Trial Summary 2019

Irrigated Cropping Council
Promoting irrigated agriculture

Innovative, locally driven research, development and extension leading to best practice irrigation for croppers and mixed farmers.

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EXECUTIVE OFFICERS REPORT

Irrigated Cropping Council
Promoting irrigated agriculture

I'm going to break with tradition and not talk about last years trials, this is Damian's thunder so I won't steal it. Instead I wanted to share what the Irrigated Cropping Council (ICC) is doing now and into the future to deliver on our mission of a commercially competitive and sustainable sector that can confidently use best practice irrigation to respond flexibly and rapidly to market demands in an environmentally and socially responsible manner.

ICC is leading the GRDC project "Facilitated Action Learning Groups to support profitable irrigated farming systems in the northern and southern regions". As part of this project we have established an Irrigation Discussion Group (IDG) in Barham. At the first meeting growers wanted to tap into the knowledge of farmers in the room and the region to help them increase flexibility, freedom and foresight within their farming businesses. As a result of their brainstorming we are road-testing our "focus farm case study" project which aims to capture the learnings of growers, the discussion between them and then give us the opportunity to share it more broadly. Our next meeting in March will focus on two different case study farms. We will visit a farm where they have recently converted to overhead irrigation to talk about the decision-making process, the successes and the obstacles they've come across. Then the second farm looks at the inclusion of cover cropping, multispecies mixes, subservice drip and zero till in an irrigated rotation including maize. To become a member of the discussion group please contact mel.mann@irrigatedcroppingcouncil.com.au

ICC is working with FAR Australia on the GRDC project "Development and validation of soil amelioration and agronomic practices to realise the genetic potential of grain crops grown under a high yield potential, irrigated environment in the northern and southern regions". As part of this Damian will put in a number of trials at Kerang investigating the agronomy of canola, durum, barley, faba beans, chickpeas and maize. Damian will also be running a smaller agronomy site in Griffith focused on maize and chickpeas and a soil amelioration site at Noorong. These trials should enable us to continue to build on the "bang for your buck" irrigation trials started by ICC this year.

This year we have also changed how we source funding for the irrigated variety trials. We believe these are an important resource providing greater insight than NVT into how varieties perform in an irrigated environment. We are now partnering with a number of breeders and seed companies to ensure this work is ongoing in our region and we are grateful to the organisations who have contributed to this program.

Other projects that ICC is currently involved in include:

- Smarter Irrigation for Profit Phase Two – ICC has a key learning site looking at improving irrigation efficiency in wheat. The wheat included in the irrigation scheduling trials was supported by this project including the installation of soil moisture monitoring. This work is supported by CRDC, GRDC and AgriFutures, through funding from the Australian Government Department of Agriculture as part of its Rural R&D for Profit Program.

- Pulse Check – ICC's group meet twice a year and bring in pulse experts from across Australia to the Moulamein region.

- GMBCA – From the Ground Up - Increasing soil carbon to ameliorate compaction in irrigated soils- This project is supported by the Goulburn Broken CMA and the Australian Government's National Landcare Program.

- Soil Limitations – ICC will deliver a workshop addressing key soil constraints in our region and how to manage them.

As always, we are looking for opportunities to deliver research that is relevant to you, please get in touch if you have any ideas or issues you would like to see us addressing.

Finally, I want to acknowledge the ICC trials team, thank you to Damian Jones and Rohan Pay for continuing to deliver high quality field research. Their dedication is what keeps ICC delivering locally relevant research.

Charlie Aves

Executive Officer

Thanks to the following for supporting the trials program

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Pacific Seeds
Growing possibilities

PIONEER
BRAND · SEEDS

ADAMA

Grain Growers

AGT

More Questions than Answers - Observations from 2019

Damian Jones, Trials Manager

Growing Irrigated Barley

A combination of bird damage and excessive lodging saw reduced barley yields despite achieving high grain numbers per head.

There is always some bird damage, however, it is usually confined to the buffer around the crops as the birds have other crops surrounding the trials to target. This season saw the bulk crop area significantly reduced which concentrated the feeding on the trials, in particular the barley trials, as these are the earliest maturing. In 2020 all areas around trials will be sown to an early maturing barley to reduce risk of bird damage to the trials.

The lodging that occurred in the barley trial was due to excessive Nitrogen (N) early in the season, which resulted in excessive vegetative growth. To avoid the problem seen in 2018 where we applied N but couldn't get it into the crop because of the lack of good rainfall events, we topdressed before it became apparent that there was more N in the soil than the pre-irrigation soil test indicated. The crop began to lodge even before stem elongation occurred. During stem elongation the plant stems ran along the ground for a short length before heading vertical. Lodging re-occured as grain filled. Looking at the yield results, the shorter season barleys performed close to average, but the overall result was dragged down by the later maturing varieties. Using an information sheet produced by the International Maize and Wheat Improvement Centre (CIMMYT) which takes into account the angle of the lodged crop (the flatter, the greater the yield penalty), proportion of the crop that is lodged and the number of days of lodging until the crop is ripe the potential yield losses resulting from the lodging ranged from 5% to 18%.

When a barley head first forms, it has 42 possible grains on it, grains are shed depending on various stresses. Our irrigated trials average around 32 for the main stem heads. So, given the plants had adequate moisture and N for yields, why did we lose 10 grains? My initial suspicion was that when the head is forming, which is about 6-8 weeks post-emergence, that the light received by the crop in winter was insufficient to produce enough photosynthates (food) to keep all those grains alive.

In 2019, there were some very healthy heads produced, with up to 41 grains found in the Westminster heads. This got me thinking that it may have something to do with our N nutrition. Does restricting N to control vegetative growth result in loss of grains as well? Or does extra N mean greater leaf area that can supply enough "food" to keep all the developing grains?

In the end, the extra grains in the head didn't translate to higher yields. This could also indicate an issue with the current varieties when they are pushed to their genetic limit. Westminster is rated as resistant to head loss, but is this rating based on smaller 32 grain heads and the extra 10 grains prove too much for the stem and are more prone to breaking, particularly if the cop is lodged or the spring more windy than usual? It was difficult to see how many heads had broken off at harvest due to damage from birds and lodging but this will be investigated further in 2020.

Partial Irrigation Agronomy

As a response to low/no allocations and high prices for temporary water, a trial was established to determine the best value for using irrigation water. The trial consisted of 4 sub-trials that were either pre-irrigated or not, followed by 1 spring or full spring irrigation. The management of these trials posed some interesting questions.

Nitrogen Budgets

As part of the Smarter Irrigation for Profit project, we set up what we called the 'plus/minus' trial where we had 4 similar trials that had combinations of pre-irrigation/no pre-irrigation and 1 spring/full spring irrigation with a range of wheat varieties ranging from the early maturing Axe to the late maturing DS Bennett. As each trial would receive differing amounts of water, it seemed sensible to vary the target yields, hence the amount of N applied to reach these yields. Target and actual yields (and the range in wheat where variety did make a difference) in brackets in t/ha were:

Crop	Pre-irrigation + Full Spring	Pre-irrigation + 1 Spring	No pre irrigation + Full Spring	No pre irrigation + 1 Spring
Canola	4 (3.7)	2.75 (2.2)	2 (1.2)	0.5 (0.9)
Wheat	8 (4.7 – 8.3)	5 (3.5 – 6.3)	4 (3.8 – 6.2)	2 (2.8 – 4.1)
Barley	8 (4.8)	6 (4.7)	4 (3.8)	2.5 (2.8)

Based on pre-sowing soil testing, there was sufficient soil N to meet the 'No-pre irrigation + 1 Spring' target yields and urea rates were calculated to meet the rest. However, a couple of issues arose during the season.

Even though we had above average rainfall for May, followed by an average June, lack of soil moisture did become an issue in mid-June in the 'No pre irrigation' trials. If there is no readily available soil moisture, then the plant cannot access the soil N. This manifested itself in a couple of ways. Firstly, crop growth was limited by both the lack of moisture and N deficiency. Reduced crop growth also saw the early maturing Axe produce very few tillers. It seems the stress resulted in Axe deciding the season was finished and it bolted to head simply to survive. When water became available in mid-August, Axe had already committed to its yield and there was little benefit from irrigation. However, the longer maturing wheats were still in their vegetative stage through the stresses and kept tillering when rain did arrive and could take advantage of the spring irrigation.

Another effect of reducing the amount of N to match the anticipated yield was that the grain protein was lower than expected, particularly in the pre-irrigated trials. It seems the crop thought there was more on the way and had used the N supplied to create more vegetative growth and didn't have enough left in reserve to achieve grain protein above 10%. So does this mean we have to supply enough N for the yield potential assuming that the crop will be fully irrigated or save some of the topdressed N for later in the season (possibly at the time of the first irrigation) to ensure there is some N available for grain protein?

Irrigation

With no pre-irrigation, average rainfall never really accumulated any soil moisture below 200mm. In spring, the crop quickly ran out of moisture and needed to be irrigated almost as soon as water became available. While we couldn't measure the amount taken, the first spring irrigation did seem to require a similar amount to that of an autumn pre-irrigation, which makes sense in that we hadn't accumulated any moisture to depth and the crop had used all of the available soil moisture closer to the surface. The only difference was that you couldn't see the cracks you get in autumn. From a trials perspective, it was easy to get the small area irrigated quickly and not stress the crop too much, but it would have been an issue on a broadacre scale unless you were monitoring soil moisture and had planned to start irrigation well before any signs of moisture stress.

As for the value of irrigations, the individual trial reports have the gross margin analyses, which will vary from year to year as water and grain prices fluctuate, the yield responses were quite interesting. The benefit of the second spring irrigation in canola was 1.4 t/ha, of little benefit in barley and variable in wheat. One result. I was surprised with the faba bean quality. I was expecting to see more shrivelled beans in the '1 Spring irrigation' treatments, but the crop seemed to know how many beans to set and filled them reasonably well, although they were smaller than usual.

Early in 2019 I was asked to present at the Agriculture Victoria dry season workshops on the value of pre-irrigation. The focus of my presentation was the theoretical yield differences between pre-irrigation allowing sowing 'on time' to maximise yield potential versus waiting for the break. For Kerang, the realistic expectation for the break is the 3rd week of May or later. I then made a comparison between the cost of pre-irrigation (1.5 Ml/ha x $500/Ml = $750/ha) and potential lost production based on later sowing (cereals $330/ha and canola $525/ha), which made it hard to justify pre-irrigation from an economic viewpoint. I did mention some of the other benefits of pre-irrigation but concentrated on the potential yield loss.

However actually putting a trial in the ground highlighted the benefits (and some of the negatives) which made me look at the larger picture. The definite benefits were weed control, establishment and early crop growth. Even though we had the almost perfect break (20.6mm on May 1 & 2 and a total of 47mm for the month), establishment in the 'no pre-irrigation' trials were patchy and had further germinations as more rain fell later in May.

We had more issues with weeds, beginning with no opportunity for a knockdown (we dry sowed prior to the forecast rain), multiple germinations through the season and non-competitive crop due to low or patchy plant numbers. The lack of crop competition was exacerbated by spring irrigation, particularly in the faba beans.

As mentioned previously, while June was 'average' for rainfall, there was a dry spell in the middle of the month that saw the 'no pre-irrigation' trials struggle a little. This was borne out by a quick dry matter cut in late June where pre-irrigation had seen these trials bounding ahead. The 'no pre irrigation' wheat and barley had 150 and 200kg DM/ha respectively while the pre-irrigated wheat and barley had 800 and 1100kg DM/ha.

Wheat plots on June 21st – pre-irrigated (LHS) and no pre-irrigation (RHS)

Variety Selection

At the start of the 2019 season, it was thought that a short or early season variety would have been the most appropriate. From the barley and canola results, variety maturity didn't make much difference to yield, keeping in mind the barley results may have been compromised by the bird damage. However, there were differences in the wheat varieties which is probably not that surprising given the relatively big differences in maturity compared to the other crop types in the trial. Looking at the results, and keep in mind that the break occurred on May 1st, it was better to go with a long season variety when not pre-irrigating as these varieties could respond to spring irrigation(s).

Summary of the best performing wheat varieties under the different pre-irrigation and spring irrigation scenarios.

Treatment	Highest Yielding Maturity
No pre-irrigation + 1 spring	Long Season
No pre-irrigation + Full spring	Long Season
Pre-irrigation + 1 spring	Mid-Long Season
Pre-irrigation + Full spring	Early-Mid Season

The results may have been different (highly likely) if the break didn't occur until June, or if spring irrigation didn't occur. The most obvious negative from pre-irrigation was that it created a thirsty crop looking for irrigation not that long after the 'no pre-irrigation' trials needed irrigation, but at a reduced volume as there was still subsoil moisture. So, in an ideal scenario with limited/ expensive water, we would want pre-irrigation to set the crop up (delivering timely sowing, establishment, nutrition and weed control), but not with excessive water use and creating a vegetative and N hungry crop.

Plant Growth Regulators (PGR) and Lodging Control

The PGR work we have been undertaking over the past few seasons has had mixed results. Some yield increases in barley (variety and plant population dependent), height reduction in canola and variable results in the faba beans. Faba beans have been especially frustrating, with results varying from nothing at all to promising results in 2018. The 2019 faba PGR trial had a couple of facets to it – can earlier sowing result in higher yield potential, and does using a PGR limit the canopy height and reduce lodging? Unfortunately the trial didn't answer the questions as (1) the early sowing was watered up and we suffered from far too many broadleaf weeds to get any meaningful results and (2) while the PGR did produce some reduction in crop height, it still lodged quite badly.

So why the promising result in 2018 and not in 2019? One difference was in the PGR we used, due to product availability we switched formulation. The other is sowing date. From a limited data set, a subjective assessment could be made that suggests when we sow in April, we produce a crop that lodges. If we sow in May, we have reduced lodging.

PGR's act as a stress on the plant and there is a fine line between having no effect and a yield penalty if the PGR adds to an existing stress on the plant like drought. So maybe the PGRs we have been experimenting with are simply not 'stressful' enough in a better season to have much effect on the canopy/height/lodging?

Looking at the faba variety trials rather than the PGR trials, 2018 average plant height was 121cm and a lodging score of 1.4 (where 0 = no lodging). 2019 was 114cm and 5.3 lodging score. So maybe crop height isn't the major factor influencing lodging and that irrigation timing + wind + canopy density + sowing date are all contributing factors?

Plant Canopies/Biomass/Yield Relationships

The GRDC Irrigated Agronomy Project will allow us to investigate some of the issues holding back increased yields of canola, and to a lesser extent, fabas. The dryland response to increasing yield is to increase biomass as there is a strong relationship between the two.

However, irrigation creates an environment where simply increasing biomass results in problems such as lodging or simply doesn't translate into grain yield. For many years I have heard numerous anecdotes about how the huge canola crop in bay x yielded no better than the 'poor' bay next door. It was a similar story this year when chasing up a summary of how local faba bean crops went for the GRDC Northern Pulsecheck Project – the excellent areas of fabas (based on a visual assessment of the canopy) didn't yield any better than the poorer areas. Similarly, a faba crop we sampled as part of the Goulburn Broken CMA Soilcare Project yielded close to our variety trial despite being half the height and biomass.

Biomass isn't everything in an irrigated environment, in fabas, excessive biomass can result in negative influences on yield apart from the obvious lodging. Dense canopies create conditions that are conducive for disease, make fungicide and insecticide penetration more difficult, reduce the sunlight reaching lower leaves (making them competitors with the developing pods for photosynthates) and possibly reducing pollinator access to flowers. I still believe we need to keep the target plant populations around 25 plants/m^2 for high yielding crops, but we can influence the canopy development with sowing date, row spacing and maybe PGRs. I think we still don't know enough about the influence of vernalisation and day length response on our varieties and the target date for flowering – one of the major changes on how to grow canola has been the identification of the target flowering date and the biomass required at this stage to maximise yield. The Irrigated Agronomy Project will allow us to investigate these options, and I welcome ideas from irrigators that may form part of our trials program over the next few years.

To wrap up;

- To maximise barley yields, a re-think on barley N management may be necessary.
- Reducing yield targets due to reduced irrigation isn't a matter of simply lowering inputs.
- Bigger isn't always better.
- Where PGRs fit in the management of irrigated crops still needs further investigation.

Trial gross margins are calculated using the actual cost of water used.

Whenever irrigated gross margins are discussed, there is always debate regarding the price of water. Is it the actual purchase cost according to either the supply authority or water market, the opportunity cost if it was sold or somewhere in between? For this publication, the actual cost of water is used as we had sufficient allocation to irrigate the trials. If you wish to calculate the gross margins using your own value for water, a simple gross margin calculator is available from the ICC or there are others available on various websites such as the Correct Crop Sequencing DST at https://www.dpi.nsw.gov.au/agriculture/budgets/costs/cost-calculators/correct-crop-sequencing-decision-support-tool .

Commodity price is based on the average yield and quality and Graincorp price in early January.

One year's outstanding performance does not make a variety

Look at a variety's performance over a number of seasons to ensure you are choosing a reliable variety. Frost events, birds that did affect some of the earlier maturity wheats.

The majority of varietal data in seed company brochures is generated under dryland conditions, whereas irrigation brings along its own unique characteristics that can affect how a variety may perform. The National Variety Testing website (nvt-online.com.au) does have the results from the irrigated wheat sites at Numurkah and Blighty/Mayrung. Irrigated Faba Bean data is available from Griffith (Yanco) and Kerang (ICC data). There are no irrigated barley or canola NVT sites.

Varieties should never be chosen on yield alone.

Marketability, disease resistance and maturity are important factors that must be considered.

Trial Notes

Most of the trials are either replicated (each variety or treatment is sown three times in a small 15 x 2 m plot) or **nearest neighbour** (every third plot is the same treatment and usually with large plots). This allows a statistical analysis to assess whether differences between treatments are due to the treatment or simply due to chance or site variability. The term **demonstration** is applied where replication is not used and so there is less confidence in the results being due to the treatments.

On some of the trial graphs there is a statement immediately below with the letters LSD = ….. . This is the **Least Significant Difference**. Unless two varieties or treatments have a yield difference of greater than the LSD, the difference could simply be by chance. Similarly, some tables have superscripts after the data. Data with the same superscript are not significantly different. The term "significant" refers to the analysis of the trial data and whether it is statistically different, not necessarily the size of the difference – e.g. the PGR applied to the wheat trial reduced the height of the crop by 3.7 cm which was statistically a significant difference but practically an insignificant result.

The **co-efficient of variation** (cv%) is an indicator of the amount of variability in the trial. The lower the cv% the better; less than 5 is good, 5 – 10 is OK and over 15 suggests that any data from the trial should be interpreted with caution as there is a large amount of variability in the trial data.

Lodging Scores range from 0 to 9, where a "0" means the crop is standing straight up, i.e. 90 degrees to the soil surface, while a "9" means the crop is completely flat on the ground.

Many of the timing of operations are given a Z value, such as Z30. This is an accurate description of the growth stage of a **cereal** crop as described by the **Zadoks decimal growth scale**. There are several references to the Zadoks growth scale in this report. It can also be written as DC or GS. It is a relatively simple system once you get the hang of it. Some of the key growth stages are:

- Z30/31 – the start of stem elongation/first node detected.
- Z39 – flag leaf fully emerged
- Z45 – booting
- Z65 – mid flowering
- Z72 – the early stage of grain development post flowering

Many of the nitrogen applications start just as the stem begins to elongate or Z30 (stem elongation stage of development, but before the first node is detectable). There is some flexibility around this timing as we are generally relying on rainfall for incorporation of N fertilisers, but crop N demand increases rapidly as stem elongation begins and we want to ensure the crop has adequate nutrition, so yield isn't affected. Knowing how to identify the growth stages is essential if you are considering using plant growth regulators.

Canola also has a growth scale, with the growth stages having similar numbers to the Zadoks scale – i.e. beginning of bolting is stage 3.0.

If you are interested in any of the trials and would like to discuss the trials further, please feel free to contact the Irrigated Cropping Council via the website, or Damian Jones 0409 181 099.

Likewise, if you have an issue that you think needs investigation, please contact ICC to see if there is a possibility of a trial being conducted in 2020.

Thanks to the efforts of the ICC Technical Officer Rohan Pay for day-to-day management of the trials and Neroli Graham, DPI NSW, for the guidance on the statistical analysis of the trial results.

2019 - The season that was…

Planning for 2019

The major consideration when planning 2019 operations was to manage the quantity of irrigation water available. Following the legume/canola/cereals rotation we adopted, we were due to sow fabas in 2019. However, to grow a successful crop of fabas would require pre-irrigation and budgeting for 3 spring irrigations. While profitability doesn't always figure in our choice, we also don't want to ignore the fact that this scenario would have been quite expensive. Therefore, to keep the rotation as a legume/pulse, vetch was chosen for 2019. Vetch gave us the opportunity to mix up our herbicide groups and put some nitrogen and organic matter back into the soil. As to what end product we were going to have depended on rainfall – worst case was brown manure and best was hay.

Given the season, we decided on a trial that would investigate the 'best bang for your water buck', which was made up of 4 sub-trials. The treatments included pre-irrigation or not as the autumn treatments or 1 or full irrigation as the spring treatments, giving four treatments of 'no pre + 1 spring', 'no pre + full spring', 'pre + 1 spring' and 'pre + full spring' using barley, canola, fabas and wheat varieties of various maturities.

Preparation began in April with pre-irrigation. Usually we will burn cereal stubble residues prior to pre-irrigation. The general lack of stubble thanks to most of the trial areas being cut for hay in 2018 and fire restrictions still in place, saw no burning prior to sowing.

The 2019 season started with pre-irrigation on April 8th, and the first sowing of a small canola trial for AWB and a faba bean population trial. These trials were sown dry into the oaten hay stubble and watered up.

This was followed by the main canola variety trial, which was sown into receding moisture on April 24th. Normally we would be sowing this trial dry, but the site needed to be irrigated for the early canola trial and it did give us the opportunity to apply a knockdown herbicide before sowing, something that sowing dry doesn't offer. Looking towards the extended forecasts, there was rain on the horizon but the decision was made to irrigate the canola trial as there had been poor establishment of canola trials in the past where receding moisture and forecast rainfall non-events resulted in poor establishment.

The wheat variety trial was split into 3 for 2019. Following feedback regarding matching maturity with sowing date, it was decided to sow the later maturing varieties (no true winter wheats) in April, the main season trial (early-mid to mid-late maturity) in early May and the early maturing wheats later in May, all dates depending on soil moisture and rain. This resulted in the late wheat trial being sown on April 24th.

Russian Wheat Aphid was detected at the Trial Block early in 2016, again in untreated cereals in 2017 and 2018. Therefore, expecting to see RWA again, the seed for the cereal trials was treated with imidacloprid. Theoretically there should have been low numbers of RWA due to the lack of green bridge thanks to the dry start to the year, but we cannot afford to have the cereal trials compromised by pests.

Conditions were perfect for sowing in late April, with rain forecast for April 30th/May1st. Therefore we took the opportunity to sow the fabas, the 'bang for your buck', a small wheat trial sown to the early variety Axe to investigate the potential spring irrigation savings by having an early maturing wheat as well as having N upfront versus topdressing and the main wheat variety trials on April 30th. The rain did arrive, which was great for these trials but was a little too much for the recently sown and watered up canola trial. The canola trial sown on April 24th suffered from waterlogging for an extended period and subsequently had poor establishment in 2 replicates and had to be resown on May 20th. The waterlogging was exacerbated by the direct sowing of the trial into the oaten hay stubble. We use a light set of chain harrows to help cover the seed and smooth the surface. With the stubble remaining, the short straw often lifted the harrows up and the furrow remained. These furrows channelled the rain onto the germinating seed and resulted in waterlogging and poor establishment, aggravated by the poorer soil structure as the trial progressed down the bay.

The barley variety trial was sown on May 7th. Based on advice from the Northern Durum Project leader and our own results, the durum trials are not sown until the third week of May (May 22nd). The early maturing wheat trial was also sown on May22nd. Sowing was completed on June 7th with a late sowing of two varieties of early maturing wheat.

The Trial Block was sown with vetch at 60 kg/ha between May 7th and 10th. An area of chickpeas was also sown, which also included a small inoculation demonstration.

Rainfall for the growing season was below average for the year – 196.6mm versus 372mm the long term average. Sowing commenced on April 30th for most trials thanks to a forecast of 20+mm for the 1st of May. May was above average followed by an average June and July. An 'average' June was due to rainfall at the beginning and end of the month, which created a dry pinch in the middle, affecting the development of the non-pre-irrigated crop and trials.

Where pre-irrigation did occur, the trials established well and developed quickly. Pre-irrigation resulted in higher and uniform establishment, aided weed control and allowed crops to develop.

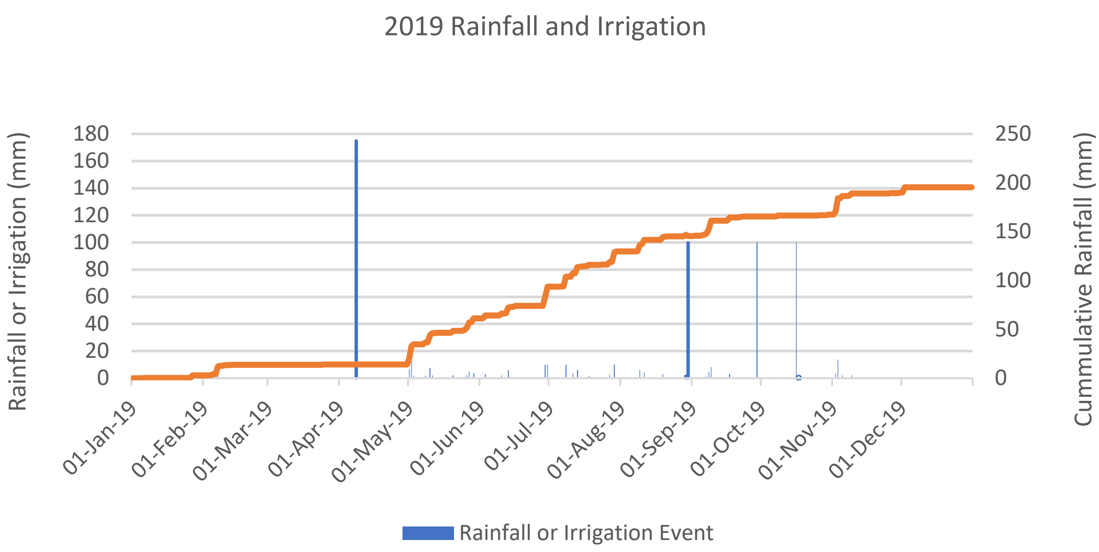
Despite a better than average winter, any soil not pre-irrigated remained dry below 250mm. Therefore, when August rainfall was well below average, soil moisture rapidly declined and irrigation was required mid-August. This was followed a week later by the pre-irrigated trials thanks to the much larger canopies using more water.

As per usual, we calculate an N budget based on our target yield, soil N and mineralisation estimates, and adjust our fertiliser inputs accordingly. The Trial Block had above average soil N levels at sowing (80 kg N/ha). Topdressing was started a little earlier than usual given the lack of opportunities in 2018. This was to the detriment of the barley variety trial, which became excessively vegetative.

Our usual soil moisture monitoring probe that can be viewed at www.intelliweb.mait.com.au (login and passwords are both "dpi") is a little bit misleading due to the bay being sown to chickpeas. The chickpeas were relatively slow to develop and therefore would not have used the same amount of soil moisture as the cereals and canola. Soil moisture monitoring equipment was installed in other trials thanks to the Smarter Irrigation for Profit 2 project funding.

First spring irrigation occurred on August 23rd/30th depending on pre-irrigation or soil type, followed by irrigations on September 29th, October 17th and October 30th (Durums only). The early wheat trial had slightly different timings due to the different plant available water.

2019 Rainfall and Irrigation Summary of the red soil on the Trial Block.



Average Growing Season Rainfall 232mm, Growing Season Rainfall for 2019, 152.8mm (up to September 24th)

CatapultΦ New
Mid to late maturity AH wheat. Suited to late April to mid-May planting. Excellent choice for wheat on wheat situations.
IllaboΦ
Dual purpose winter wheat with an AH quality classification, suited to mid-April planting.
BeckomΦ
Elite yielding, AH variety that exhibits great adaption throughout southern Australia.
ScepterΦ
Mace replacement that exhibits higher yields and increased levels of stripe rust resistance over Mace. Equal CCN and Yellow Leaf Spot resistance to Mace.
Our wheat varieties for 2020
AGT
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AGT137-001

KEY MESSAGES

The main season wheat trial included varieties with early-mid to late maturity plus the early maturing Vixen.

The trial averaged 7.2 t/ha, with the highest yielding variety being LRPB Cobra at 9.3 t/ha.

The longer term analysis shows a fairly consistent selection of varieties that rank highly for yield that range from early-mid maturity to mid-late maturity.

Variety Trials

BACKGROUND

Irrigation provides a unique environment that allows high yields to be targeted. However, most varieties are developed and tested under dryland conditions.

In order to perform under irrigated conditions, a variety should have the following characteristics:

- High yield potential
- Maturity that matches sowing date and the optimal grain filling period
- (avoiding frost at flowering but also avoiding high temperatures during grain filling)
- High tolerance to crop lodging
- Waterlogging tolerance
- Good disease tolerance/rating, although a disease management plan can address some shortfalls

Wheat Variety Trials

SUMMARY

Nineteen wheat varieties were sown on April 30th and harvested on November 28th. Average yield was 7.2 t/ha, with LRPB Cobra having the highest yield of 9.3 t/ha.

OBJECTIVES

- Evaluate the yield potential and grain quality of longer maturity wheat varieties.
- Assess varietal characteristics such as maturity, height, disease and lodging.

METHODS

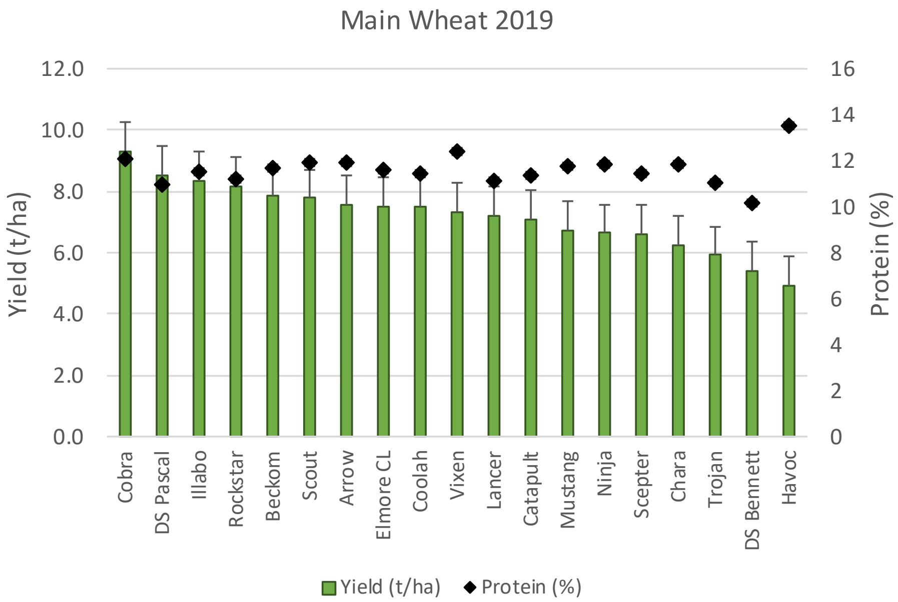
Sowing Date	30th April
Target Plant Population	160 plants/m^2
Seeding Rates	64 - 123 kg/ha based on TGW
Water	1.75 Ml/ha - 10th April 1.0 Ml/ha - 31st August 1.0 Ml/ha - 27th September 0.9 Ml/ha - 17th October 4.65 Ml/ha - TOTAL 154.6mm GSR
Nitrogen	Total N Budget - 320 kg N/ha. Topdressing 70 kg N/ha 27th June Topdressing 70 kg N/ha 23rd July Topdressing 40 kg N/ha 4th August
Harvest	28th November
Average Yield	7.19 t/ha

*: Thousand Grain Weight

Nineteen wheat varieties and lines were sown, following pre-irrigation (1.75 ml/ha) on April 30th with variable sowing rates aiming at 160 plants/m^2. Emergence was even across the plots and establishment was average, at 70%. The trial was topdressed three times - with 70 kg N/ha on June 27th and July 23rd and 40 kg N/ha on August 4th, making the total N supply of 320 kg N/ha, enough for an 8 t/ha crop. The trial did not receive a foliar fungicide application based on the dry conditions during August and September. However, stripe rust was noticed in DS Bennett and Trojan on September 22nd, which is likely to be the new race first detected in Victoria in 2018. The trial was irrigated three times in spring, beginning August 31st (1.0 Ml/ha), again on September 27th (1.0 Ml/ha) and on October 17th (0.9 Ml/ha). Harvested on November 28th.

RESULTS

Harvested on November 28th the trial averaged 7.2 t/ha.



P= <0.001, lsd = 0.95 t/ha, cv% = 8.0

Gross margin analysis of the main wheat variety trial

WHEAT		7.2 t/ha				
Price	$ 330					$ 2,376
		number		cost $		cost $/ha
Pre-sowing	spray	1	operation	15	/ha	15
	cultivation		operation	35	/ha	0
	pre-irrig	1.75	Ml/ha	60	/Ml	105
Sowing	machinery	1	operation	43	/ha	43
	fertiliser	125	kg/ha	700	/tonne	87.5
	seed	80	kg/ha	500	/tonne	40
Post sowing	herbicide	2	operation	30	/ha	60
	fungicide	0	sprays	10		0
	topdress	390	kg/ha	550	/tonne	214.5
	irrigation	2.9	Ml/ha	60	/Ml	174
Harvest	windrow	0	operation	30	/ha	0
	mow/rake/bale	0	operation	92	/ha	0
	header	1	operation	72	/ha	72
					Total Variable Cost	$ 811.00 /ha
					Variable Cost - water	$ 532.00 /ha
					Gross Margin	$ 1,565 /ha
						$ 337 /Ml

All grain quality and agronomic data is summarised in the Appendix.

Long term yield performance as a percentage of LRPB Scout. NVT data from the Numurkah site.

Wheat	2014	2015	2016	2017	2018	2019	Average	NVT
Beaufort	112%	103%	114%	100%	134%		113%	104%
Illabo					118%	107%	113%	89%
DS Pascal				103%	110%	110%	108%	87%
Beckom		96%	117%	100%	112%	101%	105%	104%
Coolah					111%	96%	104%	94%
Cobra	102%	98%	109%	109%	84%	120%	103%	103%
Trojan	106%	98%	125%	99%	108%	76%	102%	103%
Scout	100%	100%	100%	100%	100%	100%	100%	100%
Arrow		90%	113%		96%	98%	99%	100%
Scepter		92%	122%	106%	84%	85%	98%	104%
SF Adagio	74%	97%	120%	100%	97%		98%	91%
Mace	98%		110%	94%	93%		98%	94%
Lancer	94%	95%	108%	90%	107%	92%	97%	95%
Corack	85%	95%	102%	103%	74%		92%	100%
Wedgetail	76%	90%	103%	87%	99%		91%	89%
Chara	89%	88%	105%	89%	92%	80%	90%	95%
Elmore CL	84%	87%		92%	96%	97%	90%	92%
Suntop	95%	78%	100%	81%	86%		88%	97%
Mustang					89%	86%	88%	88%
Havoc					74%	63%	69%	87%
Scout t/ha	7.6	8.7	8.2	10.6	7.1	7.8	8.5	8.1

CONCLUSIONS

The ‘top 5’ remain reasonably consistent, with stripe rust possibly reducing the performance of Trojan. Sowing was a little earlier than planned on April 30th due to forecast rain. Frost was not an issue in 2019, allowing some of the early-mid maturity varieties to perform to their potential. While yield is important, agronomic and marketing characteristics should also be considered.

Early Maturity Wheat Variety Trial

SUMMARY

Six wheat varieties, and lines were sown on May 22nd and harvested on November 27th. Average yield was 5.8 t/ha with a top yield 8.4 t/ha for Vixen. Emu Rock did become infected with stripe rust, despite having a higher resistance rating than some of the other varieties. This may indicate a new rust race has emerged and keeping up-to-date with the current ratings is essential for disease management.

The decision was made to separate the early maturing (or early season) varieties from the main trial, and to sow them at a more appropriate time that suited their maturity.

OBJECTIVES

- Evaluate the yield potential and grain quality of 6 early maturing wheat varieties.
- Assess varietal characteristics such as maturity, height, disease resistance and lodging.

METHODS

Sowing Date	22nd May
Target Plant Population	175 plants/m^2
Seeding Rates	86 - 105 kg/ha based on TGW
Water	1. 5 Ml/ha - 10th April 1.0 Ml/ha – 23rd August 0.9 Ml/ha - 20th September 0.8 Ml/ha - 4th October 0.6 Ml/ha - 17th October 4.2 Ml/ha - TOTAL 154.6mm GSR
N application	June 23rd - 70 kg N/ha July 23rd - 70 kg N/ha
Harvest	27th November
Average Yield	5.8 t/ha

*: Thousand Grain Weight

Six varieties were sown, following pre-irrigation (1.5 ml/ha), on May 22nd with variable sowing rates aiming at 175 plants/m^2.

The trial was irrigated three times in spring, beginning August 23rd, (1.0 Ml/ha), again on September 20th (1.0 Ml/ha) and on October 4th (0.8 Ml/ha). A fourth irrigation did occur due to there being a later third time of sowing.

The trial was harvested on November 27th.

KEY MESSAGES

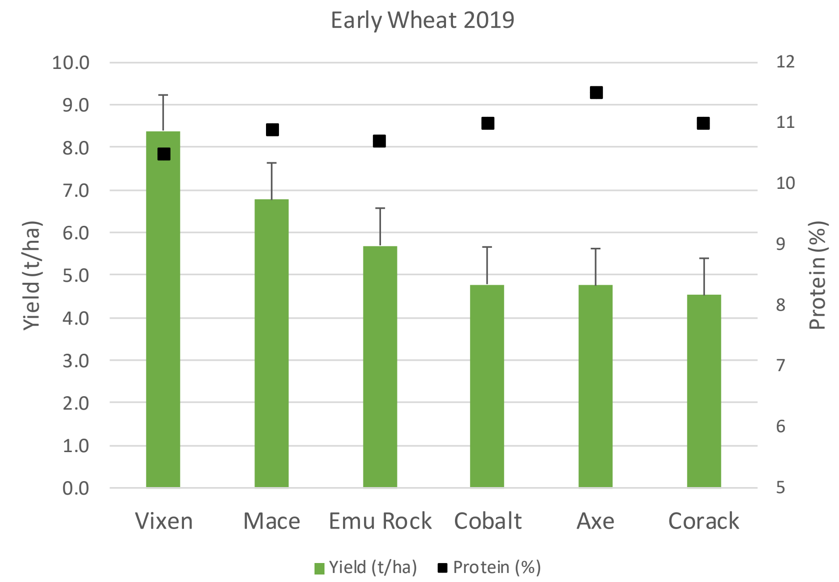
The early season wheat varieties were given their own trial in 2019 so as to sow them at a time more appropriate to their maturity rather than the early May sowing for the main trial.

Vixen was the highest yielding variety.

Keeping up-to-date on a varieties disease rating is essential so as to pro-actively plan and manage disease during the season.

RESULTS

The trial averaged 5.8 t/ha. There was considerable variation in yields, ranging from below 5 t/ha for Axe, Cobalt and Corack, to 8.4 t/ha for Vixen. Emu Rock did become infected with stripe rust, despite having a higher resistance rating than some of the other varieties. This may indicate a new rust race has emerged and keeping up-to-date with the current ratings is essential for disease management.



P= <0.001, lsd = 0.87 t/ha, cv% = 8.1

All grain quality and agronomic data is summarised in the Appendix.

Gross margin analysis of the early wheat variety trial.

EARLY WHEAT		5.8 t/ha					
Price	$ 330					$ 1,914	
		number		cost $		cost $/ha	
Pre-sowing	spray	1	operation	15	/ha	15	
	cultivation		operation	35	/ha	0	
	pre-irrig	1.5	Ml/ha	60	/Ml	90	
Sowing	machinery	1	operation	43	/ha	43	
	fertiliser	125	kg/ha	700	/tonne	87.5	
	seed	90	kg/ha	500	/tonne	45	
Post sowing	herbicide	2	operation	30	/ha	60	
	fungicide	0	sprays	10		0	
	topdress	300	kg/ha	550	/tonne	165	
	irrigation	2.7	Ml/ha	60	/Ml	162	
Harvest	windrow	0	operation	30	/ha	0	
	mow/rake/bale	0	operation	92	/ha	0	
	header	1	operation	72	/ha	72	
					Total Variable Cost	$ 739.50	/ha
					Variable Cost - water	$ 487.50	/ha
					Gross Margin	$ 1,175	/ha
						$ 280	/Ml

CONCLUSIONS

The shift of sowing date to the third week of May saw most varieties flowering in the last week of September. However, the 2019 season saw no improvement in yield. Given there is only one season's data, Vixen does look to have better yield potential than many of the other early maturing varieties. Keeping up-to-date on a varieties disease rating is essential so as to pro-actively plan and manage disease during the season.

Late Maturity Wheat Variety Trial

SUMMARY

Eight wheat varieties were sown on April 24th and harvested on November 28th. Average yield was 9.5 t/ha, with LRPB Trojan having the highest yield of 10.3 t/ha, although not statistically different to all other varieties.

The longer season varieties may have a fit in seasons where an opportunity to sow early is available.

OBJECTIVES

- Evaluate the yield potential and grain quality of longer maturity wheat varieties.
- Assess varietal characteristics such as maturity, height, disease and lodging.

METHODS

Sowing Date	24th April
Target Plant Population	160 plants/m²
Seeding Rates	72 - 89 kg/ha based on TGW
Water	1.75 Ml/ha - 10th April 1.0 Ml/ha - 31st August 1.0 Ml/ha - 27th September 0.9 Ml/ha - 17th October 4.65 Ml/ha - TOTAL 154.6mm GSR
Nitrogen Management	Total N Budget - 320 kg N/ha for an 8 t/ha crop Faba bean stubble Topdressing 70 kg N/ha 27th June Topdressing 70 kg N/ha 23rd July
Harvest	28th November
Average Yield	9.5 t/ha

*: Thousand Grain Weight

Eight longer season (maturity) varieties were sown, following pre-irrigation (1.75 ml/ha), on April 24th with variable sowing rates aiming at 160 plants/m². The trial was topdressed with 140 kg N/ha as urea, split over 2 applications on June 27th and July 23rd. Targeting an 8 t/ha crop. The trial was irrigated three times in spring, beginning August 30th (1.0 Ml/ha), again on September 29th (1.0 Ml/ha) and on October 17th (0.9 Ml/ha). Stripe rust was detected in DS Bennett and LRPB Trojan in late September and not in other varieties.

KEY MESSAGES

The late season wheat varieties were given their own trial in 2019 to enable them to be sown at a time more appropriate for their maturity rather than the early May sowing for the main trial.

All varieties yielded in the vicinity of 9.5 t/ha.

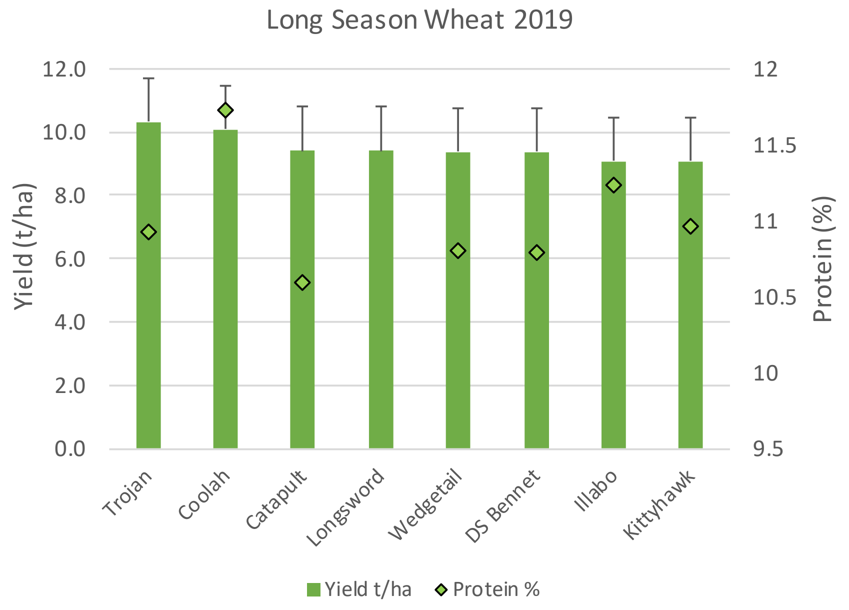
Lodging did become an issue late in the season and presented a harvesting issue rather than a yield penalty.

DS Bennett and LRPB Trojan were affected by a possibly new race of stripe rust.

Checking the variety disease rating updates is essential for disease management.

RESULTS

Harvested on November 28th, the trial averaged 9.5 t/ha.



P= 0.519, lsd = NS, cv% = 8.5

All grain quality and agronomic data is summarised in the Appendix.

Gross margin analysis of the early wheat variety trial.

LONG WHEAT		9.5 t/ha				
Price	$	330				$ 3,135
		number		cost $		cost $/ha
Pre-sowing	spray	1	operation	15	/ha	15
	cultivation		operation	35	/ha	0
	pre-irrig	1.75	Ml/ha	60	/Ml	105
Sowing	machinery	1	operation	43	/ha	43
	fertiliser	125	kg/ha	700	/tonne	87.5
	seed	90	kg/ha	500	/tonne	45
Post sowing	herbicide	2	operation	30	/ha	60
	fungicide	0	sprays	10		0
	topdress	300	kg/ha	550	/tonne	165
	irrigation	2.9	Ml/ha	60	/Ml	174
Harvest	windrow	0	operation	30	/ha	0
	mow/rake/bale	0	operation	92	/ha	0
	header	1	operation	72	/ha	72
					Total Variable Cost	$ 766.50 /ha
					Variable Cost - water	$ 487.50 /ha
					Gross Margin	$ 2,369 /ha
						$ 509 /Ml

CONCLUSIONS

Statistically speaking, all varieties yielded the same. While not truly comparable, the earlier sown yields did exceed those of the main season trial. While not measured in this trial, the longer season wheats do offer the opportunity for some grazing, particularly if they are sown in early April. Knowing the disease rating is important to manage disease throughout the season. The stripe rust on Trojan and DS Bennett was unexpected both from a seasonal perspective and the disease ratings published for 2018. However, there was an alert in late 2018 about a new stripe rust race detected not far from the Kerang Trial Block which overcame the resistance genes in some of the varieties such as DS Bennett, Coolah and Trojan. Only Trojan and DS Bennett became infected in September 2019, which may indicate another race may have emerged.

Barley Variety Trial

KEY MESSAGES

Yields were below expectations due several factors including:

- Bird damage
- Excessive N early in the season resulting in excessive vegetative growth
- Lodging

Earlier maturing varieties performed better than the later varieties which may be as a result of less time lodged during grain fill.

Selection of a variety should not be based on one season's result.

SUMMARY

Twelve barley varieties were sown on May 7th and harvested on November 25th. Average yield was 4.2 t/ha as a result of bird damage and lodging due to excessive vegetative growth. The highest yielding variety was Rosalind at 5.8 t/ha. The longer season varieties were the most disappointing.

There are no National Variety Trials that test barley varieties under irrigated conditions so irrigators have little information on how new varieties will perform.

OBJECTIVES

- Evaluate the yield potential and grain quality of barley varieties.
- Assess varietal characteristics such as maturity, height, disease and lodging.

METHODS

Sowing Date	7th May
Target Plant Population	160 plants/m^2
Seeding Rates	83 - 102 kg/ha based on TGW*
Irrigation	1.75 Ml/ha – 10th April 1.0 Ml/ha – 31st August 1.0 Ml/ha – 27th September 3.75 Ml/ha - TOTAL 154.6mm GSR
Nitrogen	Total N Budget - 260 kg N/ha targeting 8 t/ha Fallow 2018 65 kg N/ha topdressed 27th June
Harvest	25th November
Average Yield	4.22 t/ha

*: Thousand Grain Weight

Sown on May 7th into good soil moisture thanks to pre-irrigation and rain in early May. Target plant population was 160 plants/m^2, or sowing rates of between 83 and 102 kg/ha. Emergence was consistent across the trial and plant counts met the target with an average of 162 plants/m^2, or 70% establishment.

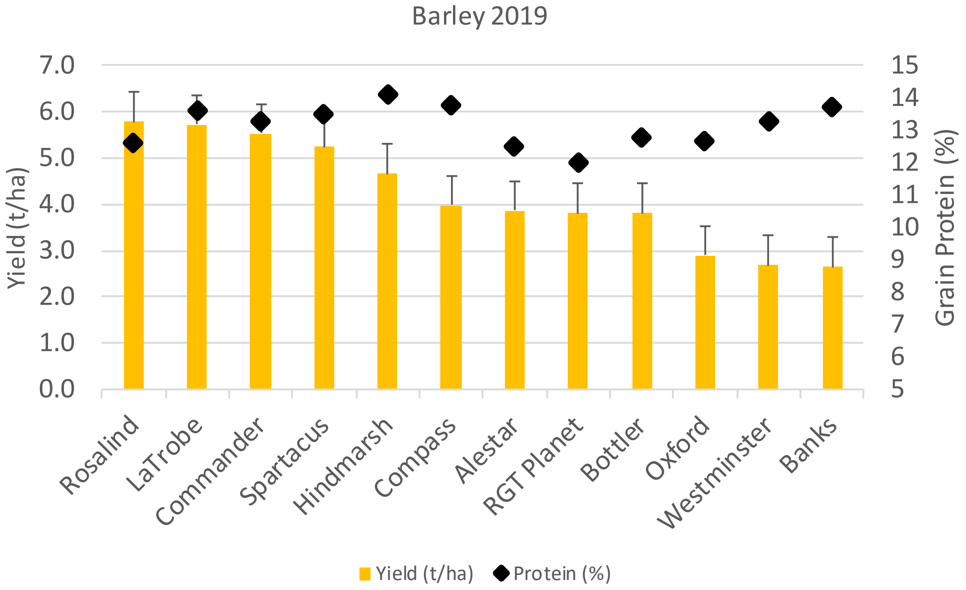
The total N budget was 260 kg N/ha, enough for an 8 t/ha crop. 135 kg N/ha was planned to be topdressed, split over two applications. The first topdressing occurred on June 27th but the second was cancelled due to excessive vegetative growth. In hindsight, the soil N at sowing was underestimated, and was exacerbated by the relatively early topdressing resulting in excessive growth that resulted in lodging.

The trial received the first spring irrigation on August 31st, and again on September 27th.

Lodging occurred early in the season prior to stem elongation from which the plants recovered. However, as heads emerged, most varieties lodged again. Prior to harvest, apart from the lodging, it was also noted that there was noticeable bird damage and loss of heads in many plots.

RESULTS

Harvested on November 25th, the trial averaged 4.2 t/ha.



P= <0.001, lsd = 0.64 t/ha, cv% = 8.9

All grain quality and agronomic data is summarised in the Appendix.

High grain protein is a reflection of yields not matching the target of 8 t/ha.

Long term variety yield performance at the ICC Trial Block.

Barley	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average
Oxford	120%		123%	114%	109%	107%	110%	121%	107%	53%	107%
Rosalind							129%	117%	76%	105%	107%
Navigator					93%	110%	123%	111%	100%		107%
Urambie		100%	101%		114%	105%	115%	113%	102%		107%
Spartacus						104%	138%	110%	84%	95%	106%
LaTrobe						99%	132%	111%	84%	103%	106%
Hindmarsh	100%	115%	115%	96%	103%	101%	122%	113%	92%	85%	104%
RGT Planet								126%	113%	69%	103%
Baudin	95%	106%		99%	100%	103%	112%	110%	99%		103%
Westminster		123%	114%	104%	103%	98%	106%	112%	100%	48%	101%
Commander	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Gairdner	78%	117%	111%		90%	90%	109%	98%	95%		99%
Compass					94%	91%	119%	101%	92%	72%	95%
Commander t/ha	7.3	6.4	7.9	8.2	6.4	8.2	5.5	8.4	8.1	5.5	7.2

Gross margin analysis of the barley variety trial.

BARLEY		4.22 t/ha				
Price	$	285				$ 1,203
		number		cost $		cost $/ha
Pre-sowing	spray	1	operation	20	/ha	20
	cultivation		operation	35	/ha	0
	pre-irrig	1.75	Ml/ha	60	/Ml	105
Sowing	machinery	1	operation	43	/ha	43
	fertiliser	125	kg/ha	700	/tonne	87.5
	seed	80	kg/ha	450	/tonne	36
Post sowing	herbicide	2	operation	20	/ha	40
	fungicide	0	sprays	10		0
	topdress	150	kg/ha	550	/tonne	82.5
	irrigation	2	Ml/ha	60	/Ml	120
Harvest	windrow	0	operation	30	/ha	0
	mow/rake/bale	0	operation	92	/ha	0
	header	1	operation	72	/ha	72
					Total Variable Cost	$ 606.00
					Variable Cost - water	$ 381.00 /ha
					Gross Margin	$ 597 /ha
					Gross Margin	159 /Ml

CONCLUSIONS

Bird damage was probably more apparent in 2019 as the Trial Block did not have a crop sown that would be an alternative food source. 2020 will see more areas sown to barley to reduce the targeting of the trials. While varieties like Planet and Oxford did not perform well in the 2019 trial, previous results and paddock performance indicate their suitability as high yielding irrigated barley varieties.

Without additional barley trials, the variety trial acts as a test for our recommended agronomic practices such as sowing rates and N management. Underestimating the soil N available at sowing, coupled with topdressing too early, resulted in excessive vegetative growth that caused all varieties to lodge. This could have been addressed by the use of a PGR at early stem elongation, but as it is a variety trial, we want to test the varietal characteristics rather than mask weaknesses.

Soil testing may be delayed until sowing or mid-tillering to ensure accurate soil N results.

Faba Bean Variety Trial

SUMMARY

Twelve faba bean varieties and lines were sown on April 30th and harvested on December 5th. Average yield was 5.1 t/ha. Lodging was an issue in 2019. Yields didn't appear to reflect the size of the canopy.

There are limited National Variety Trials that test faba bean varieties under irrigated conditions so irrigators have little information on how new varieties will perform.

OBJECTIVES

- Evaluate the yield potential and grain quality of faba bean varieties and lines.
- Assess varietal characteristics such as maturity, height, disease and lodging.

METHODS

Sowing Date	30th April
Target Plant Population	25 plants/m^2
Seeding Rates	140 - 193 kg/ha based on TGW
Water	1.75 Ml/ha - 10th April 1.0 Ml/ha - 31st August 1.0 Ml/ha - 27th September 0.9 Ml/ha - 17th October 4.65 Ml/ha - TOTAL 154.6mm GSR
Fungicide	Mancozeb 1.5 kg/ha 27th June Chlorothalonil 1.5 l/ha 27th August Chlorothalonil 1.5 l/ha 27th September
Harvest	5th December
Average Yield	5.06 t/ha

*: Thousand Grain Weight

Twelve faba bean varieties and lines were sown, following pre-irrigation (1.75 ml/ha), on April 30th with variable sowing rates aiming at 25 plants/m^2. The trial received three fungicide applications, beginning on June 27th and then on August 27th and September 27th. The trial was irrigated three times in spring, beginning August 31st (1.0 Ml/ha), again on September 27th (1.0 Ml/ha) and on October 17th (0.9 Ml/ha). After flowering, lodging began to occur in all varieties/lines. The trial was harvested on December 5th.

KEY MESSAGES

Earlier sowing resulted in a trial that suffered from lodging.

While average height was lower than the 2018 trial, lodging was far worse and yields were reduced.

Varieties with improved yield are in the pipeline.

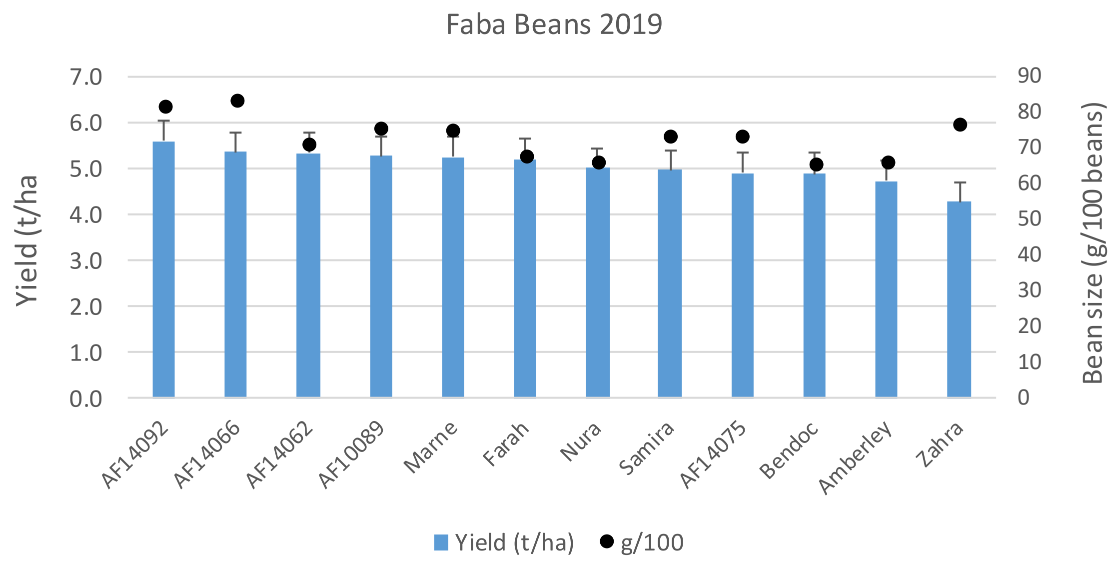
New varieties PBA Bendoc and PBA Marne performed to a similar yield as PBA Samira.

PBA Bendoc is tolerant to some imidazolinone (Group B) herbicides.

*Only apply products with a registered label or current permit. All directions for use must be adhered to

RESULTS

Harvested on November 25th, the trial averaged 5.1 t/ha. Lodging did make the trial more difficult to harvest. Average lodging score for the trial was 5.3, with 0 being no lodging and 9 representing a crop flat on the ground.



P= <0.001, lsd = 0.44 t/ha, cv% = 5.2

All grain quality and agronomic data is summarised in the Appendix.

Long term variety yield performance at the ICC Trial Block.

Variety	2014	2015	2016	2017	2018	2019	Ave
AF10089			102%	105%	109%	106%	105%
PBA Amberley		99%	107%	107%	98%	95%	101%
Samira	100%	100%	100%	100%	100%	100%	100%
PBA Marne	99%	94%	89%	103%	98%	106%	100%
PBA Bendoc				95%	97%	99%	97%
Zahra	103%	92%	87%	91%	89%	86%	94%
Fiesta	88%	93%	101%	93%			93%
Nura	94%	93%	76%		93%	101%	91%
Farah	82%	96%	81%	93%	97%	105%	91%
Samira t/ha	5.5	5.9	6.7	7.2	6.2	5.0	5.9

Gross margin analysis of the faba bean variety trial.

FABAS	5.1 t/ha					
	$ 600					$ 3,060
		number		cost $		cost $/ha
Pre-sowing	spray	1	operation	15	/ha	15
	cultivation	0	operation	35	/ha	0
	pre-irrig	1.75	Ml/ha	500	/Ml	875
Sowing	machinery	1	operation	43	/ha	43
	fertiliser	200	kg/ha	450	/tonne	90
	seed	150	kg/ha	1000	/tonne	150
Post sowing	herbicide	1	operation	20	/ha	20
	fungicide	3	sprays	18		54
	topdress	0	kg/ha	550	/tonne	0
	insecticide	1	sprays	15		15
	irrigation	2.9	Ml/ha	60	/Ml	174
Harvest	windrow	0	operation	30	/ha	0
	mow/rake/bale	0	operation	92	/ha	0
	header	1	operation	75	/ha	75
				Total Variable Cost		$ 1,511.00 /ha
				Variable Cost - water		$ 462.00 /ha
				Gross Margin		$ 1,549 /ha
						$ 333 /Ml

CONCLUSIONS

As per usual, there are faba bean lines that show higher yield potential than the current varieties.

PBA Bendoc offers tolerance to some Group B herbicides, but the relevant permits and label instructions must be adhered to.

The trial did become badly lodged despite being overall slightly shorter than 2018 where lodging was an average score of 1.4 (versus 5.3 in 2019) with a similar list of varieties/ lines.

The amount of biomass did not result in higher yields, highlighted by a comparison of the soil care project faba bean crop of approximately half the height and only a 1 t/ha yield difference.

Previous sowing rate by row spacing trials have confirmed a target population of 25 plants/m^2 and narrower rows as the recommended practice for high yielding (> 5 t/ha) crops. However, if beans are going to be profitable in low allocation years, then we need to grow the most efficient canopy and not waste moisture on excessive growth that does not generate yield.

One area of investigation for 2020 may be to re-visit sowing date as a method of reducing excessive growth and poor harvest index (proportion of grain yield to overall crop biomass).

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Canola Variety Demonstration

SUMMARY

The variety trial for 2019 effectively became a three-part trial/demonstration based on sowing dates. A small selection of varieties, principally the AWB/Cargill Victory varieties and lines were sown in early April, followed by the main trial of 26 varieties and lines on April 24th. Both trials were watered up, but rainfall a week after sowing of the main trial resulted in poor establishment and the decision was made to resow 1 replicate on May 20th. The early and main trials/demonstrations were windrowed on October 31st and harvested on November 18th. The late sowing was direct headed on November 20th. The early sown trial had an average yield of 3.1 t/ha. The second sowing averaged 3.7 t/ha and the later May sowing averaged 2.5 t/ha. There are no National Variety Trials that test canola varieties under irrigated conditions and so irrigators have little information on how new varieties will perform.

KEY MESSAGES

Due to establishment issues, replicates of the trial were abandoned or resown and therefore the data is unreplicated and so **interpret with caution!**

Conventional hybrid varieties continued to be the highest yielding.

Early sowing did not appear to improve yields, but late sowing reduced yields by an average of 1.3 t/ha.

Consider other varietal characteristics when choosing your canola variety, not just yield.

OBJECTIVES

- Evaluate the yield potential of canola varieties.
- Assess varietal characteristics such as maturity, height, disease and lodging.

METHODS

Trial 1: Sown 8th April

Sowing Date	8th April
Target Plant Population	40 plants/m^2
Seeding Rates	2.0 – 3.4 kg/ha based on TGW*
Irrigation	1.75 Ml/ha – 8th April 1.0 Ml/ha – 23rd August 1.0 Ml/ha – 27th September 3.75 Ml/ha - TOTAL 154.6mm GSR
Nitrogen	Total N Budget - 280 kg N/ha targeting 4 t/ha Oaten Hay 2018 70 kg N/ha topdressed 23rd May 65 kg N/ha topdressed 6th July
Windrow/Harvest	31st October/18th November
Average Yield	3.1 t/ha

*: Thousand Grain Weight

Sown dry on April 8th into oaten hay stubble and watered up using 1.75 Ml/ha. Target plant population was 40 plants/m^2, or sowing rates of between 2.0 and 3.4 kg/ha. Emergence was consistent across the trial and plant counts exceeded the target with an average of 44 plants/m^2, or 82% establishment. A downside to the early sowing was increased broadleaf weed competition. Some plots were overrun with marshmallow and were removed from the yield analysis. Due to the close proximity of the plots, the trial was conducted as if all varieties were conventional, and the herbicide tolerant varieties did not receive their respective herbicide when managing weeds. The total N budget was 280 kg N/ha, enough for a 4 t/ha crop. 135 kg N/ha was topdressed, split over two applications, May 23rd at 70 kg N/ha and July 6th 65 kg N/ha.

Trial 2: Demonstration: Sown April 24th/partial resow on May 20th.

Sowing Date	8th April
Target Plant Population	40 plants/m^2
Seeding Rates	1.8 – 3.4 kg/ha based on TGW*
Irrigation	1.75 Ml/ha – 8th April
	1.0 Ml/ha – 23rd August
	1.0 Ml/ha – 27th September
	3.75 Ml/ha - TOTAL
	154.6mm GSR
Nitrogen	Total N Budget - 280 kg N/ha targeting 4 t/ha Oaten Hay 2018 70 kg N/ha topdressed 23rd May 65 kg N/ha topdressed 6th July
Windrow/Harvest	31st October/18th November; 20th November
Average Yield	3.7 t/ha (April) 2.5 t/ha (May)

*: Thousand Grain Weight

Sown dry on April 24th into oaten hay stubble and watered up using 1.75 Ml/ha. Target plant population was 40 plants/m^2, or sowing rates of between 1.8 and 3.4 kg/ha. Emergence was very patchy across the trial due to waterlogging caused by rainfall approximately a week later. The waterlogging was exacerbated by the sowing furrows that were not levelled by the chain harrows due to being lifted by the oat stubble. The furrows directed the rain onto the seed rows and affected germination, particularly further down the bay as the soil became heavier. Subsequently the decision was made to persevere with Replicate 1, abandon Replicate 2 and resow Replicate 3 on May 20th, when the site had dried out.

Unfortunately, there is no replication and so the harvest yields must be only regarded as an indicator of a variety's performance rather than a definitive guide.

The total N budget was 280 kg N/ha, enough for a 4 t/ha crop. 135 kg N/ha was topdressed, split over two applications; 7th June at 70 kg N/ha and July 6th at 65 kg N/ha.

All Trials/Demonstrations

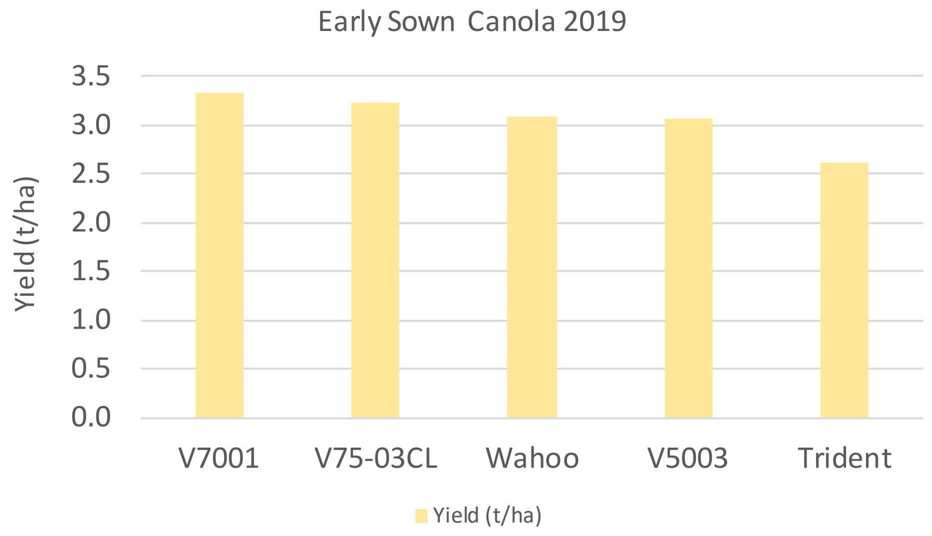
Flowering began with Trident in the early sown trial on July 6th and Diamond on July 15th in the main demonstration, and most varieties were flowering by the end of the first week of August. Average flowering period was 48 days, which is a little longer than the average period for our variety trial.

The demonstration was irrigated twice in spring, starting on August 23rd and again on September 27th.

The April sowings were windrowed on October 31st and harvested on November 18th. The May sowing was direct headed on November 20th.

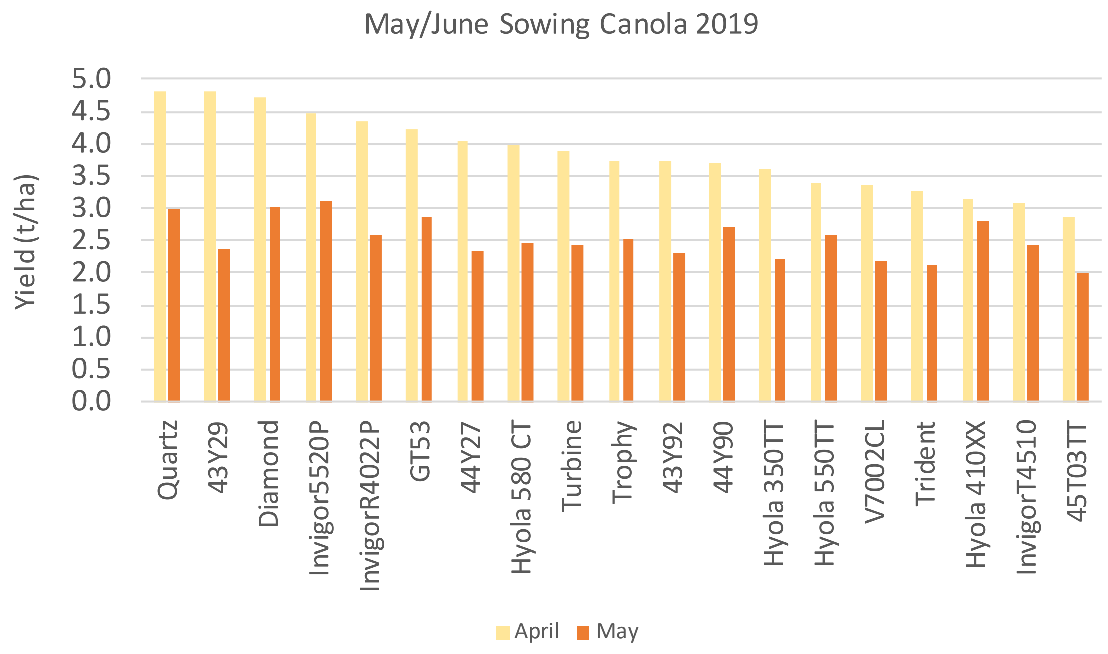
RESULTS

Trial 1: Harvested on November 18th, the trial averaged 3.1 t/ha.



P= 0.088, lsd = NS, cv% = 4.8

Demonstrations



Yield based on herbicide tolerance.

Herbicide Group	No.	April Sowing (t/ha)	May Sowing (t/ha)
Conventional	2	4.76	3.01
Roundup Ready	7	3.84	2.64
Triazine Tolerant	11	3.35	2.46
Clearfield	3	2.62	2.35

Long term variety yield performance at the ICC Trial Block.

Canola	2014	2015	2016	2017	2018	2019	Average
Quartz				98%	103%	102%	101%
Diamond	100%	100%	100%	100%	100%	100%	100%
GT53			120%	88%	92%	90%	98%
Hyola 506RR				92%	92%		92%
InvR5520P				91%	84%	95%	90%
45Y25	97%	92%	97%	84%	78%		90%
44Y90			118%	82%	81%	78%	90%
Hyola 404RR			100%	82%	81%		88%
45Y91			92%	91%	67%		83%
HyTTec Trident				91%	88%	69%	83%
44Y27				82%	80%	86%	83%
HyTTec Trophy				82%	82%	79%	81%
V7002CL					82%	71%	76%
Hyola 559 TT	83%	78%	76%	77%	66%		76%
Hyola 575CL	82%	81%			63%		75%
InvT4510				81%	79%	65%	75%
V5003RR					84%	65%	74%
V7001CL					77%	71%	74%
Hyola 650TT	70%		70%	74%	72%		72%
45T03 TT					62%	61%	62%
Diamond t/ha	4.95	4.62	4.52	5.17	3.82	4.71	4.63

Gross margin analysis of the main canola variety demonstration.

CANOLA		3.7 t/ha				
Price	$ 605					$ 2,239
		number		cost $		cost $/ha
Pre-sowing	spray	1	operation	20	/ha	20
	cultivation	1	operation	25	/ha	25
	water up	1.75	Ml/ha	60	/Ml	105
Sowing	machinery	1	operation	43	/ha	43
	fertiliser	125	kg/ha	700	/tonne	87.5
	seed	3	kg/ha	25000	/tonne	75
Post sowing	herbicide	1	operation	20	/ha	20
	fungicide	0	sprays	5		0
	insecticide	0	sprays	15		0
	topdress	300	kg/ha	550	/tonne	165
	irrigation	2	Ml/ha	60	/Ml	120
Harvest	windrow	1	operation	45	/ha	45
	mow/rake/bale	0	operation	92	/ha	0
	header	1	operation	70	/ha	70
					Total Variable Cost	$ 775.50 /ha
					Variable Cost - water	$ 550.50 /ha
					Gross Margin	$ 1,463 /ha
						$ 390 /Ml

CONCLUSIONS

Once again, a reminder to 'interpret with caution' as the main trial was reduced to a demonstration where positioning of the plot could have had more influence on the yield than the genetic potential. A point to remember with some of the varieties is that yield isn't everything. Marketing issues, such as price discounts, added transport costs due to limited receivals or flexible retail programs need be considered. Conversely a price discount may be acceptable if a herbicide tolerant variety allows problem weeds to be managed as part of an integrated program. The late sowing did highlight the yield penalty, but the early sowing didn't give the benefits that may have been anticipated. The GRDC Irrigated Agronomy Project will allow us to look at some of the barriers to higher yields in irrigated canola.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Durum Agronomy Trial

KEY MESSAGES

While not all treatments attained DR1 (13% protein), it did show that the assumed N target of 50 kg N/t is correct for our 'durums after fabas' rotation.

Making sure the yield target is close to the actual yield is the key – if the yield exceeds the predicted yield, then grain protein is likely to miss the DR1 target unless extra N is applied.

The trial averaged 9.5 t/ha, with DBA Aurora and DBA Vittaroi having similar performance in all aspects apart from better lodging resistance with Vittaroi.

Delaying sowing until the third week of May is continuing to result in high yields.

SUMMARY

Two durum wheat varieties were sown on May 22nd and harvested on November 29th. Average yield was 9.5 t/ha, with DBA Aurora and DBA Vittaroi having similar yields. Grain protein was almost identical, averaging 12.8%, and statistical analysis showed no treatment effects leading to higher grain protein. N budgets were calculated using 50 kg N/t and a yield target of 8 t/ha. Exceeding the yield target resulted in grain protein of slightly below DR1 specifications of 13%.

BACKGROUND

Durum wheat has offered a premium over bread wheat at times in the past. However high yields require relatively high N inputs to ensure the minimum 13% grain protein is met. The ICC have been investigating strategies to minimise the risk of committing the inputs to a durum crop and failing to meet DR1 requirements.

Our strategy is as follows:

- Sown after a faba bean crop to utilise the N fixed by the fabas
- Assuming the N requirement is 50 kg N/ha
- Delaying sowing until at least the third week of May.
- Topdressing weighted towards the later part of the season.

The way we address the difference between the nitrogen we have (soil N pre-sowing plus the estimated mineralisation) and the crop demand has been the subject of trials over the past few seasons. The key is to get the yield prediction right and so supply the crop with adequate N in crop through various topdressing strategies.

OBJECTIVES

- Evaluate two durum varieties for yield potential and grain quality under various N topdressing strategies.
- Assess varietal characteristics such as maturity, height, disease and lodging.

METHODS

Sowing Date	22nd May
Target Plant Population	160 plants/m^2
Seeding Rates	129 (V) and 143 (A) kg/ha based on TGW
Water	1.75 Ml/ha - 10th April 1.0 Ml/ha - 31st August 1.0 Ml/ha - 27th September 0.9 Ml/ha - 17th October 0.9 Ml/ha – 30th October 5.55 Ml/ha - TOTAL 154.6mm GSR
Nitrogen (Standard treatment)	Total N Budget - 400 kg N/ha. Topdressing 65 kg N/ha 23rd July Topdressing 80 kg N/ha 30th August Topdressing 80 kg N/ha 27th September
Harvest	29th November
Average Yield	9.51 t/ha

*: Thousand Grain Weight

The trial site was following a crop of faba beans. Two wheat varieties, DBA Aurora and DBA Vittaroi were sown following pre-irrigation (1.75 ml/ha) on May 22nd with variable sowing rates aiming at 160 plants/m^2. Emergence was slightly delayed in some plots due to variation in soil cover due to 'bulldozing' occurring due to trash (faba bean stubble) building up under the seeder. Once all plots had emerged, establishment was even across the plots and averaged 70%. The 'standard' treatment was topdressed three times - with 65 kg N/ha on July 23rd, 80 kg N/ha on August 30th and 80 kg N/ha on September 27th, making the total N supply of 400 kg N/ha, enough for an 8 t/ha crop that exceeds 13% grain protein. The table below summarises the other treatments (kg N/ha), including a post-flowering spray application of UAN (TD4).

N Strategy	TD1 23/7	TD2 31/8	TD3 27/9	TD4 9/10	Applied N	Total N
Standard	65	80	80		225	400
High N	65	100	100		265	440
Late N	65	40	120		225	400
Foliar N	65	40	80	40	225	400

Total N is the sum of N supplied from all sources; soil N before pre-irrigation (75 kg N/ha), starter fertiliser (20 kg N/ha), mineralisation (estimated to be approximately 80 kg N/ha) and applied N.

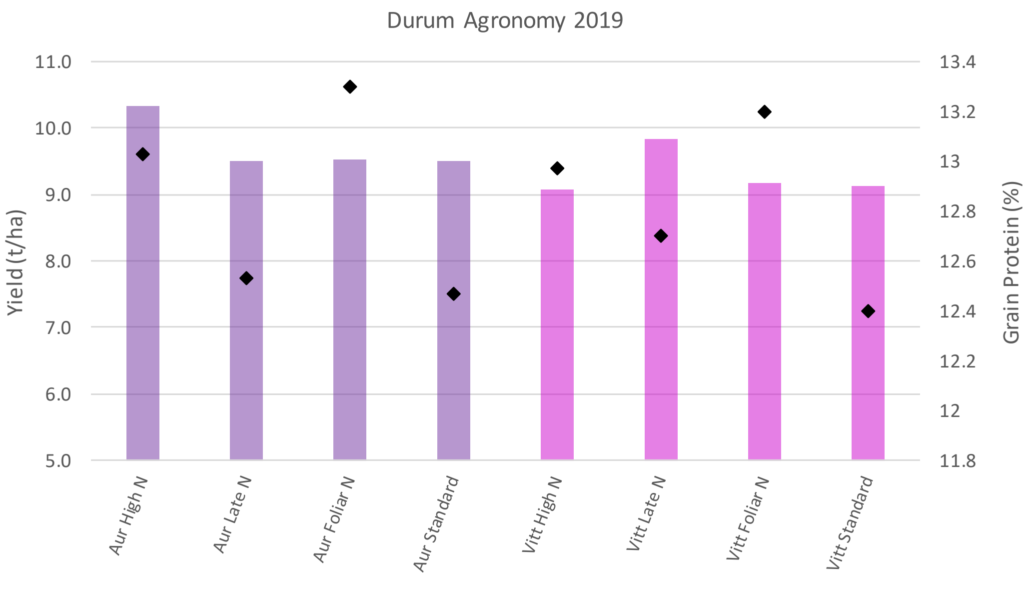
Weed control was sub-optimal, with some ryegrass competition in plots, particularly in those in the header trails from the 2017 wheat harvest. The pre-emergent herbicide Boxer Gold was applied (Sakura is not registered for durum wheat) but issues with incorporation due to the above mentioned 'bulldozing' resulted in in-complete control. However, this competition was not reflected in yields.

The trial was irrigated four times in spring, beginning August 31st (1.0 Ml/ha), September 27th (1.0 Ml/ha, October 17th (0.9 Ml/ha) and again on October 30th (0.9 Ml/ha).

The trial was harvested on November 29th.

RESULTS

The trial averaged 9.51 t/ha, with DBA Aurora averaging 9.72 t/ha and DBA Vittaroi 9.30 t/ha. When all yield data is analysed, no treatment resulted in a statistically valid yield difference (p=0.239). If the yields are analysed by variety, there was no difference in treatment yields when applied to Aurora, but there was a slight improvement with the 'late N' treatment (p=0.044, lsd = 0.54 t/ha) in Vittaroi over the standard treatment.



P_{yield}= 0.239, lsd = NS, cv% = 8.7

Examining the grain protein results, while there was a trend to higher protein with the ‘high’ and ‘foliar’ treatments, these were not statistically significant from that of the ‘standard’. Similarly looking at the amount of grain protein produced, no treatment was statistically any better than another and both varieties were similar. All grain quality and agronomic data is summarised in the Appendix.

CONCLUSIONS

While some treatments did not achieve DR1 or 13% grain protein, the assumption of 50 kg N/t was supported when durum is grown on an irrigated faba bean stubble. The previous faba bean crop is a significant contributor to the N budget, with ICC research suggesting approximately 120 kg N/ha, with most mineralisation occurring in the month following pre-irrigation.

However, some mineralisation may occur prior to pre-irrigation and this will be indicated by the deep N test being above 40 kg N/ha or so. If the soil test comes back with a relatively high N, then this will be subtracted from the mineralisation that was expected. For example, the soil test results for 2019 saw the site having 80 kg N/ha, or 40 kg of N above our base. Therefore, the amount we expect to see mineralised in-crop would be 120 – 40 = 80 kg N/ha and this is the figure used in our N budget.

Where the N budget fell down was under-estimating the yield – setting a target yield too low results in insufficient N for high protein.

One of the findings from the 2018 GRDC survey of irrigated wheat crops across Northern Victoria and Southern NSW was the prediction of grain yield based on tiller number. While there is limited data on durum wheats, preliminary data suggests they may yield around 2 t/100 tillers, therefore yield targets can be re-assessed before flag emergence and N budgets adjusted accordingly. Further work will be needed to confirm the ratio between tillers/heads and yield.

Wheat Agronomy Trials

Nitrogen Strategy and Hay Trial

SUMMARY

Axe wheat was sown on April 30th with two differing N strategies. Both were supplied with 140 kg N/ha (300 kg urea/ha). The ‘early N’ strategy split N applied into pre-sowing and at mid-tillering applications, while the ‘standard’ strategy split N applications to mid-tillering and early stem elongation. Dry matter cuts were taken on October 4th at milky dough. The ‘early N’ treatment averaged 16.43 t/ha and the ‘standard’ treatment averaged 15.94 t/ha, which was not statistically significant. Plots taken through to grain saw no difference in yield, but protein was slightly higher in the ‘standard’ treatment but not statistically different. Grain yield was lower than expected given the dry matter produced.

BACKGROUND

The ICC has developed its irrigated wheat best management practices based on the assumption of the crop being grown for grain. The recommended N strategy is to delay N application to late tillering so as to avoid excessive early vegetative growth that can lead to lodging during grain fill. However, if the crop is to be grown for hay, does withholding early N reduce vegetative growth and hence hay yields? In order to minimise irrigation inputs in a season of high water prices, the early maturing variety Axe was sown as it was likely it would only require one spring irrigation to ensure maximum hay yield.

OBJECTIVES

- To test whether early N application results in added vegetative growth and thus higher hay yields.

METHODS

Sowing Date	30th April
Target Plant Population	160 plants/m^2
Seeding Rates	76 kg/ha based on TGW
Water	1. 5 Ml/ha - 10th April 1.0 Ml/ha – 23rd August 0.9 Ml/ha - 20th September^ 0.8 Ml/ha - 4th October 0.6 Ml/ha - 17th October 4.8 Ml/ha - TOTAL 154.6mm GSR
Harvest	27th November
Average Yield – Dry Matter	16.2 t/ha
Average Yield - Grain	4.8 t/ha

*: Thousand Grain Weight
^: The first spring irrigation was sufficient to get the trial to hay cutting stage.
The extra irrigations were required for grain yields and later time of sowings in the same trial area.

KEY MESSAGES

Applying N earlier in the season did not change wheaten hay yields when compared to a later topdressing strategy.

Comparing hay and grain gross margins, hay was the clear winner in 2019.

The trial had a poor harvest index meaning it failed to convert dry matter into grain.

The wheat variety Axe was sown, following pre-irrigation (1. 5 ml/ha), on April 30th at 76 kg/ha targeting 160 plants/m^2.

The trial plots received 140 kg N/ha (300 kg urea/ha), targeting 8 t/ha. The treatments for the trial were based on the timing of the application of N.

Timing and N rates (kg N/ha).

Treatment	Pre-sowing	Topdress 1	Topdress 2
	30-Apr	27-Jun	23-Jul
'Early'	70	70	0
'Standard'	0	70	70

The first spring irrigation was on August 23rd (1.0 Ml/ha). This was enough water to get the trial sufficiently developed to the milky dough stage. The trial was irrigated a further three times which allowed the trial to proceed through to a grain harvest, as well as to ensure later time of sowing plots in the same bay had sufficient moisture for grain fill.

The dry matter cuts were taken on October 4th. Samples were cut off at ground level, dried and dry matter production calculated. The trial was harvested on November 27th for grain.

RESULTS

Dry matter cuts and grain harvest results are in the table below.

Treatment	Dry Matter (t/ha)	Yield (t/ha)	Harvest Index	Protein %	Screenings %	Test Wt kg/hl
'Early'	16.43	4.76	0.29	12.8	0.6	81.1
'Standard'	15.95	4.75	0.30	13.4	0.5	80.5
p	0.480	0.790	0.860	0.098	0.58	0.275
lsd	NS	NS	NS	NS	NS	NS
cv%	6.8	3.2	6.9	2.9	36	0.7

While the 'early' treatment resulted in slightly higher dry matter yields, these were not statistically significant. Keep in mind these are not hay yields as the samples were cut at ground level and are dried down to 0% moisture.
Similarly, there was no difference in grain yield or grain protein.

Harvest index (the ratio between grain and total biomass) was poor. Wheat typically has a harvest index of 0.4 (eg a 4 t/ha grain crop would have a total biomass of 10 t/ha), but in this trial the average was approximately 0.3 for both treatments. As a comparison, the 2018 harvest survey of 24 irrigated crops saw an average of 0.39. Grain crops can have a low harvest index due to frost, poor grain fill or grain shedding, but neither were observed in the trial.

All grain quality and agronomic data is summarised in the Appendix.

Gross margin analysis of the trial suggests hay would have been the more profitable option and had a positive gross margin even with high water price scenarios.

Wheat	Irrigation (Ml)			Water = $60		Water = $500/750	
	Pre-irrigation	Spring	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
Hay @ $280/t	1.5	1.0	13.0*	$2,489	$995	$1,139	$455
Grain @ $338/t	1.5	2.0	4.76	$921	$245	-$1,229	-$328

*: Estimated hay yield

CONCLUSIONS

Early N may have resulted in extra vegetative growth early in the season, but by the time the crop had reached maturity, there was no difference in dry matter or grain yield and quality. While either N strategy resulted in the same result, the topdressing strategy does allow for greater flexibility to adjust to the season and change N inputs to suit amended yield targets. Too much N early can result in excessive vegetative growth and increases the risk of lodging. In years of high hay prices, cutting for hay may be a more profitable option.

Irrigated Vetch Trial

SUMMARY

Vetch was topdressed with three forms of N, and at two rates, prior to irrigation in August to see if dry matter production could be increased, maximising the return from the water applied. 46 kg N/ha (in any form) did not increase dry matter production, but the rate of 92 kg N/ha did see a 13% increase.

KEY MESSAGES

Legumes and pulse crops are capable of producing their own N via the rhizobia in the root nodules, but this does cost the plant energy.

Adding N fertiliser to a pulse crop can boost production, but the trial only saw an increase in dry matter yields when 200 kg urea was applied and no response to 100 kg urea/ha

BACKGROUND

Pulses and legumes have the capacity to source their N requirements via their relationship with the bacteria, Rhizobia. The rhizobia have the ability to convert nitrogen gas from the air to a form that can be used by plants. Forming a partnership in the root nodules, the plant supplies the rhizobia with energy and the rhizobia supplies the N.

However, this process costs the plant energy and if N is available in the soil, the plant will choose the soil N over the rhizobia. In a season with high water prices, maximising productivity for any input is essential. Will topdressing N result in the plant having more energy available for growth?

Another aspect of N fertiliser is the form that N is supplied as. Plants can take up N as either nitrate or ammonium. When crops are topdressed with urea, the urea has to be converted. This happens quickly in summer but more slowly in winter. By comparing the different forms of N in this trial, we can see if the extra expense of ammonium sulphate or potassium nitrate are justified.

OBJECTIVES

- To increase the dry matter response in irrigated vetch by supplying additional N to the soil.

METHODS

Sowing Date	15th May
Target Plant Population	40 plants/m^2
Seeding Rates	60 kg/ha based on TGW
Water	1. 5 Ml/ha - 10th April 1.0 Ml/ha – 23rd August 2.5 Ml/ha - TOTAL 154.6mm GSR
N Application	23rd August
N Treatments	46 kg N/ha as urea 46 kg N/ha as nitrate 46 kg n/ha as ammonium 92 kg N/ha as urea
Harvest	1st October
Average Yield	6.2 t/ha

*: Thousand Grain Weight

Vetch was sown on the Trial Block in May as a green manure or hay crop, depending on the season and water availability. Prior to spring irrigation, the treatments were based on a nominal rate of 100 kg urea/ha or 46 kg N/ha. 46 kg N/ha was applied as urea, ammonium sulphate and potassium nitrate, in addition to a double rate of urea at 92 kg N/ha. Dry matter cuts were taken to establish the amount of vetch present prior to irrigation (2.64 t/ha). The dry matter cuts were at ground level and dried to 0% moisture. Dry matter cuts were taken on October 1st when plant available soil moisture was almost depleted.

RESULTS

The results of the dry matter cuts (not hay cuts) are presented below.

Treatment	Rate kg/ha	kg N/ha	kg DM/ha	
Urea	200	92	7.05	a
Ammonium Sulphate	219	46	6.49	ab
Urea	100	46	6.40	ab
Control	0	0	6.20	b
Potassium Nitrate	355	46	5.79	b
		p	0.03	
		lsd	0.70	
		cv%	11.8	

The control treatment, or no extra N, yielded 6.2 t/ha, an overall increase in 3.56 t/ha from approximately 120mm of water (irrigation plus rainfall).

The effect of 46 kg N/ha, in any form, was not statistically different from that of the control.

92 kg N/ha did increase yield to 7.05 t/ha (or an increase of 4.41 t/ha), which was statistically different to that of the control.

Gross margin analysis of the early wheat variety trial, assuming vetch hay is $330/t and urea is $550/t.

		Water = $60		Water = $500/750	
Vetch Hay @ $300/t	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
Control	6.20	$1,147	$459	-$204	-$81
Urea @ 200 kg/ha	7.05	$1,258	$503	-$93	-$37

CONCLUSIONS

To see any benefit, the N rate had to be the equivalent of 200 kg urea/ha.

No response was measured when the N rate was equivalent to 100 kg urea/ha.

The form of N applied did not make any difference to yield but would have influenced any gross margin as urea tends to be the cheapest form of N readily available in Victoria.

Although there was a positive return to using 200 kg urea/ha, it did require the investment of approximately $110/ha to return $255/ha.

The above figures are based on dry matter cuts rather than hay cuts using a commercial broadacre mower. An observation from the trial was the increase in dry matter present was noticeable after irrigation but the weight of the crop eventually caused lodging/compaction and the extra dry matter produced might not have been 'harvestable'.

Irrigated Chickpea Demonstrations

Part 1: Inoculation

SUMMARY

Chickpeas were sown that were either not inoculated, inoculated with 'old' peat inoculum stored in the ICC office for 12 months (not refrigerated) or with fresh peat inoculum. Plants were assessed for nodulation in August, with all plants having some nodules but higher numbers where the plants had been inoculated. At harvest, the fresh inoculated chickpeas had the highest yield while 'not inoculated' chickpeas had the lowest yield.

BACKGROUND

Pulses and legumes have the capacity to source their N requirements via their relationship with the bacteria, Rhizobia. The rhizobia have the ability to convert nitrogen gas from the air to a form that can be used by plants. Forming a partnership in the root nodules, the plant supplies the rhizobia with energy and the rhizobia supplies the N. For the most efficient N fixation, specific strains of rhizobia have been selected for the various legumes and pulses. Therefore, if we are to see the best results, we need to match the rhizobia with the crop rather than hope for the natural rhizobia present in the soil are the right ones, particularly where the pulse has not been grown before.

To check, there are charts that match the crop to the preferred inoculum such as the table below taken from the GRDC 'Rhizobial Inoculants' factsheet.

TABLE 1 Examples of legume inoculant groups used in Australian agriculture and their rhizobia. Currently, 39 different legume inoculants are manufactured in Australia, covering about 100 legume species

Rhizobia	Commercial inoculant group	Legumes nodulated
Sinorhizobium spp.	AL	Lucerne, strand and disc medic
	AM	All other annual medics
Rhizobium leguminosarum bv. trifolii	B	Perennial clovers
	C	Most annual clovers
Bradyrhizobium spp.	G[1]	Lupin, serradella
	S[1]	Serradella, lupin
Mesorhizobium ciceri	N	Chickpea
Rhizobium leguminosarum bv. viciae	E[2]	Field pea and vetch
	F[2]	Faba bean and lentil
Bradyrhizobium japonicum	H	Soybean
Bradyrhizobium spp.	I	Cowpea, mungbean

1 Both inoculant groups G and S can be used for lupin and serradella
2 Although group E is recommended for pea/vetch and group F for faba bean/lentil, if required group E can also be used for faba bean/lentil and group F used for pea/vetch

Nodule effectiveness can be assessed by cutting the nodule in half and taking note of the colour. Nodules that are fixing N are pink-red inside, while green nodules are considered ineffective.

KEY MESSAGES

For legumes and pulses to fix the most nitrogen, they need to have sufficient numbers of effective nodules.

Chickpeas have their own specific inoculum and if you are growing them for the first time, inoculation is essential.

Peat inoculum is a living product and will deteriorate over time, particularly if it is stored incorrectly.

OBJECTIVES

- To demonstrate the need to use fresh inoculum from the appropriate group for your pulse crop.

METHODS

Sowing Date	22nd May
Target Plant Population	35 plants/m^2
Seeding Rates	150 kg/ha based on TGW
Inoculum Treatments	Not Treated 'Old' Group N inoculum 12 months old Fresh Group N inoculum
Inoculum Rate	2.5 kg/ 1.0 t
Water	1. 5 Ml/ha - 10th April 1.0 Ml/ha – 30th August 1.0 Ml/ha – 27th September 3.5 Ml/ha - TOTAL 154.6mm GSR
Harvest	6th December
Average Yield	1.2 t/ha

*: Thousand Grain Weight

Genesis 090 kabuli chickpeas were sown as a demonstration on May 22nd.

Nodulation was assessed by digging up plants on August 8th, washing the dirt from the root system and examining the number of nodules as well as the colour of the nodules. This was repeated on September 27th.

The plots were harvested on December 6th.

RESULTS

Nodules were present on all three treatments. Comparing the numbers of nodules to the GRDC 'Tips and Tactics: Legumes and Nitrogen Fixation' guide, the numbers of nodules were rated as poor to adequate on the untreated seed plants, and adequate on the 'old' and 'fresh' plants. However, the untreated plants had green nodules while the treated seeds had pale pink to dark pink nodules.

Left to right: Not inoculated, old and fresh treatments pictured in August.

As plants began to flower, it was noted the untreated seed plots were noticeably yellower than the treated plots, suggesting a nitrogen deficiency. Untreated seed plots in the foreground.

The yield results are presented below.

Treatment	Yield (t/ha)
No inoculant	0.84
'Old'	1.32
'Fresh'	1.55

Please keep in mind these were demonstration plots and not replicated and therefore view the results with caution.

CONCLUSIONS

The demonstration did illustrate the benefit of inoculating pulse seed where that crop had not been grown before. One of the reasons to grow pulses is for the N that they fix into the rotation. Making sure the optimal amount of N is fixed relies on adequate nodulation and active rhizobia in the nodules. Peat based inoculum is a living creature and the rhizobia will die if they are subject to high temperatures and/or allowed to dry out. Using fresh inoculum suited to the crop type is a relatively inexpensive way of giving the rhizobia the best chance of producing nodules and optimising N fixation.

Part 2: Irrigated Chickpeas

SUMMARY

Inoculated Genesis 090 chickpeas were sown into pre-irrigated bays on the Trial Block on May 14th at 150 kg/ha targeting 35 plants/m^2. Establishment was patchy and the plant population ranged from 25 – 35 plants/m^2. Waterlogging was monitored with redox probes, which indicated only one brief waterlogging event during the season when the chickpeas were irrigated on August 31st. The yields were below expectations, averaging 1.3 t/ha, which may be partly explained by the lower plant population.

BACKGROUND

The ICC have grown irrigated chickpeas and lentils in the past three seasons with promising results. Yields have been up to 3.3 t/ha and drainage the key to success. Another finding was the better-than-expected drought tolerance, where despite the dry Septembers, yields were not improved by more than one spring irrigation following pre-irrigation. 2019 saw the transformation of the irrigated chickpea evaluation from small plots to sowing whole bays.

OBJECTIVES

- To demonstrate the viability of growing irrigated chickpeas with surface irrigation.

METHODS

Sowing Date	14th May
Target Plant Population	35 plants/m^2
Seeding Rates	150 kg/ha based on TGW
Inoculum Rate	2.5 kg/ 1.0 t
Fungicide	Chlorothalonil 1.5 l/ha 27th August
Water	1.75 Ml/ha - 10th April 0.8 Ml/ha – 31st August 2.55 Ml/ha - TOTAL 154.6mm GSR
Harvest	6th December
Average Yield	1.3 t/ha

*: Thousand Grain Weight

Chickpeas were sown into pre-irrigated grey clay on May 14th. 35 plants/m^2 was the target plant population but establishment was patchy and ranged from 25 – 35 plants/m^2. Soil moisture redox equipment was installed in July to monitor waterlogging. The chickpeas received one fungicide application on August 27th prior to irrigation. No foliar disease was detected throughout the season. The chickpeas were irrigated on August 31st, in line with the rest of the Trial Block. Water use was slightly below the rest of the Trial Block due to a higher level of soil moisture at depth. Irrigation took approximately 6 hours. The crop was harvested on December 6th. Strips across the bays where the redox sensors were placed were harvested and yield calculated.

KEY MESSAGES

Irrigated chickpea yields averaged 1.3 t/ha from surface irrigation on grey clay soil at the Trial Block.

The yield was below that seen in the previous small plot trials where the average was 3.3 t/ha (2017) and 2.3 t/ha (2018).

Plant population was below the targeted 35 plants/m^2 which may have impacted on yields.

Peat inoculum is a living product and will deteriorate over time, particularly if it is stored incorrectly.

RESULTS

Please keep in mind these were demonstration plots and not replicated and therefore view the results with caution.

Harvest Location	Yield (t/ha)
Top of Bay	1.22
Mid Bay	1.45
Bottom of Bay	1.20

Average yield was 1.3 t/ha, which was disappointing given the previous results.

Gross margin analysis of the irrigated chickpea trial.

IRRIGATED CHICKPEAS		1.3 t/ha				
Price	$	600 /t				$ 780
		number		cost $		cost $/ha
Pre-sowing	spray	1	operation	15	/ha	15
	cultivation		operation	35	/ha	0
	pre-irrig	1.75	Ml/ha	60	/Ml	105
Sowing	machinery	1	operation	43	/ha	43
	fertiliser	125	kg/ha	700	/tonne	87.5
	seed	150	kg/ha	1000	/tonne	150
Post sowing	herbicide	2	operation	20	/ha	40
	fungicide	1	sprays	20		20
	topdress	0	kg/ha	550	/tonne	0
	irrigation	0.8	Ml/ha	60	/Ml	48
Harvest	windrow	0	operation	30	/ha	0
	mow/rake/bale	0	operation	490	/ha	0
	header	1	operation	70	/ha	70
					Total Variable Cost	$ 578.50 /ha
					Variable Cost - water	$ 425.50 /ha
					Gross Margin	$ 202 /ha
						$ 79 /Ml

CONCLUSIONS

Information on target plant populations for irrigated chickpeas is relatively poor and the target adopted for this demonstration was based on high rainfall trials. Seeding rates need to be tested to establish a population target for irrigated chickpeas.

The target population of 35 plants/m^2 seemed to be too low, and combined with patchy establishment, the biomass of the crop seemed to be below that of previous small plot trials. Poorer biomass was reflected in poorer yields, with the bay averaging 1.3 t/ha compared with yields achieved in the small plots of approximately 3.3 t/ha. Whether this was a seasonal response or due to wetter conditions following irrigation on a bay scale rather than faster drainage with plot scale trials remains to be seen.

The bay did have surface water present for approximately 8 hours after water was shut off. Despite the irrigation, the bay was only briefly waterlogged at the lower part of the bay at 5cm depth. This highlights the difference between having soil that is saturated and waterlogging. True waterlogging is where there is insufficient oxygen in the pore space for plant roots to be able to adequately respire ('breathe') and affects their ability to function. While the soils at the Trial Block do become saturated via irrigation, they do not necessarily become waterlogged as there is still enough oxygen in the soil for the roots to continue to function.

Best Value for Your Water Trial

KEY MESSAGES

If you had allocation available in 2019, broadleaf crops returned the best gross margins when fully irrigated while the cereals had the best returns with no pre-irrigation and a single spring irrigation.

If you cost water at the opportunity cost or purchase water, then only one of the many crops, varieties and irrigation strategies broke even.

If you decide to irrigate, the crop must be irrigated when it needs it in order to maintain yield potential. Delaying irrigation could result in lost potential that cannot be recovered by late irrigation.

When reducing the number of irrigations in wheat consider long-season varieties, under no pre-irrigation BS Bennett (Late) performed best with Beckom (Mid) performing best when pre-irrigating and using one spring and Cobra (Early-Mid) top performer under full irrigation.

Reducing irrigation by not pre-irrigating can have several negative agronomic consequences such as weed control, nutrition uptake and poor establishment.

As with any trial results, treat one years' worth of data with caution. 2019 had favourable breaking rains and above average to average rainfall for the first 3 months at Kerang. If the break was poor or delayed, the results may have been different.

There are many ways to value water and so the gross margins provided are for a certain set of circumstances – your situation will be different to that used in this report.

SUMMARY

Pre-irrigation assisted with better establishment, plant vigour and weed control.

Despite above average rainfall for May and average for June and July, the soil moisture did not improve below 200mm. This also saw a period of soil moisture stress in mid-June which affected crop nutrition and vigour.

As the season progressed and rainfall dropped to below average, the developing crops quickly depleted soil moisture. No pre-irrigation treatments were irrigated on August 23rd and used a slightly lower volume of water than the pre-irrigated treatments in autumn. These pre-irrigated areas also needed irrigation soon after on August 30th thanks to the vigorous crop growth.

Maturity made little difference in yields in either the barley or canola. Maturity did affect yield in the wheat, with the late maturing DS Bennett having the highest yield in both no pre-irrigation treatments, mid-season Beckom having the highest yield in the 'pre-irrigation + 1 spring' and Cobra, early mid maturity, the highest yield in the 'pre-irrigation + full spring' treatment.

BACKGROUND

Low or no allocations in the past few seasons has seen water availability decline and is reflected in higher prices in the water market.

The aim of the trial was to look at irrigation strategies more suited to seasons of low or zero allocation and the resultant high prices for temporary water.

Some degree of crystal ball gazing is required when planning for the irrigated winter crop season. Pre-irrigation can use high volumes of water that may prove wasted or at the worst have negative impacts with poor crop establishment, poor weed control and difficulties with N management if rain falls around sowing. Holding water until the spring does deliver better crop response per megalitre but you need a crop that has the capacity to respond. Added to the uncertainty is that the commodity prices at sowing can be entirely different at harvest.

Much of the ICCs research has involved fully irrigated trials that maximise production, but is this the correct strategy when faced with high water prices?

OBJECTIVES

- Evaluate pre-irrigation and spring irrigation strategies on a range of crop types and maturities to calculate the best return for irrigation water.
- Establish crop yield potentials based on the level of irrigation input.

METHODS

Crop Treatments

Table 1: Crop, variety and sowing rates included in the trial

Crop	Variety	Maturity	Sowing Rate (kg/ha)
Barley	LaTrobe	E-M	90 kg/ha
	RGT Planet	EML	90 kg/ha
Canola	43Y29	E	4.5 kg/ha
	44Y27	E-M	5.5 kg/ha
	45Y25	M	3.8 kg/ha
Faba Beans	Samira	M	190 kg/ha
Wheat*	Axe	E	76 kg/ha
	Cobra	E-M	64 kg/ha
	Scepter	E-M	81 kg/ha
	Beckom	M	64 kg/ha
	Trojan	M-L	77 kg/ha
	DS Bennett	L	83 kg/ha

*: Small seed supplied via GRDC Experimental Supply

Irrigation and Nitrogen Treatments

Table 2: Irrigation and Nitrogen applied to crops and varieties detailed above. Nitrogen budgets calculated on the yield estimates detailed in table 3 below

Crop	Irrigation Strategy	Water Applied	N Applied
Barley	No Pre-irrigation + 1 Spring	23/08/2019 – 1.5ML/ha	20 kg N/ha
	No Pre-irrigation + Full Spring	23/08/2019 – 1.5ML/ha 27/09/2019 – 1 ML/ha	35 kg N/ha
	Pre-irrigation + 1 Spring	10/04/2019 – 1.75ML/ha 30/08/2019 – 1 ML/ha	85 kg N/ha
	Pre-irrigation + Full Spring	10/04/2019 – 1.75ML/ha 30/08/2019 – 1 ML/ha 27/09/2019 – 1 ML/ha	155 kg N/ha
Canola	No Pre-irrigation + 1 Spring	23/08/2019 – 1.5ML/ha	20 kg N/ha
	No Pre-irrigation + Full Spring	23/08/2019 – 1.5ML/ha 27/09/2019 – 1 ML/ha	35 kg N/ha
	Pre-irrigation + 1 Spring	10/04/2019 – 1.75ML/ha 30/08/2019 – 1 ML/ha	65 kg N/ha
	Pre-irrigation + Full Spring	10/04/2019 – 1.75ML/ha 30/08/2019 – 1 ML/ha 27/09/2019 – 1 ML/ha	155 kg N/ha
Faba Beans & Wheat*	No Pre-irrigation + 1 Spring	23/08/2019 – 1.5ML/ha	20 kg N/ha
	No Pre-irrigation + Full Spring	23/08/2019 – 1.5ML/ha 27/09/2019 – 1 ML/ha 17/10/2019 – 0.9 ML/ha	55 kg N/ha
	Pre-irrigation + 1 Spring	10/04/2019 – 1.75ML/ha 30/08/2019 – 1 ML/ha	75 kg N/ha
	Pre-irrigation + Full Spring	10/04/2019 – 1.75ML/ha 30/08/2019 – 1 ML/ha 27/09/2019 – 1 ML/ha 17/10/2019 – 0.9 ML/ha	175 kg N/ha

*: N applied to wheat only

Table 3: estimated yield (t/ha) used to calculate nitrogen budgets

Crop	No pre + 1 Spring	No pre + Full Spring	Pre-irrig + 1 Spring	Pre-irrig + Full Spring
Canola	0.5	2	2.75	4
Wheat	2	4	5	8
Barley	2.5	4	6	8

All treatments where sown on April 30th with 20.6mm of rain falling on May 1st and 2nd.

Soil moisture was monitored using Irrometer loggers and gypsum blocks installed in the wheat plots.

Pre-irrigated + 1 spring canola was windrowed on October 31st and the pre-irrigation + full spring treatment was windrowed on November 8th. The no pre-irrigation treatments were direct harvested on November 18th along with the pre-irrigation + 1 spring treatments. The pre-irrigation + full spring treatment was harvest on November 20th.

Barley treatments were harvested on November 25th.

Wheat treatments were harvested on November 27th except for the pre-irrigation + full spring treatment on November 29th.

Fabas were harvested on December 5th, the date determined by the header being set up for fabas rather than the treatments been ready for harvest.

Gross margins were calculated based on trial inputs and commodity prices as published by Graincorp on January 15th, except for fabas which was based on data from growers. For each treatment, the gross margin has been calculated using two different prices. One is assuming allocation was available and cost $60/Ml for both pre-irrigation and spring irrigation. The second is assuming purchase on the temporary market with water priced at $500/Ml for pre-irrigation and $750/Ml for spring irrigations. If you wish to calculate the gross margins using your figures, the ICC has a simple gross margin calculator that is available to assist.

RESULTS

BARLEY

Despite the rain in early May establishment was patchy in the no pre-irrigation plots, a secondary germination occurred later in May when we had a follow up rain. Dry matter (DM) cuts conducted on Latrobe demonstrated the great vigour provided by pre irrigation (pre-irrigated 1.09 t DM/ha and 0.18 t DM/ha on dry plots at 52 days post sowing).

Analysis of the yield data showed that variety made no difference to yield (p=0.481). There were varietal differences in the grain quality in response to the irrigation treatments, for details of these and the full statistical analysis, please refer to the appendix.

Table 4: Average barley yield and grain quality for all varieties.

Treatment	Yield (t/ha)	Protein (%)	Retention (%)	Screen (%)	Test Wt (kg/hl)
No pre-irrigation + 1 spring	2.75	8.6	86.9	2.8	65.7
No pre-irrigation + Full spring	4.03	9.0	92.4	1.5	67.3
Pre-irrigation + 1 spring	4.69	11.9	82.7	4.1	65.9
Pre-irrigation + Full spring	4.83	13.3	81.3	6.1	66.3

Looking at the data, the following observations can be made:

- Pre-irrigation did improve yield, with the no pre-irrigation treatments averaging 3.4 t/ha and the pre-irrigation treatments averaging 4.8 t/ha, there was variability in the yield data due to the bird damage (p<0.001, lsd = 0.711, cv%=20)
- Pre-irrigation improved grain protein with 'no-pre-irrigation averaging 8.8% and 'pre-irrigated' averaging 12.6% (p<0.001, lsd = 0.738, cv% = 8.1). There was some influence with variety, LaTrobe had the highest protein. The low grain protein in the 'no pre-irrigation' may reflect the lack of mineralisation and general inability to access soil N due to the marginal soil moisture for part of the season.
- There was little different in yield (p=0.122), protein (p=0.340) or any other of the grain quality tests, between one spring or full spring for pre-irrigated treatments, suggesting one spring irrigation was sufficient.

The best return on barley was $860/ha or $313/Ml from pre-irrigated and 1 spring irrigation. If you had chosen to sell your water at the time, the return from the water would have been approximately $1450.

Table 5: Barley gross margins for each irrigation strategy based on the use of allocation water at $60/Ml and buying temporary water at $500/Ml in autumn and $750 in spring. Calculated using a grain price of $291/t and input costs (excluding water and urea) of $227/ha

	Irrigation (Ml)			Water = $60		Water = $500/750	
Barley @$291/t	Pre-irrigation	Spring	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	0	1.5	2.75	$412	$275	-$623	-$416
No pre-irrigation + full spring	0	2.5	4.03	$702	$281	-$1,023	-$409
Pre-irrigation + 1 spring	1.75	1.0	4.69	$860	$313	-$600	-$218
Pre-irrigation + full spring	1.75	2.0	4.83	$717	$191	-$1,433	-$382

CANOLA

Although three varieties of canola were sown with different maturities, the yield data showed variety to be not significant (p=0.884). Therefore, our analysis has disregarded variety.

Pre-irrigation generated an average yield of 2.9 t/ha versus 1.0 t/ha for no pre-irrigation (p<0.001, lsd = 0.215, cv%=16). Similarly, full spring irrigation yielded 2.4 t/ha significantly higher than one spring irrigation 1.5 t/ha (p<0.001, lsd=0.215). There was interaction between the two – yield was boosted by pre-irrigation allowing timely growth and development of biomass that could then be built upon with spring irrigation. The treatments that did not receive pre-irrigation struggled to develop biomass and were already flowering by the time spring irrigation was available. The second spring irrigation also saw a 1.5 t/ha improvement in yield over the 1 spring treatment.

Table 6: Average canola yield

Treatment	Yield (t/ha)
No pre-irrigation + 1 spring	0.9
No pre-irrigation + Full spring	1.2
Pre-irrigation + 1 spring	2.2
Pre-irrigation + Full spring	3.7

The best return was $1463/ha or $390/Ml from pre-irrigation plus full spring irrigation. If you had chosen to sell your water at the time, the return from the water would have been approximately $2150.

Table 7: Canola gross margins, calculated using a grain price of $605/t and total inputs (excluding water and urea) cost of $271/ha

	Irrigation (Ml)			Water = $60		Water = $500/750	
Canola @$605/t	Pre-irrigation	Spring	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	0	1.5	0.9	$114	$76	-$921	-$614
No pre-irrigation + full spring	0	2.5	1.2	$214	$85	-$1,512	-$605
Pre-irrigation + 1 spring	1.75	1.0	2.2	$720	$262	-$740	-$269
Pre-irrigation + full spring	1.75	2.0	3.7	$1,463	$390	-$687	-$183

FABA BEANS

Pre-irrigation allowed for better establishment and winter growth of the fabas but needed extra water in spring to ensure the growth resulted in beans. Faba beans are an indeterminate crop meaning they continue to grow (and flower) while conditions are favourable. This is an advantage for a crop that is not pre-irrigated as it can then use the water in spring to grow. Whereas canola and to a certain extent the cereals have limited ability to respond to the relatively late irrigation in their development. However, where establishment is reduced, there is simply not enough shoots or time to compensate and the reduced population was less effective in competing with weeds. Limited spring irrigation saw smaller bean size, but they did fill reasonably well with few shrivelled beans in the harvested sample.

Table 8: Samira grain yield and bean size

Treatment	Yield (t/ha)	Bean Size (g/100s)
No pre-irrigation + 1 spring	0.32	52.7
No pre-irrigation + Full spring	2.66	68.5
Pre-irrigation + 1 spring	1.88	59.8
Pre-irrigation + Full spring	4.20	68.0

The best return was $1779/ha or $383/Ml from a pre-irrigated and 3 spring irrigations. If you had chosen to sell your water at the time, the return from the water would have been approximately $2770.

Table 9: Faba Bean gross margin calculated on a F1 grain price of $600/t due to small bean size. Input costs (excluding water) used in the calculation were $462/ha

	Irrigation (Ml)			Water = $60		Water = $500/750	
Fabas @ $600/t*	Pre-irrigation	Spring	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	0	1.5	0.3	-$372	-$248	-$1,407	-$938
No pre-irrigation + full spring	0	3.4	2.66	$960	$331	-$1,041	-$359
Pre-irrigation + 1 spring	1.75	1.0	1.88	$501	$182	-$959	-$349
Pre-irrigation + full spring	1.75	2.9	4.2	$1,779	$383	-$992	-$213

WHEAT

Despite the rain in early May, establishment was patchy in the no pre-irrigation plots with a secondary germination occurring later in May. Dry matter cuts comparing pre-irrigated and 'no pre-irrigation' Beckom plots demonstrated the greater vigour with 0.79 t DM/ha and 0.16 t DM/ha respectively, 52 days post sowing.

Varieties did respond to the season differently, the short season Axe in the no pre-irrigation treatments quickly started the stem elongation phase with heads emerged by August 22nd, just prior to irrigation. Therefore, yield potential was set so irrigation could only improve grain size or begin secondary tillering, which would then require more than 1 irrigation to finish properly.

Table 10: Wheat yield and quality results as an average of all six varieties

Wheat	Yield (t/ha)	Protein (%)	Screen (%)	Test Wt (kg/hl)
No pre-irrigation + 1 spring	3.62	8.9	2.8	78.6
No pre-irrigation + Full spring	5.00	10.3	1.8	74.9
Pre-irrigation + 1 spring	4.95	9.8	1.5	79.1
Pre-irrigation + Full spring	6.15	12.1	1.8	80.3

Table 11: Best performing varieties based on irrigation strategy

Treatment	Variety	Maturity
No pre-irrigation + 1 spring	DS Bennett	Late
No pre-irrigation + full spring	DS Bennett	Late
Pre-irrigation + 1 spring	Beckom	Mid
Pre-irrigation + full spring	Cobra	Early-Mid

Table 12: Gross margin for the average of the 6 wheat varieties. Input costs (excluding water and urea) used in the calculation were $318/ha

	Irrigation (Ml)			Water = $60		Water = $500/750	
Wheat ASW @$329/t	Pre-irrigation	Spring	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	0	1.5	3.62	$780	$520	-$255	-$170
No pre-irrigation + full spring	0	3.4	5.00	$1,105	$381	-$897	-$308
Pre-irrigation + 1 spring	1.75	1.0	4.95	$1,075	$391	-$385	-$140
Pre-irrigation + full spring	1.75	2.9	6.15	$1,255	$270	-$1,516	-$326

The best return was $1255/ha or $270/Ml from a pre-irrigated and 3 spring irrigations if you had allocation to use. The est return per megalitre was to not pre-irrigate and 1 spring irrigation. If you had chosen to sell your water at the time, the return from the water would have been approximately $2770.

Tables 13 to 18 below show the variety response, with the highest return per hectare (assuming water @ $60/Ml) produced by fully irrigated Cobra yielding 8.31 t/ha or $426/Ml. Best return per Ml was DS Bennett with a no pre-irrigation + 1 spring strategy returning $611/Ml or
$927/ha.

Only one treatment returned a positive gross margin under the high water price scenario. Beckom with a 'pre-irrigation + 1 spring' treatment returned $68/ha or $25/Ml.

Tables 13-18: Gross margins for each variety included in the trial. These comparisons are based on simply highlighting the highest figures rather than from a statistical analysis. For example, the difference between returns in DS Bennet are in the vicinity of $339/ha or $110/Ml before treatment gross margins can be regarded as significantly different.

		Water = $60		Water = $500/750	
Axe	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	2.82	$517	$345	-$518	-$345
No pre-irrigation + full spring	3.82	$733	$253	-$1,268	-$437
Pre-irrigation + 1 spring	3.53	$509	$110	-$2,262	-$486
Pre-irrigation + full spring	4.72	$775	$167	-$1,996	-$429

		Water = $60		Water = $500/750	
Beckom	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	3.95	$888	$592	-$147	-$98
No pre-irrigation + full spring	5.43	$1,246	$429	-$755	-$261
Pre-irrigation + 1 spring	6.33	$1,528	$556	$68	$25
Pre-irrigation + full spring	6.86	$1,494	$321	-$1,277	-$275

		Water = $60		Water = $500/750	
Cobra	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	3.58	$767	$511	-$268	-$179
No pre-irrigation + full spring	4.94	$1,105	$381	-$896	-$309
Pre-irrigation + 1 spring	5.59	$1,285	$467	-$175	-$64
Pre-irrigation + full spring	8.31	$1,981	$426	-$790	-$170

		Water = $60		Water = $500/750	
DS Bennett	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	4.07	$927	$618	-$108	-$72
No pre-irrigation + full spring	6.20	$1,498	$517	-$503	-$173
Pre-irrigation + 1 spring	4.77	$1,016	$369	-$444	-$161
Pre-irrigation + full spring	5.13	$892	$192	-$1,879	-$404

		Water = $60		Water = $500/750	
Scepter	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	3.69	$803	$535	-$232	-$155
No pre-irrigation + full spring	4.67	$996	$344	-$1,005	-$346
Pre-irrigation + 1 spring	3.57	$622	$226	-$838	-$305
Pre-irrigation + full spring	4.86	$822	$177	-$1,949	-$419

		Water = $60		Water = $500/750	
Trojan	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	3.86	$767	$511	-$268	-$179
No pre-irrigation + full spring	4.94	$1,085	$374	-$916	-$316
Pre-irrigation + 1 spring	5.91	$1,390	$505	-$70	-$25
Pre-irrigation + full spring	7.03	$1,551	$334	-$1,220	-$262

Full results including statistical analysis can be found in the appendix.

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CONCLUSIONS

The best response to water is from the first irrigation in the spring, but the crop being irrigated must be sufficiently developed, either with sufficient biomass or tiller numbers, to be able to respond to the irrigation. Irrigation has to be on time and the crop not subject to moisture stress. No pre-irrigation resulted in very little subsoil moisture and crops went from adequate to low soil moisture rapidly.

The results obtained in 2019 may be different to those in 2020. 2019 saw a relatively early and above average start to the season, however there was still short term moisture stress in June.

Crop growth was always lagging in the 'no pre-irrigation' treatments for all crops, but the cereals, maturity dependent, and fabas had some ability to recover in the spring with irrigation.

In 2019, irrigated cropping did not return positive gross margins with water valued at the market price. If water is valued at the cost charged by the water authorities, broadleaf crops returned the best gross margins, either $/ha or $/Ml, when fully irrigated, while the cereals had the best returns with no pre-irrigation and a single spring irrigation.

The early maturing wheat Axe had reduced tillering and was too committed to grain production rather than vegetative growth to respond to spring irrigation. However, the long season DS Bennett responded as it had continued to tiller through winter and had sufficient shoot numbers to respond to the spring irrigation.

Nitrogen management needs to be revisited as the partial irrigation treatments tended to have low grain protein despite having sufficient N topdressed to meet or exceed the target yield. This may require delaying topdressing until well into stem elongation to limit the plant 'wasting' the N on vegetative growth and improving grain protein. An alternative explanation could be that the single spring irrigation had insufficient time for the plant to translocate the protein in the plant into the grain before the plant began to prematurely ripen from moisture stress.

Economically it made little sense to irrigate crops in 2019. If water had to be purchased only one scenario in the whole trial had a positive (and very small) return. In the higher water price markets, if water was available, there were greater returns from selling water on the temporary market. However, for many irrigators, it isn't simply about the money and a degree of social and/or personal principals comes into the decision.

Appendix – Wheat Variety Trial

Variety	Yield t/ha	Protein %	Screening %	Test Weight kg/hl	GS 16/9	Lodge Sc	Height (cm)
Cobra	9.31	12.1	0.9	82.1	65	2	80
DS Pascal	8.52	11.0	1.1	82.0	59	0	83
Illabo	8.33	11.5	1.4	77.5	47	3	85
Rockstar	8.16	11.2	2.0	79.8	67	0	85
Beckom	7.87	11.7	0.9	82.2	65	2	80
Scout	7.77	11.9	1.0	83.2	65	1	87
Arrow	7.58	11.9	0.7	80.3	67	0	78
Elmore CL	7.52	11.6	0.9	82.4	63	5	85
Coolah	7.5	11.5	1.7	83.0	59	1	93
Vixen	7.31	12.4	1.4	80.5	69	0	85
Lancer	7.18	11.1	1.2	82.5	57	1	80
Catapult	7.09	11.4	2.0	79.9	59	3	90
Mustang	6.7	11.7	1.3	82.3	69	1	78
Ninja	6.63	11.9	1.1	81.1	61	1	85
Scepter	6.6	11.4	1.1	82.3	67	1	95
Chara	6.24	11.8	1.9	80.1	63	2	90
Trojan	5.91	11.0	4.0	76.5	61	2	82
DS Bennett	5.38	10.2	3.9	79.0	37	2	95
Havoc	4.93	13.5	1.0	80.0	67	0	87
p	<0.001						
lsd	0.95						
cv%	8.0						

Appendix – Early Maturing Wheat Trial

Variety	Yield (t/ha)	Protein (%)	Screen (%)	Test Weight kg/hl	Height (cm)	Lodge Sc
Vixen	8.38	10.5	1.9	79.7	83	1
Mace	6.77	10.9	1.4	80.2	85	1
Emu Rock	5.69	10.7	3.0	80.0	82	0
Cobalt	4.79	11.0	1.8	81.5	97	3
Axe	4.76	11.5	1.3	81.2	82	0
Corack	4.53	11.0	2.2	81.8	85	0
p	<0.001					
lsd	0.873					
cv%	8.1					

Appendix - Late Maturity Wheat Trial

Variety	Yield t/ha	Protein %	Screening %	Test Weight kg/hl	Lodge Sc
Trojan	10.31	10.9	1.1	80.2	2
Coolah	10.08	11.7	0.9	82.0	1
Catapult	9.40	10.6	0.9	82.1	3
Longsword	9.39	12.4	0.4	81.6	2
Wedgetail	9.37	10.8	0.7	79.4	4
DS Bennet	9.37	10.8	3.0	79.6	3
Illabo	9.08	11.2	1.0	80.2	5
Kittyhawk	9.07	11.0	1.9	82.6	2
p	0.519				
lsd	1.415				
cv%	8.5				

Appendix – Barley Variety Trial

Variety	Yield (t/ha)	Protein %	Screening %	Retention %	Test Weight (kg/hl)	GS 16 Sept	Height (cm)	Lodge Sc
Rosalind	5.79	12.6	4.8	80.4	67.4	69	80	5
LaTrobe	5.72	13.6	11.6	66.2	67.1	61	88	5
Commander	5.53	13.3	4.4	86.6	67.5	53	85	2
Spartacus	5.25	13.5	4.8	78.2	67.5	57	90	3
Hindmarsh	4.67	14.1	10.4	68.9	66.8	65	87	4
Compass	3.98	13.8	2.0	91.5	67.0	61	95	2
Alestar	3.87	12.5	3.7	86.7	68.2	53	90	2
RGT Planet	3.81	12.0	4.0	83.7	66.5	57	80	2
Bottler	3.81	12.8	9.1	72.5	65.7	61	85	2
Oxford	2.90	12.7	15.6	55.6	63.1	49	83	1
Westminster	2.68	13.3	5.8	76.9	67.4	51	85	1
Banks	2.64	13.7	2.4	88.3	71.1	57	95	1
p	<0.001							
lsd	0.64							
cv%	8.9							

Appendix – Faba Bean Variety Trial

Variety	Yield (t/ha)	g/100	Height (cm)	Lodging Sc	Flowering Start	Finish
AF14092	5.60	82	120	5	6-Aug	27-Sep
AF14066	5.35	84	120	7	6-Aug	4-Oct
AF14062	5.33	71	100	7	1-Aug	4-Oct
AF10089	5.27	76	110	5	1-Aug	4-Oct
Marne	5.24	75	120	6	6-Aug	4-Oct
Farah	5.20	68	110	4	29-Jul	6-Oct
Nura	5.01	67	115	2	9-Aug	6-Oct
Samira	4.96	73	120	5	6-Aug	4-Oct
AF14075	4.90	73	100	6	13-Aug	4-Oct
Bendoc	4.89	66	120	6	13-Aug	4-Oct
Amberley	4.73	67	120	4	6-Aug	4-Oct
Zahra	4.27	77	110	7	6-Aug	4-Oct
p	<0.001					
lsd	0.444					
cv%	5.2					

Appendix – Irrigated Vetch Trial

Treatment	Rate kg/ha	kg N/ha	kg DM/ha	
Urea	200	92	7.05	a
Ammonium Sulphate	219	46	6.49	ab
Urea	100	46	6.40	ab
Control	0	0	6.20	b
Potassium Nitrate	355	46	5.79	b
		p	0.03	
		lsd	0.70	
		cv%	11.8	

Gross Margins

		Water = $60		Water = $500/750	
Vetch Hay @ $300/t	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
Control	6.20	$1,147	$459	-$204	-$81
Urea @ 200 kg/ha	7.05	$1,258	$503	-$93	-$37

Appendix – Canola Variety Trial/Demonstration

Variety	Yield (t/ha)		Flowering*		Height	Lodging
	April Sowing	May Sowing	Start	Finish	(cm)	Score
43Y29	4.80	2.38	6-Aug	23-Sep	145	2
43Y92	3.73	2.31	2-Aug	20-Sep	160	1
44Y27	4.03	2.33	2-Aug	16-Sep	150	3
44Y90	3.69	2.71	2-Aug	20-Sep	160	0
45T03TT	2.88	2.01	2-Aug	23-Sep	150	1
Diamond	4.71	3.02	15-Jul	16-Sep	150	2
GT53	4.24	2.86	6-Aug	20-Sep	155	1
Hyola 350TT	3.62	2.23	2-Aug	16-Sep	130	0
Hyola 410XX	3.15	2.80	6-Aug	1-Oct	160	3
Hyola 530XT	2.09	2.28	9-Aug	1-Oct	160	2
Hyola 540XC	2.44	2.25	2-Aug	20-Sep	165	0
Hyola 550TT	3.40	2.57	2-Aug	20-Sep	145	1
Hyola 580 CT	3.99	2.48	2-Aug	20-Sep	160	0
Invigor5520P	4.48	3.10	13-Aug	20-Sep	170	0
InvigorR4022P	4.35	2.58	2-Aug	20-Sep	160	0
InvigorT4510	3.08	2.42	2-Aug	20-Sep	150	0
Quartz	4.81	3.00	2-Aug	20-Sep	150	0
Trident	3.25	2.13	2-Aug	16-Sep	135	2
Trident	2.61	2.02	7-Jul	6-Sep	140	0
Trophy	3.74	2.54	6-Aug	20-Sep	140	3
Turbine	3.87	2.44	6-Aug	23-Sep	150	2
V5003	3.07	1.82	2-Aug	16-Sep	140	0
V7001	3.33	2.21	23-Jul	23-Sep	155	1
V7002CL	3.35	2.20	6-Aug	27-Sep	165	0
V75-03CL	3.23	2.43	2-Aug	16-Sep	140	1
Wahoo	3.10	2.14	2-Aug	27-Sep	145	1

April 8th sowing

* Flowering data from April 24th sowing

Appendix – Durum Wheat Agronomy Trial

Treatment	Aurora			Vittaroi		
	Yield (t/ha)	Protein (%)	Protein kg/ha	Yield (t/ha)	Protein (%)	Protein kg/ha
High N	10.33	13.0	1345	9.08	13.0	1178
Late N	9.50	12.5	1195	9.83	12.7	1255
Foliar N	9.53	13.3	1272	9.17	12.4	1218
Standard	9.51	12.5	1186	9.12	13.2	1125
p	0.64	0.285	0.512	0.04	0.62	0.462
lsd	NS	NS	NS	0.54	NS	NS
cv%	9.40	4.3	11.2	3.0	6.1	8.2

Appendix – Wheat Agronomy Trial

Treatment	Dry Matter (t/ha)	Yield (t/ha)	Harvest Index	Protein %	Screenings %	Test Weight kg/hl
'Early'	16.43	4.76	0.29	12.8	0.6	81.1
'Standard'	15.95	4.75	0.30	13.4	0.5	80.5
p	0.480	0.790	0.860	0.098	0.58	0.275
lsd	NS	NS	NS	NS	NS	NS
cv%	6.8	3.2	6.9	2.9	36	0.7

Gross Margins

Wheat	Irrigation (Ml)			Water = $60		Water = $500/750	
	Pre-irrigation	Spring	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
Hay @ $280/t	1.5	1.0	13.0*	$2,489	$995	$1,139	$455
Grain @ $338/t	1.5	2.0	4.76	$921	$245	-$1,229	-$328

Appendix – Best Value for Water Trial

Axe (Early)					Water = $60		Water = $500/750	
Treatment	Yield (t/ha)	Protein (%)	Screen (%)	Test Weight (kg/hl)	$/ha	$/Ml	$/ha	$/Ml
No pre + 1 spring	2.82	9.9	1.6	78.4	$517	$345	-$518	-$345
No pre + Full spring	3.82	11.4	1.3	75.1	$733	$253	-$1,268	-$437
Pre-irrigation + 1 spring	3.53	11.1	0.6	77.8	$509	$110	-$2,262	-$486
Pre-irrigation + Full spring	4.72	13.6	0.4	80.1	$775	$167	-$1,996	-$429
p	0.007				0.242	0.14		
lsd	0.72				NS	NS		
cv%	9.3				17.7	19.2		

Beckom					Water = $60		Water = $500/750	
Treatment	Yield (t/ha)	Protein (%)	Screen (%)	Test Weight (kg/hl)	$/ha	$/Ml	$/ha	$/Ml
No pre + 1 spring	3.95	8.8	1.8	80.0	$888	$592	-$147	-$98
No pre + Full spring	5.43	10.2	1.9	79.7	$1,246	$429	-$755	-$261
Pre-irrigation + 1 spring	6.33	9.4	0.9	80.1	$1,528	$556	$68	$25
Pre-irrigation + Full spring	6.86	12.1	0.7	81.7	$1,494	$321	-$1,277	-$275
p	0.007				0.032	0.010		
lsd	0.72				408.10	144.80		
cv%	9.3				16	15.3		

Cobra					Water = $60		Water = $500/750	
Treatment	Yield (t/ha)	Protein (%)	Screen (%)	Test Weight (kg/hl)	$/ha	$/Ml	$/ha	$/Ml
No pre + 1 spring	3.58	9.0	2.5	78.6	$767	$511	-$268	-$179
No pre + Full spring	4.94	10.7	1.8	72.4	$1,105	$381	-$896	-$309
Pre-irrigation + 1 spring	5.59	9.7	1.3	79.8	$1,285	$467	-$175	-$64
Pre-irrigation + Full spring	8.31	12.5	0.6	81.9	$1,981	$426	-$790	-$170
p	0.007				0.003	0.224		
lsd	0.72				425.60	NS		
cv%	9.3				16.9	17.9		

DS Bennett

Treatment	Yield (t/ha)	Protein (%)	Screen (%)	Test Weight (kg/hl)	Water = $60 $/ha	Water = $60 $/Ml	Water = $500/750 $/ha	Water = $500/750 $/Ml
No pre + 1 spring	4.07	7.9	4.7	75.3	$927	$618	-$108	-$72
No pre + Full spring	6.20	8.8	2.7	71.0	$1,498	$517	-$503	-$173
Pre-irrigation + 1 spring	4.77	10.0	3.0	77.0	$1,016	$369	-$444	-$161
Pre-irrigation + Full spring	5.13	10.8	5.6	76.9	$892	$192	-$1,879	-$404
p	0.007				0.016	<0.001		
lsd	0.72				338.30	110.10		
cv%	9.3				15.7	13.0		

Scepter

Treatment	Yield (t/ha)	Protein (%)	Screen (%)	Test Weight (kg/hl)	Water = $60 $/ha	Water = $60 $/Ml	Water = $500/750 $/ha	Water = $500/750 $/Ml
No pre + 1 spring	3.69	8.8	3.4	79.0	$803	$535	-$232	-$155
No pre + Full spring	4.67	10.1	1.6	76.3	$996	$344	-$1,005	-$346
Pre-irrigation + 1 spring	3.57	9.5	1.9	80.0	$622	$226	-$838	-$305
Pre-irrigation + Full spring	4.86	12.2	1.0	81.8	$822	$177	-$1,949	-$419
p	0.007				0.32	0.003		
lsd	0.72				NS	142.80		
cv%	9.3				>20	>20		

Trojan

Treatment	Yield (t/ha)	Protein (%)	Screen (%)	Test Weight (kg/hl)	Water = $60 $/ha	Water = $60 $/Ml	Water = $500/750 $/ha	Water = $500/750 $/Ml
No pre + 1 spring	3.58	9.1	3.1	80.1	$767	$511	-$268	-$179
No pre + Full spring	4.94	10.4	1.5	74.8	$1,085	$374	-$916	-$316
Pre-irrigation + 1 spring	5.91	9.3	1.2	80.2	$1,390	$505	-$70	-$25
Pre-irrigation + Full spring	7.03	11.5	2.6	79.4	$1,551	$334	-$1,220	-$262
p	0.007				0.003	0.013		
lsd	0.72				217.70	104.70		
cv%	9.3				8.2	10.9		

Appendix – Best Value for Water Trial

	Irrigation (Ml)			Water = $60		Water = $500/750	
Barley @ $291/t	Pre-irrigation	Spring	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	0	1.5	2.75	$412	$275	-$623	-$416
No pre-irrigation + full spring	0	2.5	4.03	$702	$281	-$1,023	-$409
Pre-irrigation + 1 spring	1.75	1.0	4.69	$860	$313	-$600	-$218
Pre-irrigation + full spring	1.75	2.0	4.83	$717	$191	-$1,433	-$382
p	<0.001			0.011	0.357		
lsd	0.858			249.70	NS		
cv%	17.1			>20	>20		

	Irrigation (Ml)			Water = $60		Water = $500/750	
Canola @ $605/t	Pre-irrigation	Spring	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	0	1.5	0.9	$114	$76	-$921	-$614
No pre-irrigation + full spring	0	2.5	1.2	$214	$85	-$1,512	-$605
Pre-irrigation + 1 spring	1.75	1.0	2.2	$720	$262	-$740	-$269
Pre-irrigation + full spring	1.75	2.0	3.7	$1,463	$390	-$687	-$183
p	<0.001			<0.001	<0.001		
lsd	0.284			172.50	70.00		
cv%	14.9			>20	>20		

	Irrigation (Ml)			Water = $60		Water = $500/750	
Fabas @ $600/t*	Pre-irrigation	Spring	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	0	1.5	0.3	-$372	-$248	-$1,407	-$938
No pre-irrigation + full spring	0	3.4	2.66	$960	$331	-$1,041	-$359
Pre-irrigation + 1 spring	1.75	1.0	1.88	$501	$182	-$959	-$349
Pre-irrigation + full spring	1.75	2.9	4.2	$1,779	$383	-$992	-$213
p	<0.001			<0.001	<0.001		
lsd	0.394			236.40	60.00		
cv%	8.8			16.6	18.0		

	Irrigation (Ml)			Water = $60		Water = $500/750	
Wheat ASW @$329/t	Pre-irrigation	Spring	Yield (t/ha)	$/ha	$/Ml	$/ha	$/Ml
No pre-irrigation + 1 spring	0	1.5	3.62	$780	$520	-$255	-$170
No pre-irrigation + full spring	0	3.4	5.00	$1,105	$381	-$897	-$308
Pre-irrigation + 1 spring	1.75	1.0	4.95	$1,075	$391	-$385	-$140
Pre-irrigation + full spring	1.75	2.9	6.15	$1,255	$270	-$1,516	-$326
p	<0.001			0.001	<0.001		
lsd	0.422			138.90	53.00		
cv%	4.3			6.7	6.8		

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