t/ha) of common vetch varieties and breeding lines at Watchupga, 2021.

Variety	Grain yield		Biomass yield	
	t/ha	Rank	t/ha	Rank
37107	2.0^{b}	5	4.1^{abcd}	4
37878	1.7^{cd}	11	4.0^{abcd}	5
37907	1.8^{c}	9	3.7^{bcd}	9
38179	2.4^{a}	2	3.8^{bcd}	8
38397	1.8^{bc}	8	4.3^{ab}	2
38563	1.8^{bc}	7	3.9^{abcd}	6
38593	2.2^{a}	4	3.6^{de}	11
38819	2.4^{a}	1	4.2^{abc}	3
Morava	2.2^{a}	3	3.2^{e}	12
Studenica	1.6^{d}	12	3.9^{bcd}	7
Timok	1.9^{bc}	6	3.7^{cd}	10
Volga	1.7^{cd}	10	4.5^{a}	1
Sig. diff.	**<0.001**		**0.006**	
LSD (P=0.05)	**0.2**		**0.6**	
CV%	**6.4**		**10**	

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The new variety, Studenica, demonstrated its potential for use as an early fodder source in mixed farming systems, particularly for winter grazing. This variety has very early flowering and maturity so does not always suit spring hay production unless sown later. Seed of this variety was commercially available for the first time in 2021 from S&W Seed Company.

For more traditional hay production, the mid-maturing varieties can make the most of spring growth. They also allow for cutting at a better time of the season for curing/drying of hay.

In the area where the trial was conducted, Volga produced the best hay yields, with Morava requiring more soil moisture in October to produce its best.

The advanced line SA 37107 showed good results. It has consistently been among the best lines, in both hay and grain production, across all vetch growing regions during the past three years. It has also shown improved adaption to low pH soils, consistently topping trials of both hay and grain at sites with <5.5 pH $CaCl_2$.

With the increase in vetch use across the Mallee areas, it is important to choose varieties by initial end use goals. Time to flowering and maturity are important considerations when targeting specific end uses and will dictate the optimum sowing window. With the increasing diversity of maturity in vetch varieties, it is now possible to swap varieties if vetch can't be sown until later in the program or if it is to be the first in the ground. For specific varietal details see the Agriculture Victoria 2022 Victorian crop sowing guide.

ACKNOWLEDGEMENTS

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SOUTHERN PULSE AGRONOMY: MALLEE PULSE HIGHLIGHTS 2022, VARIETIES AND AGRONOMY

By Jason Brand (Agriculture Victoria), Sundara Mawalagedera (Agriculture Victoria) and Michael Moodie (Frontier Farming)

TAKE HOME MESSAGES

- Several new lentil varieties will offer growers improved grain yield and yield stability combined with a range of novel herbicide traits.
- Several new genetic traits in a range of pulse crops will offer alternate weed management strategies in the future.
- Significant variation in frost tolerance was observed across lentil varieties, with PBA HurricaneXT showing the worst vegetative damage of released varieties and PBA Ace showing good tolerance. Generally standing stubble treatments showed less damage than slashed stubble and row spacing, and sowing direction had little effect.
- In pulses, except lupin, a 100–210% grain yield benefit from deep ripping on deep Mallee sands, resulting gross margin gains of $312–$668/ha, has been recorded.
- In 2020 and 2021 pod drop was a minor issue with minimal wind events and the impact of agronomic practices on relative pod drop across varieties was limited. For example, in 2020 it was estimated that PBA Hallmark XT lost the equivalent of 100kg/ha ($65/ha) from pod drop and shattering, while PBA Jumbo2 only lost 16kg/ha ($10/ha).

BACKGROUND

Ongoing improvement in pulse varieties, combined with improved agronomic and disease management practices has seen pulses become commonplace in profitable farming systems in southern Australia. However, there are many emerging challenges and opportunities for ongoing research and development in partnership with industry.

In 2021, through a new GRDC investment the Southern Pulse Agronomy Victorian project had a range of agronomic trials aiming to improve the profitability and reliability of pulse in Mallee zones.

Some of the key findings in this project are:

- New lentil varieties and yield stability across soil types and sowing dates
- Weed management, novel herbicide traits and new herbicides
- Variation in varietal frost tolerance in lentil and implications for grain yield
- The yield benefit of soil amelioration practices such as deep ripping on Mallee sands
- Row space, sowing direction and stubble implications for pod drop in lentil.

PADDOCK DETAILS: SOUTHERN MALLEE

Location:	Watchupga
Crop year rainfall (Nov–Oct):	234mm
GSR (Apr–Oct):	172mm
Soil type:	Sandy Loam
Paddock history:	2020 Barley

PADDOCK DETAILS: WEST WIMMERA

Location:	Propodollah
Crop year rainfall (Nov–Oct):	324mm (data from Nhill weather station)
GSR (Apr–Oct):	216mm
Soil type:	Duplex – slightly acidic sandy loam over alkaline clay
Paddock history:	2020 Barley

New lentil varieties and yield stability across soil types and sowing dates

In lentil, all the potential new varieties were sown in trials at Watchupga, comparing sowing dates (Table 1), and at Propodollah (west Wimmera), comparing soil types (Table 1).

GIA2002L had the highest or equal highest grain yield in all trials, highlighting good potential yield stability. GIA2003L was consistently high yielding, but slightly less than GIA2002L. GIA1703 had excellent yields at Watchupga, similar to results in 2020, and on the ripped sand at Propodollah, but was slightly lower on the duplex soil type, possibly due to frosts that occurred in this location adversely affecting this breeding line than the others. GIA2004L was relatively low yielding in trials this year, and results need to be treated with caution, as there was some terbuthylazine damage observed and this breeding line has increased sensitivity compared with other varieties.

Table 1. Grain Yield (t/ha) of lentil varieties and breeding lines in 2021 grown in a sowing date trial at Watchupga and in a soil type comparison trial at Propodollah (west Wimmera) (duplex soil (sandy loam topsoil and clay subsoil) in comparison with a sand that had been ripped in 2018).

Variety/Breeding Line	'Watchupga' Sowing Date			'Propodollah' Soil Type	
	29 Apr	01 Jun	*Ave*	Duplex Flat	Ripped Sand
GIA2002L	2.68	2.39	*2.54*	2.14	2.19
GIA2003	2.65	2.40	*2.53*	1.87	1.86
GIA1703L	2.64	2.29	*2.47*	1.61	1.90
CIPAL2121	2.57	2.35	*2.46*	2.07	2.10
GIA Leader	2.55	2.34	*2.45*	1.84	2.00
PBA Jumbo2	2.38	2.49	*2.44*	1.87	2.08
PBA HighlandXT	2.49	2.35	*2.42*	1.67	1.91
PBA Ace	2.49	2.32	*2.41*	2.12	1.46
CIPAL2122	2.36	2.35	*2.36*	1.75	2.01
GIA2001	2.50	2.21	*2.36*	1.75	1.70
PBA HurricaneXT	2.48	2.23	*2.36*	1.66	1.24
PBA HallmarkXT	2.48	2.03	*2.26*	1.43	1.82
PBA Bolt	2.48	2.01	*2.25*	1.75	1.52
PBA KelpieXT	2.28	2.21	*2.25*	1.73	1.63
Nipper	2.46	2.02	*2.24*	1.24	1.37
GIA2004L	1.76	1.33	*1.55*	0.64*	0.20*
Ave	*2.45*	*2.21*	*2.33*	*1.70*	*1.69*
LSD (P<0.05)			**Sow Date = 0.12 Variety = 0.22 Sow Date x Variety = NS**	**0.42**	**0.61**

*Trial showed damage related to terbuthylazine. The low yield of GIA2004L was a result of increased sensitivity to terbuthylazine compared with other varieties.

Weed management, novel herbicide traits and new herbicides

In lentil there are potential new varietal releases combining tolerance to the imidazolinone herbicides with tolerance to metribuzin or soil residues of clopyralid. These will offer alternative weed management strategies within the farming system. In 2021, trials in the west Wimmera and southern Mallee assessed the effect of potential herbicide strategies on vetch control in lentil and field pea varieties with these novel traits and the impact on grain yield.

At the point of publication, data from trials is still being analysed and finalised, however early observations show that in the absence of herbicides, competition from vetch in lentil caused approximately 60% grain yield reduction.

In comparison, a conventional herbicide strategy reduced yield loss from vetch competition to 23%, while a strategy utilising the imidazolinone trait showed no yield loss from vetch competition.

Despite the improvements in relative grain yield neither the conventional nor the imidazolinone based strategies completely prevented vetch seed set. Both potential herbicide management strategies utilising tolerance to metribuzin or soil residues of clopyralid showed improved control of vetch.

In faba beans, a new line AF14092, has shown improved tolerance to metribuzin applied post sowing pre-emergent compared with PBA Samira in field trials near Horsham. This breeding line showed excellent grain yields throughout Victoria and could provide improved crop safety to metribuzin when applied post sowing pre-emergent across a range of soil types.

There has been much interest in the new Group 14 herbicide Reflex (200 g/L Fomesafen) as an alternative to Group 5 herbicides to assist with pre-emergent broadleaf weed control in pulse crops. Observations so far is that the label guidelines to maintain separation between herbicide treated soil and planted seed is critically important when used in lentil grown on sandy soils, such as in the Mallee.

There is a high risk of movement of treated soil into the crop row on these soils which can occur through soil throw from excessive sowing speed, collapse of the furrow side wall, soil drift and erosion and rolling. Actions need to be taken to mitigate these potential issues, especially in situations where the soil is soft and or has low ground cover such as on deep sandy dunes or where soil amelioration such as deep ripping has recently been completed.

Variation in varietal frost tolerance in lentil and implications for grain yield in the west Wimmera

In lentil trials at Propodollah in 2021, several significant vegetative and reproductive frost events occurred. Crop yellowing in response to two vegetative frost events (26 Aug, -2.2°C and 27 Aug, -2.9°C) was recorded. Significant variation was observed across varieties, with PBA HurricaneXT showing the worst damage of released varieties and PBA Ace showing good tolerance (Figure 1). Generally standing stubble treatments showed less damage than slashed stubble (Figure 2) and row spacing, and sowing direction had little effect (data not shown).

In addition, there was a frost event during the reproductive phase events (11 Oct, -0.8°C and 12 Oct, -0.8°C) that caused significant flower and seed abortion. Detailed assessments of flower and pod loss showed that the relative effect across a range of varieties was similar (data not shown). While in some varieties flower and pod loss were higher, they respectively set more flowers and pods to compensate.

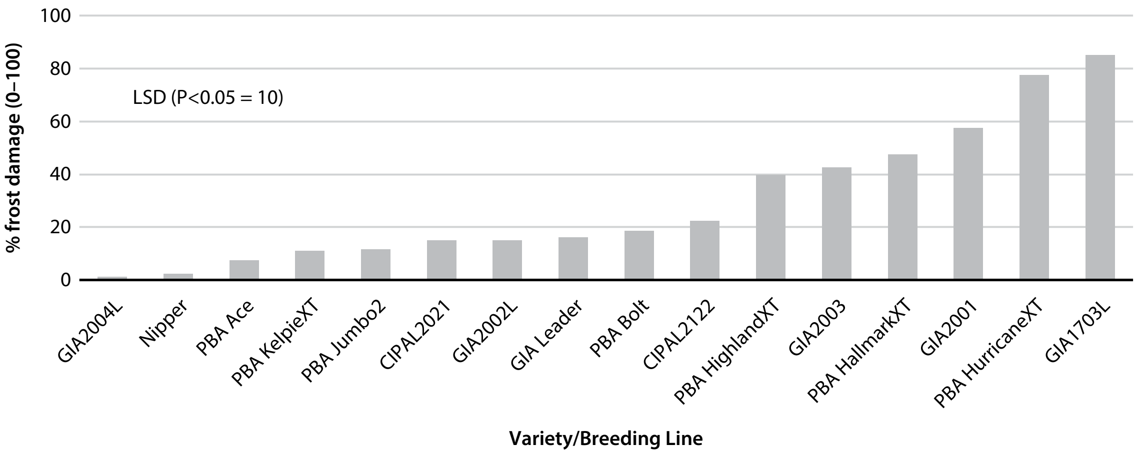

Figure 1. Frost Damage (% Crop Yellowing), recorded Aug 31, on lentil varieties and breeding lines grown at Propodollah (west Wimmera), in a trial comparing soil types, from two vegetative frost events (26 Aug, -2.2°C and 27 Aug, -2.9°C).

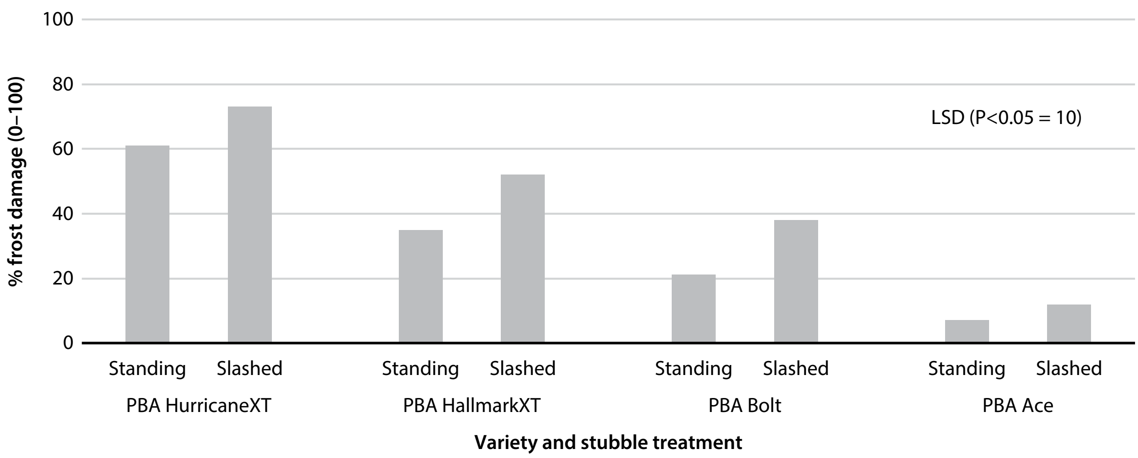

Figure 2. The effect of stubble on frost damage (% Crop Yellowing), recorded 31 Aug, in lentil varieties grown in a trial comparing stubble, row space and row direction at Propodollah (west Wimmera) from two vegetative frost events (26 Aug, -2.2°C and 27 Aug, -2.9°C).

The yield benefit of soil amelioration practices such as deep ripping on Mallee sands

Trials located on deep Mallee sands over the past three seasons have demonstrated substantial increases in the grain yields of pulse crops in response to soil amelioration practices such as deep ripping (Figure 3). Chickpea and faba bean were the most responsive pulse crops to deep ripping with an average yield increase of 210% across all trial sites.

Deep ripping provided a mean yield benefit in lentil of 166%. Deep ripping doubled the mean grain yield of field peas and vetch. In contrast to the other grain legumes, deep ripping only provided a small yield benefit in lupin. Lupin also have the highest establishment risk in sand due to their requirement for shallow seed placement, indicating that lupin should not be sown into deep ripped paddocks.

A gross margin analysis showed that the average yield response observed across the trial sites was highly profitable (Table 2). The average chickpea yield response to deep ripping was 1.1 t/ha and this would have improved gross margin by approximately $667/ha, after accounting for an annualised cost of deep ripping of $40/ha.

Field pea and faba beans had a similar yield boost from deep ripping which led to more than $360/ha profit. The average yield response to deep ripping of lentil and vetch was lower at 0.5 t/ha, but this still led to approximately $300/ha gross margin.

Lupin was the only pulse crop that did not produce an economic benefit from deep ripping in these trials. The profitability of the farming system is also likely to be improved with subsequent cereal crops benefiting from increase nitrogen supply and legacy effects from the deep ripping operation.

While these trials have shown large productivity and profitability benefits, farmers considering deep ripping should also evaluate the operational risks. For example, deep ripping before a pulse phase requires high levels of residual stubble to ensure adequate ground cover is maintained while care also needs to be taken with pre-emergent herbicides to minimise risk of crop damage.

Trafficability of heavy machinery is also an issue that needs to be managed post ripping, with rolling with heavy steel drum rollers recommended to reconsolidate the surface and provide better flotation for the seeder and self-propelled sprayers. Soil testing also needs to be undertaken before deep ripping to avoid unwanted soil characteristics being brought to the surface.

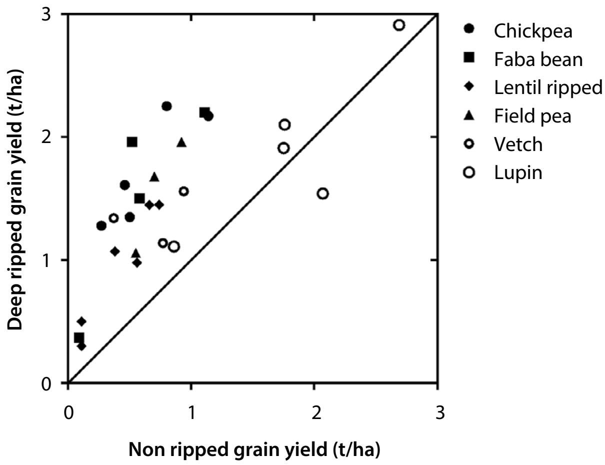

Figure 3. Grain yield of pulse crops grown on deep Mallee sands for non ripped and deep ripped treatments. Data is a collation of six Mallee trial sites conducted between 2019–2021. All deep ripping treatments used a Tilco A66 tines spaced at 56cm apart with a ripping depth of 400–500mm.

Row space, sowing direction and stubble implications for pod drop in lentil

In more recent cropping seasons several high wind events around the harvest period of lentil across southern Australia resulted in significant losses due to pod drop across a range a varieties. In preliminary trials at Curyo in 2019, significant variation was noted, with PBA HallmarkXT showing the worst susceptibility of released varieties (CIPAL1821 was noted to be one of the worst breeding lines).

It has also been suggested that stubble height, row spacing and sowing direction could have an impact on the response, due to the way the crop forms the canopy, and thus the movement that occurs at maturity during high wind events.

Throughout 2020 and 2021 a series of trials were established combining agronomic and genetic responses aiming to minimise yield losses from pod drop at harvest. Specifically focusing on the impact of row spacing, stubble and row direction on the growth, grain yield and tolerance to pod drop of lentil varieties and breeding lines differing in plant architecture, phenology and pod drop and shatter resistance.

In both seasons and across all sites pod drop was a minor issue with minimal wind events, so it has been difficult to draw specific conclusions of the impact of agronomic practices on relative pod drop across varieties. For example, in 2020 it was estimated that PBA Hallmark XT lost the equivalent of 100kg/ha ($65/ha) from pod drop and shattering, while PBA Jumbo2 only lost 16kg/ha ($10/ha).

In addition, preliminary results from 2021 appear inconsistent with observations in 2020 where sowing direction had no major impact on the number of pods dropped, while wide row treatments appeared to have slightly fewer pods dropped than narrow rows. In 2021, narrow rows tended to drop fewer pods than wide rows and north/south sowing direction more pods than east/west.

Despite minimal impact on pod drop, there have been some interesting observations on the grain yield response in lentil to these various sowing practices. In 2020, there was a clear relationship between plant architecture and response to sowing direction and row space, ie. 'Spreading varieties' (eg PBA Jumbo2) showed no response to sowing direction or row spacing. The 'Erect varieties' (eg PBA Bolt) had 6% lower grain yield sown N-S compared with E-W and were 9% higher yielding in narrow rows compared to wide rows. Much of the variation could be explained by harvestability and lodging direction.

In 2021, preliminary results did not appear to follow the same trend with no consistent differences between architecture types evident (data not shown). Some key early observations appear to show that standing stubble was about 20% higher yielding than slashed stubble; sowing across stubble had yields 10–20% higher than inter-row with the stubble direction and narrow rows had yields up to 10% higher than wide rows.

Many of these observations can be attributed to the seasonal conditions of 2021, with an extremely dry start, that resulted in improved germination and early growth sowing across stubble. Also due to the later start growth and biomass development was relatively slow, meaning that full canopy closure was not achieved in wider row treatments. Further information will be explored in the presentation.

Table 2. Grain yield (t/ha) of lentil varieties and breeding lines sowing North/South (N-S) compared with East/West (E-W) and row spacing of 0.18cm and 0.36cm at Watchupga in 2020.

Dir / RS	**Plant Type**	**N-S**			**E-W**		
Variety		**0.18**	**0.36**	***Ave***	**0.18**	**0.36**	***Ave***
PBA Jumbo2	Spreading	3.41	3.42	*3.42*	3.38	3.43	*3.41*
GIA1706L		3.30	3.22	*3.26*	3.18	3.23	*3.21*
PBA Jumbo		2.89	2.85	*2.87*	2.93	2.84	*2.89*
CIPAL1821	Erect	3.30	2.81	*3.06*	3.44	3.30	*3.37*
PBA HurricaneXT		3.17	3.03	*3.10*	3.37	3.10	*3.24*
PBA Bolt		3.33	2.80	*3.07*	3.33	3.01	*3.17*
PBA HallmarkXT		2.90	2.86	*2.88*	3.22	3.06	*3.14*
Aldinga	Flat	3.02	2.68	*2.85*	2.96	2.86	*2.91*
Ave		*3.17*	*2.96*	*3.06*	*3.23*	*3.10*	*3.17*
		P Value	LSD		P Value	LSD	
Row Space		0.04	0.20		ns		
Variety		0.10	0.40		0.10	0.30	
RS x Var		ns			ns		

Table 3. Relative grain yield response of lentil varieties and breeding lines sowing grouped by plant type at Watchupga in 2020. On left of table the relative grain yield in the N-S compared with the E-W treatment is presented. On the right of the table the relative grain yield in the narrow row spacing (0.18cm) compared with the wide row spacing (0.36cm) is presented.

	N-S/E-W			**0.18/0.36**		
Plant Type[1]	*Ave*	0.18	0.36	*Ave*	N-S	E-W
Spread	*100*	101	100	*101*	101	100
Erect	*94*	95	92	*109*	111	107
Flat	*98*	102	94	*108*	113	103

Spread – PBA Jumbo2, PBA Jumbo and GIA1706L; Erect – PBA Bolt, PBA HallmarkXT, PBA HurricaneXT and CIPAL1821; Flat – Aldinga.

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DESCRIPTION OF POTENTIAL RELEASES & NEW VARIETIES

Lentil

GIA2002L is a new broadly adapted imidazolinone (IMI) tolerant small round red lentil. EPR TBC.

GIA2003L is a new broadly adapted imidazolinone (IMI) tolerant small round red lentil. Superior adaptation to light sandy soils than GIA2002L. EPR TBC.

GIA1703L is the first imidazolinone (IMI) tolerant lentil with improved tolerance to clopyralid soil residues from a prior crop, applied according to product label directions. A small round red lentil with a grey seed coat, GIA1703L is best suited to early sowing and favourable lentil growing areas to maximise growth, height and yield. Avoid low fertility sandy soils and low rainfall frost prone environments. EPR TBC.

GIA2004L is a medium to large size red lentil with a grey seed coat, it is the first lentil to combine imidazolinone (IMI) and metribuzin (MET) herbicide tolerances. EPR TBC.

Field Peas

PBA Noosa (evaluated as OZB1308) is the first blue field pea to be released in Victoria since 1999. It has improved bleaching tolerance and is early-mid flowering and maturing. PBA Noosa has excellent grain yield, similar to the highest yielding 'Kaspa' and 'Dun' type varieties and >20% higher yield than the old blue pea Excell. Grain quality will be critical so growers should focus on insect management and timely harvest. Opportunity for premium quality niche markets, initially for domestic human consumption. Commercialised by PB Seeds with limited seed available for 2022 season.

PBA Taylor (evaluated as OZP1408) is a new high yielding semi-dwarf, semi-leafless Kaspa type field pea with wide adaptation to southern Australia. It is early to mid-flowering and maturity and has non-shattering pods. Resistant to PSbM and BLR viruses. Commercialised by Seednet.

GIA2005P is the only Kaspa type variety of field pea with improved tolerance to common in-crop and residual Group B herbicides (combined IMI and SU), and superior to GIA Kastar in both herbicide tolerance and early vigour. An early to mid-flowering and early maturing Kaspa type field pea, semi-leafless with an erect growth habit. Developed by Grains Innovation Australia (GIA).

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