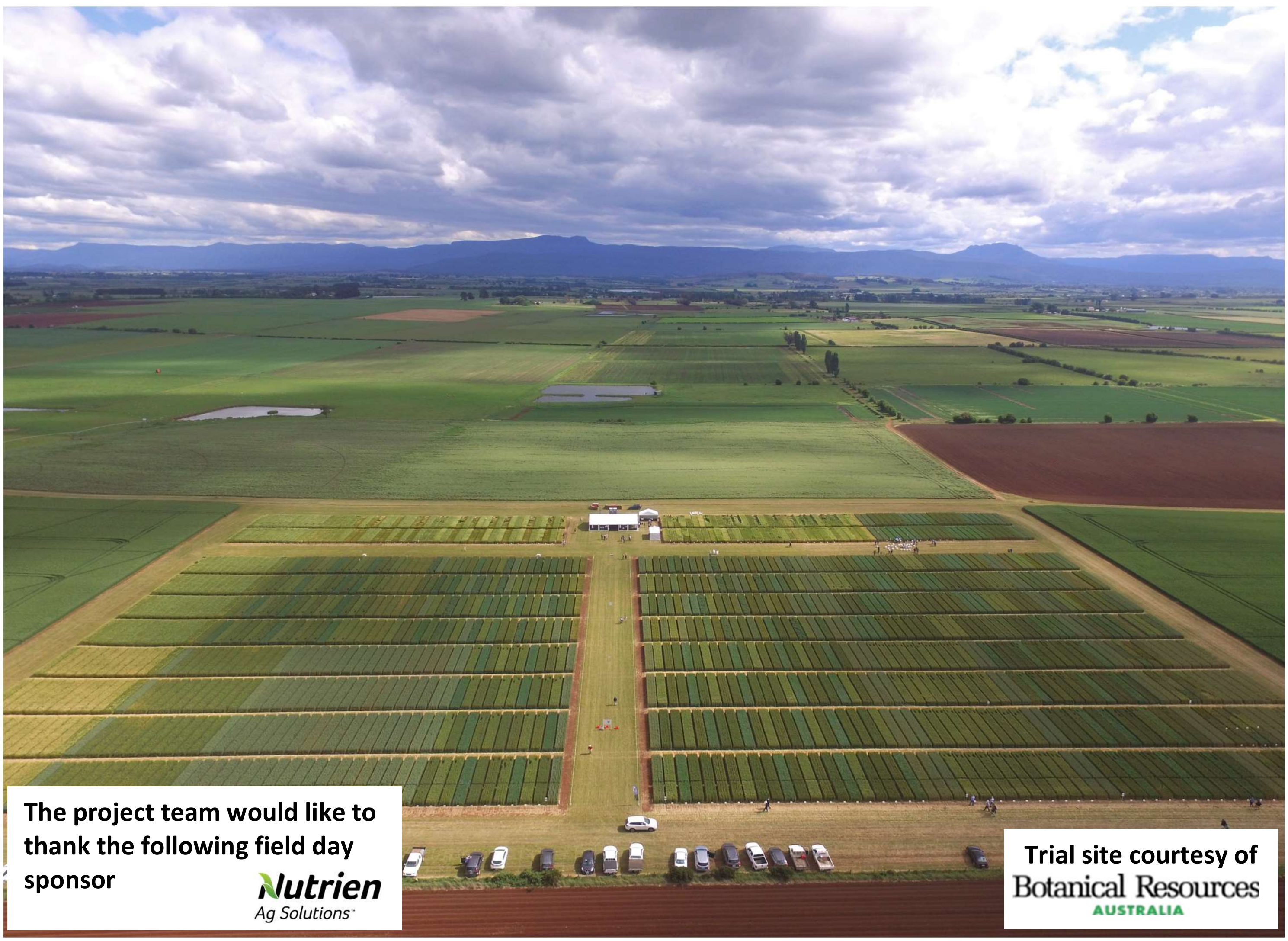
Hyper Yielding Crops: a GRDC national investment

Thursday 10 December 2020 10:30am

HAGLEY, TASMANIA



The project team would like to thank the following field day sponsor

Trial site courtesy of Botanical Resources Australia

The Hyper Yielding Crops project is funded by the GRDC and led by FAR Australia in collaboration with:

VISITOR INFORMATION

We trust that you will enjoy your day with us at our Tasmania Crop Technology Centre (CTC), host to the Hyper Yielding Crops (HYC) project, a Grains Research & Development (GRDC) national investment. Your health and safety is paramount, therefore whilst on the property we ask that you both read and follow this information notice.

HEALTH & SAFETY

- All visitors are requested to follow instructions from FAR Australia staff at all times.
- All visitors to the site are requested to stay within the public areas and not to cross into any roped off areas.
- All visitors are requested to report any hazards noted directly to a member of FAR staff.

FARM BIOSECURITY

- Please be considerate of farm biosecurity. Please do not walk into farm crops without permission. Please consider whether footwear and/or clothing have previously been worn in crops suffering from soil borne or foliar diseases.

FIRST AID

- We have a number of first aiders on site. Should you require any assistance, please ask a member of FAR Australia staff.

LITTER

- Litter bins are located around the site for your use; we ask that you dispose of all litter considerately.

VEHICLES

- Vehicles will not be permitted outside of the designated car parking areas. Please ensure that your vehicle is parked within the designated area(s).

Thank you for your cooperation, enjoy your day.

COVID–19 Event Operating Protocols

For the health and safety of all staff and field day attendees, please ensure that you read and comply with the following COVID-19 operating protocols, in accordance with current Tasmania Health Orders.

- You have completed and signed an event COVID-19 Self Declaration form upon arrival.
- You understand and will adhere to the Tasmania Government and Health Department COVID-19 health orders. Hygiene and social distancing requirements are extensively encouraged around the site.
- All participants are strongly requested to advise FAR Australia immediately should they feel or become unwell within 14 days of attending this event.

Our nominated First Aid responder for the event is Darcy Warren 0455 022 044.

Social Distancing and Hygiene

Please ensure that you continue to maintain a minimum of 1.5m between individuals.

- We are applying the minimum 2sq. meters per person.
- Hand sanitiser will be available at the entrance / exit to the site and at other various well marked locations around the site.

Field Day Access

Please ensure that you only enter and exit, within your vehicle, via the designated gate(s).

Thank you for your understanding. We appreciate your attention and co-operation in helping us to deliver an educational and safe event.

WELCOME TO FAR AUSTRALIA'S TASMANIA CROP TECHNOLOGY CENTRE (CTC)

On behalf of the project team, I am delighted to welcome you to the 2020 Tasmania Hyper Yielding Crops (HYC) field day here at the Tasmania Crop Technology Centre (CTC) Hagley, near Launceston.

Led by Field Applied Research (FAR) Australia, the Hyper Yielding Crops (HYC) project is a Grains Research & Development Corporation (GRDC) national investment which aims to push the economically attainable yield boundaries of wheat, barley and canola. HYC builds on the success of the GRDC's four-year Hyper Yielding Cereals project delivered here in Tasmania, which demonstrated that it is possible to significantly increase yields through sowing the right cultivars and effective implementation of appropriately tailored management strategies. The project team believed that there were some common threads to the research that could benefit both Tasmanian and mainland growers. The first was the ability to explore research centres that could look at the latest developments in germplasm whilst at the same time examine all the major agronomic inputs. This may not appear very unique but when laid out across a number of different research sites, this can be rather powerful. The second point is that across Australia, sowing dates are moving forward, and as a consequence, our germplasm requirements are changing.

As well as the five HYC Centres of Excellence across the higher yielding regions of southern Australia (NSW, WA, SA, VIC and TAS) the project wants to engage with you to scale up the results and create a community network aiming to lift productivity. If you are interested in getting involved in the project then please get in touch with Jon Midwood, project Co-ordinator for Focus Farms and HYC awards and the regional HYC Project Officer.

What's happening at FAR Australia's Tasmania Crop Technology Centre in 2020?

FAR Australia's Tasmania Crop Technology Centre (CTC) is host to the GRDC's Hyper Yielding Crops centre of excellence (Tasmania). It has a spring sown barley focus this year since COVID-19 restrictions prevented the establishment of the winter crop programme.

Today will provide you with an opportunity to view a series of spring sown barley research trials aimed at maximising productivity. Of all the regions in Australia this crop has the strongest fit with irrigated cropping rotations in Tasmania. Not only does it offer greater opportunities for integration with winter fodder crops grown for livestock, it is also invariably cheaper to grow than autumn sown barley and allows more flexibility in controlling herbicide resistant grass weeds. In the HYC project the aim will be to look at the ideal combinations of germplasm, phenology and management in order to turn this crop into a reliable 10t/ha option under irrigation. Rohan Brill of Brill Ag, Nick Poole, FAR Australia's Managing Director and HYC Project Leader and Darcy Warren, FAR Australia's Senior Field Research Officer will demonstrate the research programmes along with Brett Davey, Research and Extension Officer from Southern Farming Systems, our primary project collaborator in Tasmania. Specifically, there will be the opportunity to look at and discuss:

- How can you become involved in the focus farm and HYC awards scheme? - Jon Midwood from Techcrop (HYC extension co-ordinator) will be at the field day to make growers and advisers aware of how they can become involved in the project to enable a 'seeing is believing' approach to the research.
- HYC G.E.M. trials in spring sown barley looking at the interaction between genotype, environment and management in Hagley. These trials look at aspects of phenology, biomass production and final grain yields.
- The GEM trial also includes a comparison of spring sown barley with spring wheat Trojan.
- Nutrition trials – just how hard can we push productivity of spring barley with artificial nitrogen fertiliser?
- Disease management is an essential feature of HRZ grain production but could this crop require lower input relative to the winter crop, similar to what has been experienced in the UK?

Rohan Brill our principal guest speaker for the field day and the research co-ordinator for the HYC canola programme will discuss advances in canola germplasm and agronomy on the mainland and his thoughts on those aspects of relevance to the longer growing seasons of Tasmania.

Should you require any assistance throughout the day, please don't hesitate to contact a member of the FAR Australia team who will be more than happy to help.

Thank you once again for taking the time to join us today; we hope that you find the presentations useful, and as a result, can take away new ideas which can be implemented in your own farming business.

Finally, I would like to thank the Grains Research & Development Corporation (GRDC) for investing in the Hyper Yielding Crops project, without this investment nothing of what you see here today would be possible. Many thanks to our speakers for attending and making today possible. I would also like to place on record my thanks to our collaborator Brett Davey (SFS) and Don Badcock (grower) for their input into the trial site this spring. Thanks also to our sponsor Nutrien Ag Solutions for providing lunch and afternoon refreshments and last but in no way least, I would like to thank Botanical Resources Australia and their staff here at Hagley for not only hosting us on the farm, but also their input and support, it has been invaluable.

Nick Poole, Managing Director, FAR Australia

Investment Acknowledgements
The Hyper Yielding Crops project team would like to place on record its grateful thanks to the Grains Research & Development Corporation (GRDC) for its Investment in this event and featured project trials.

What is the Hyper Yielding Crops (HYC) project aiming to achieve and how did it originate?

Hyper Yielding Crops (HYC) builds on the success of the GRDC's four-year Hyper Yielding Cereals Project in Tasmania, which attracted a great deal of interest from mainland HRZ regions. The project demonstrated that increases in productivity could be made through sowing the right cultivars, at the right time and with effective implementation of appropriately tailored management strategies. The popularity of the original project highlighted the need to advance a similar initiative nationally which would strive to push crop yield boundaries in high yield potential grain growing environments.

With input from national and international cereal breeders, growers, advisers and the wider industry, this project is working towards setting record yield targets as aspirational goals for growers of wheat, barley and canola.

In addition to the research centres, the project also includes a series of focus farms and innovative grower networks, which are geared to road-test the findings of experimental plot trials in paddock-scale trials. This is where in the extension phase of the project we are hoping to get you, the grower and adviser involved.

Focus farm projects in the region have been set up by Southern Farming Systems working with industry. We will be looking to secure a small number of wheat entries this harvest for the HYC awards, which have been set up as part of the efforts to try and lift interest across the board in higher productivity.

The HYC awards aim to benchmark the yield performance of growers' wheat paddocks and, ultimately, identify the agronomic management practices that help achieve high yields in variable on-farm conditions across the country. This season HYC project officers are seeking nominations of 50 wheat paddocks nationwide (about 10 paddocks per state) as part of the awards program.

For more details on the project contact:

Rachel Hamilton: HYC Comms & Events, FAR Australia
(rachel.hamilton@faraustralia.com.au)
Nick Poole – HYC Project Leader and wheat crop research lead, FAR Australia
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Rohan Brill – HYC Canola crop research lead, Brill Ag (rohan@brillag.com.au)
Kenton Porker – HYC Barley crop research lead, SARDI (kenton.porker@sa.gov.au)
Jon Midwood – HYC Extension coordinator and Project Officer (TAS), Techcrop
(techcrop@bigpond.com)

The GRDC Hyper Yielding Crops project is a Grains Research & Development Corporation (GRDC) national investment and is led by FAR Australia in collaboration with:

Spring sown barley agronomy – Pome perspective

[1]Nick Poole, Tracey Wylie, [2]Kenton Porker
[1]Field Applied Research (FAR) Australia, Bannockburn, Victoria 3331
[2]SARDI, Plant Research Centre, Hartley Grove, Urrbrae, SA 5064

Spring sowing of barley is an important crop in UK cropping rotations, particularly on the generally lighter soils which can be cultivated and established relatively early in spring. The chalkland soils in East Anglia and the south of England are particularly favoured for the crop since unlike the other stony brash and sandy soils they tend to be less prone to drier spring conditions, particularly in the month of May when the crop develops quickly.

Rotation Position

The crop is typically grown for malt purposes as a second cereal crop after the break or following the grass phase in the rotation. As a second cereal the crop typically follows winter wheat in a crop sequence that allows both grass weed control over the autumn and winter but also volunteer wheat control that tends to be problematic in producing quality malting samples. Following the grass phase in mixed farming enterprises the crop is typically established following cultivation in the spring which allows the grass phase to be utilised over winter.

Crop establishment

The crop is typically established following cultivation in the spring with growers now encouraged to leave stubbles over winter for wild bird populations. Historically depending on the region some crops would be established following autumn ploughing allowing the frosts of the winter months to break down the larger soil clods and create a tilth for spring.

Sowing dates and seed rates

Sowing dates are difficult to translate to the southern hemisphere but sowing date traditionally depends more on soil conditions. In dry winters the crop can be established in January (approximately July in Tasmania), however it is more typical to regard February/early March (or Tasmanian equivalent of August/early September) as the primary sowing period. Very early establishment of spring barley creates crops that more resemble autumn sown crops, particularly with regard to disease burden.

True spring barley crops develop extremely quickly and as a general rule tiller far less than barley crops sown in the autumn, particularly those with spring germplasm. Although the phenology of the spring germplasm will vary and ultimately influence the degree of tillering, spring sown barley needs to be established at higher seed rates than crops sown in the autumn. Typical seed rates for the crop varies from between 300 – 400 seeds/m^2. Increasing to the upper end, or above this range for later sown crops where wet weather occurs in the spring can inadvertently delay planting.

Nutrition

As is the case with other spring crops, a greater proportion of the nutrition tends to be timed earlier in the crop's development cycle to ensure that nutrients are available for the rapid stem elongation period. Phosphorus and Potassium, if not spread in the stubbles prior to cultivation can be applied at sowing with nitrogen typically split 40% at sowing and 60% when the tramlines show at the three-leaf stage GS13. With later sown crops the proportion of nitrogen applied at sowing (broadcast) is increased to account for an even shorter tillering period (before the stem elongation period when the majority of nutrition is required).

Disease Management

Unlike crops sown in the autumn spring sown barley crops are far less disease prone and frequently reach stem elongation with very little foliar disease. In the UK and New Zealand this has allowed the use of very low rates of fungicides since there is less need for curative activity. The key to making a success of these very low rates (25-50% doses – caution UK label rates are higher than Australian label rates) is timing the first fungicide as the crop rows close over (assuming narrow row spacing up to 20cm). As the rows close over in late tillering/early stem elongation (GS23/30) the humidity in the crop increases and disease develops rapidly. In addition, since stem elongation occurs so rapidly compared to traditional autumn sown barley the timings of GS31 followed by GS39-49 can occur in little more than 14 days, therefore a GS30 start to the fungicide programme gives a better spray interval to the second spray which is equally essential as it protects flag -1 that emerges at GS33. In respect of being suited to two foliar sprays spring sown barley is no different to autumn sown barley. Since the crop tends to remain cleaner in the early growth stages it is less suited to seed treatments that give foliar disease control assuming the crop can be sprayed readily. If it can't then seed treatments such as fluxapyroxad clearly have a place. In Tasmania, as is the case in the UK and New Zealand, growers should monitor for reports of *Ramularia* as this disease can affect spring as well as autumn sown barley.

Plant growth regulation

Lodging is generally less of an issue in spring sown barley although brackling (where the straw bends over half way up the stem) is much more problematic. Prompt harvest is probably one of the main considerations where large acreages of spring barley are grown. PGR's have small effects but the variety can also be a key factor. The interaction between harvest date and PGR application is currently a research objective of the Hyper Yielding Crops project. Under irrigation making sure that the second fungicide has good persistence can prevent the deterioration of the straw at physiological maturity which in turn helps prevent brackling.

Spring sown barley research in the Hyper Yielding Crops project is irrigated removing at least some of the traditional stresses that a spring crop is exposed to. In New Zealand research on the Canterbury Plains, crop yields in excess of 10t/ha have been achieved and in some seasons in excess of 12t/ha in plots. Depending on the cost of water this makes the crop an attractive option, particularly in mixed farming systems where it can be grown after fodder crops over winter (provided the soil damage created by livestock does not reduce the yield potential. In the UK one of the attractions was lower input costs and better cash flow as lower input costs were carried for a shorter period of time compared to autumn sown crops. In Australia heat stress is higher, however in Tasmania the potential fit for the crop is far greater due to lower summer temperatures and the more varied crop rotations.

Irrigated wheat
key points for hyper yielding wheat

[1]Nick Poole, Tracey Wylie, Darcy Warren, [2]Brett Davey
[1]Field Applied Research (FAR) Australia, Bannockburn, Victoria 3331
[2] Southern Farming Systems (SFS), Longford, TAS 7301

"The Irrigated Eight" for Hyper Yielding Wheat

The following are eight key factors critical to achieving high yields from April sown irrigated wheat:

1. Pick a wheat cultivar that has four key attributes; very high yield, good standing power, good all-round disease resistance and the phenology that suits April sowing, this has primarily meant growing winter wheat cultivars in Tasmania.
2. Match the phenology or "time clock" to the sowing date. Spring wheat cultivars develop too quickly from early April sowing and flower in a period of higher frost risk. In contrast northern European winter wheats tend to flower too late from mid/late May sowings and don't fulfil their potential.
3. Early April sowing for wheat only requires slower development or "a longer-time clock" combined with standing power and disease resistance. RGT Relay is an example that has these attributes and fits this sowing window.
4. Higher final harvest biomass (whole crop) gives rise to higher yield potential but it is the crop's high final harvest biomass combined with higher harvest index (proportion of biomass that is grain) that produces hyper yielding wheat crops.
5. Hyper yielding wheat cannot be produced with artificial fertiliser alone, good farming rotations leading to high levels of inherent fertility are essential to underpin high yields (in addition to higher fertiliser rates that would be considered for dryland crops). First wheat rotation positions are essential to obtain hyper yielding wheat yields (ex pulse or brassica or longer-term pastures with high legume content history).
6. Disease management is one of the most important components of growing high yielding cereal crops in Tasmania. Target three key timings for fungicide intervention; first node GS31, flag leaf emergence GS39 and head emergence GS59.
7. Crop canopies that support 10t/ha grain yields are dependent on good straw strength and or sequences of growth regulators applied at pseudo stem erect (GS30) and second node (GS32).
8. Feed grain quality for livestock is more determined by growing season and agronomy than cultivar. Tasmanian feed grains are equal or better than grain from other states in terms of nutritive value (e.g. Apparent Metabolisable Energy (AME), % Starch).

1. Influence of germplasm traits

The key objective of the Hyper Yielding Cereal (HYC) project was to identify new germplasm lines that were more productive in an irrigated Tasmanian environment when sown in an April sowing window. So what traits are needed in order to maximise our productivity in this sowing window?
In order to successfully achieve high yielding grain crops from April sowing, cultivars must have four key attributes.

i) Very high yield potential

New germplasm selected for increasing productivity had to be proven to be higher yielding than commercial cultivars grown in the state over the initial screening period.

ii) Excellent resistance to diseases prevalent in the region

Tasmania has the longest growing season in Australia with wheat crops frequently being in the paddock for 9-10 months. This longer season combined with its naturally wetter climate makes disease resistance in germplasm more important than anywhere else in Australia, particularly against the wet weather necrotrophic diseases such as scald, net blotch and Ramularia in barley and Septoria tritici blotch in wheat.

iii) Good standing power to support 10t plus grain yields

On the mainland crops yielding 4-6t/ha may not expose weaknesses in standing power to the same degree as Tasmanian wheat crops yielding in excess of 10t/ha. Therefore good standing power is essential to exploit the higher yield potential afforded by this long season irrigated environment. If all other traits suggest high yield potential, but standing power is inadequate, the correct canopy management approach (sowing date, plant population and nutrition) will be essential, along with plant growth regulation.

iv) Slower rate of development or phenology that better matches a longer growing season

Screening nurseries conducted in the project identified winter wheat lines/cultivars sourced from all over the globe as having more yield potential than spring wheats when crops were sown in April, this was particularly the case if the grower wished to leave the crop ungrazed.

2. Matching the phenology of the cultivar to the sowing date

Selecting cultivars that have the correct "internal time clock" or phenology for a chosen sowing date is essential in order to match crop development windows to the optimum environmental conditions for growth. The Hyper Yielding Cereal project has focussed on April sowing dates in order to maximise grain yield (early April 4-6th and late April 25-27th).

Spring wheat cultivars sown in April will invariably develop too quickly, particularly if sown before late April. April sowing dates therefore result in spring wheats being at higher risk of frost damage, particularly during flowering. If not frosted then the period for stem elongation and grain fill can occur too early to maximise growth in these development windows. May sowing dates are generally better matched to spring wheat germplasm. The spring wheat Beaufort has generally performed very well when sown in Tasmanian NVT trials sown in May along with shorter or intermediate rate wheats.

In contrast winter wheat cultivars sown in April have a vernalisation requirement (period of cooler weather) that prevent them developing too quickly, more ably enabling them to fulfil the yield potential of April sowing. The winter wheat cultivars can be further split into shorter season winter wheat cultivars that still perform strongly when May sown and longer season cultivars that require April sowing in order to fulfil their potential.

3. Optimum flowering date window

In dryland scenarios on the mainland there are well established benefits to optimising flowering date in a specific calendar window in order to balance frost risk (risk of flowering too early) and heat/drought stress (risk of flowering too late). Evidence from the irrigated Hyper Yielding Cereal project is that whilst the same general principles apply, the use of irrigation results in optimum flowering windows not being as tightly defined as they would be for dryland scenarios, in other words irrigation assists to offset drought stress. This can be particularly noticeable in seasons with warmer more drought stressed grain fill periods when irrigation helps alleviate the moisture stress associated with later flowering periods. The data generated from the HYC screening trials in 2016 & 2017 enabled us to select four wheat cultivars for further studies. Using data from all 4 years it is clear that there are key differences in phenology and flowering date based on April sowing dates at Hagley Tasmania.

Flowering date windows for April sowing (plus and minus seven days either side)

	Early April sowing (4-6th April)	**Late April sowing (25-27th April)**
Anapurna	25 October	30 October
RGT Accroc	30 October	5 November
RGT Calabro	5 November	10 November
RGT Relay	15 November	30 November
Manning (Control)	5 November	10 November

4. Influence of harvest dry matter and harvest index on optimum grain yields

So, do big biomass crops lead to higher grain yields under irrigation? Higher final harvest dry matter (DM) leads to higher yield potential but it is the germplasm selected and agronomic management practices that influence the partition of this dry matter into grain. Therefore, bigger crops potentially lead to greater grain yields but germplasm choice and management still dictate how much of this dry matter will be converted into grain. What factors increase harvest index? To date the biggest factors tested affecting harvest index in hyper yielding wheat crops were germplasm, fungicide application and grazing, however grazing invariably reduces final harvest dry matter as harvest index increases.

5. Nutrition and rotation for hyper yielding wheat – more fertiliser is not the only answer!

Clearly you can't grow hyper yielding crops without higher levels of applied crop nutrition to support higher yield potential, however the project results made clear this nutrition could not be applied purely as bag fertiliser! Despite the removal of 350-450kg N/ha in hyper yielding wheat trials, it was not possible to demonstrate yield responses above 225-250kg N/ha applied as urea, indicating the very high wheat yields (13-17t/ha) in the project can only be achieved with good soil fertility that supplies the additional nutrients required. Recent analysis of independent trials on wheat in the UK produced similar findings i.e. high wheat yields were produced on inherently fertile soils and that purely adding more nitrogenous fertiliser could not be guaranteed to generate the same results in the absence of that inherent soil fertility provided by rotation.

6. Disease management maximises yield potential

Irrigated wheat crops in Tasmania have longer growing cycles than dryland crops on the mainland and as a result crops stay greener for longer (9-10 month growing seasons). A longer growing season results in crops with higher yield potential being exposed to fungal pathogens for longer. This makes disease management one of the most important factors in maximising yield potential and achieving hyper yielding wheat and barley crops in an irrigated Tasmanian scenario, unless of course crops have good disease resistance. With cultivars susceptible to Septoria and Leaf rust it is not uncommon for three fungicide applications to be the most economic option. Greater use of fungicides has however meant that Tasmania is on the frontline with regards to slowing down and preventing fungicide resistance developing. ***Adopting good anti resistance practices when using fungicides and considering Integrated Disease Management (IDM) principles will be the key to achieving hyper yielding irrigated cereals going forward.***

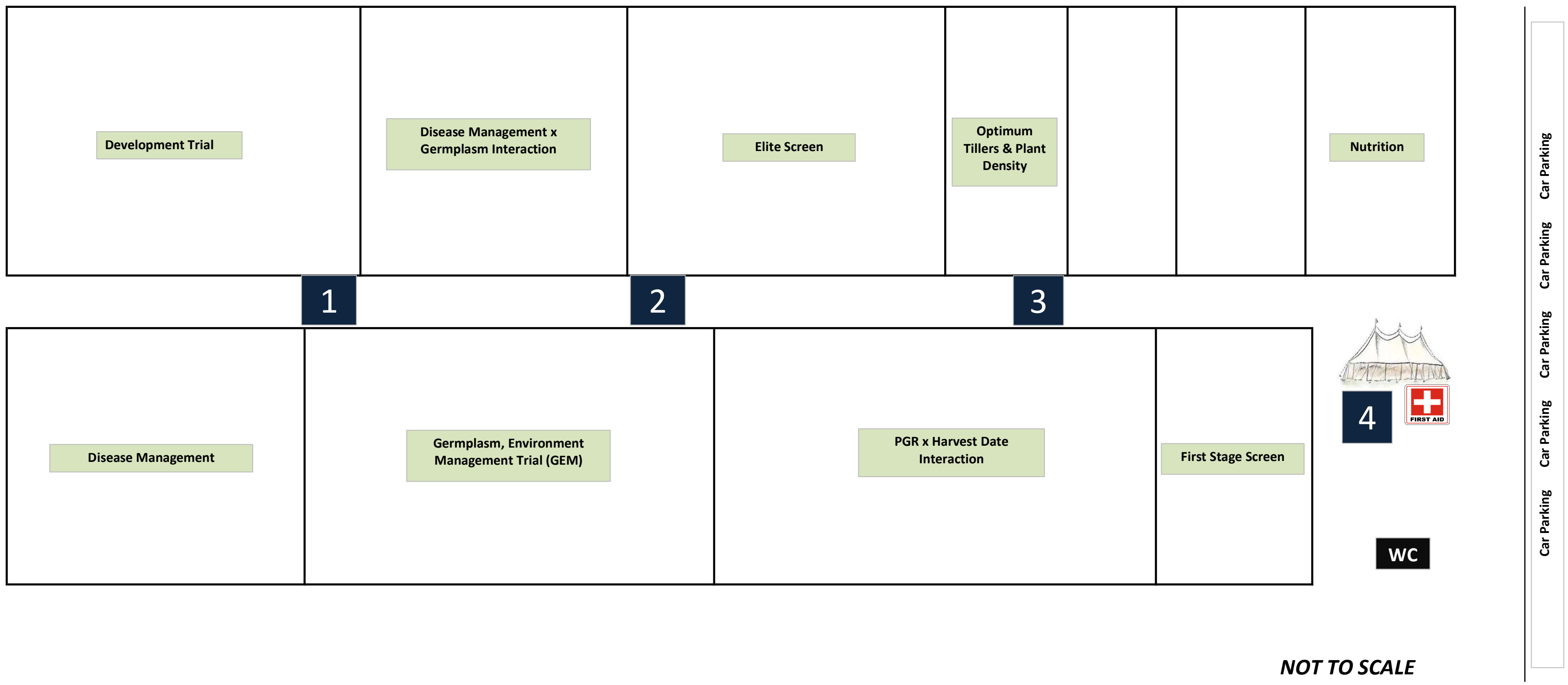
7. Keeping hyper yielding crops standing

The majority of wheat crops in Australian broadacre farming are grown under conditions not usually associated with yield reductions due to lodging. However, in high production systems such as irrigated crops and cereals grown in high rainfall zones, the risk of yield reductions due to lodging is considerably higher, especially when seasonal conditions favour such events or cultivars are more predisposed. RGT Accroc and Manning sown in April are lodging prone and have shown good response to plant growth regulators (PGRs) in this sowing window when yields are in the range of 10-12t/ha. Growers should target plant populations between 100-150 plants/m^2 when sowing in April and consider sequencing PGRs at GS30 & GS32 without exceeding maximum dose rates for PGRs in select cultivars (see individual cultivar descriptions).

TASMANIA HYC
RESEARCH CENTRE

FEATURING HYPER YIELDING CROPS

(a national GRDC investment)



FAR AUSTRALIA GRDC SFS

TASMANIA HYC
RESEARCH CENTRE

FEATURING HYPER YIELDING CROPS

(a national GRDC investment)

TIMETABLE

In-field presentations	Station No.	10:30	10:45	11:15	11:45	12:15	12:45	1:30	2:00	2:30	3:00	3:30
			SESSION 1					SESSION 2				
Nick Poole, FAR Australia	1	Welcome and opening address	1			2	Lunch kindly sponsored by Nutrien Ag Solutions	1			2	Closing address and refreshments kindly sponsored by Nutrien Ag Solutions
Jon Midwood, Techcrop	2		2	1				2	1			
Darcy Warren, FAR Australia Brett Davey, Southern Farming Systems	3			2	1				2	1		
Rohan Brill, Brill Ag	4				2	1				2	1	
In-field presentations	Station No.	10:30	10:45	11:15	11:45	12:15	12:45	1:30	2:00	2:30	3:00	3:30

We would be obliged if you could remain within your designated group number throughout the Session.

1	GROUP 1
2	GROUP 2

Thank you for your cooperation.

FAR AUSTRALIA GRDC GRAINS RESEARCH & DEVELOPMENT CORPORATION SFS

8. Tasmanian feed grain wheat – achieving good feed grain quality for livestock

Over the past four years the nutritive value of cereal grains collected from Tasmania for the Feedgrain R&D Partnership Project were often the highest amongst the States in Australia, or at the very least, were in the upper levels in most years compared to cereal grains collected from other States. Over 250 wheat and barley samples were collected over four seasons from the Hyper Yielding Cereals (HYC) Project that had been harvested in the research trials at Hagley, Tasmania. These samples were then sent for NIR analysis for the major nutrients to Feed Quality Service laboratory located at Wagga Wagga, NSW. There was sufficient variation in the energy and starch levels in the wheat samples to justify price differentials for feeding to livestock if these wheat samples could be segregated. Further examination of the data failed to identify any variety that had an inherently higher energy or starch value. The yield, agronomy and growing conditions would have a much greater influence on the nutritive value of cereals than variety type.

Irrigation

Although access to irrigation is clearly a route to higher yields, it was not a variable that was specifically experimented upon in the Hyper Yielding Cereal project and hence is not specified in the above eight key points. The HYC research site was subject to supplementary irrigation over the four years, which in the years 2017 – 2019 may have prevented the project from achieving the highest yields possible. Where full irrigation is available for wheat it is essential to have a soil water monitoring sensor system in place in order to identify soil moisture deficits.

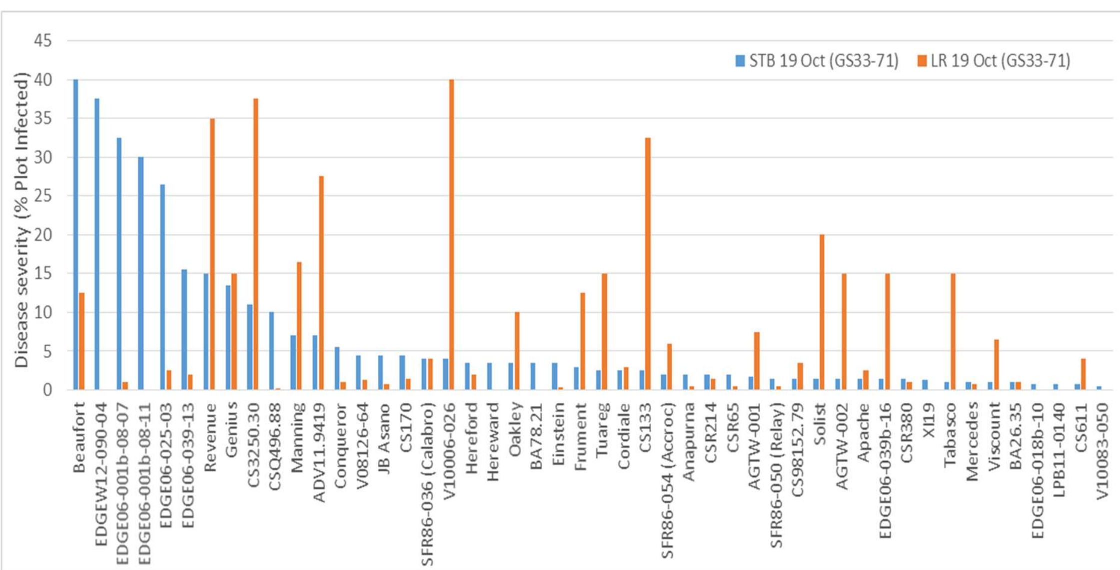
Disease resistance and response to fungicide in irrigated wheat

[1]Nick Poole, Darcy Warren, Tracey Wylie, [2]Brett Davey
[1]Field Applied Research (FAR) Australia, Bannockburn, Victoria 3331
[2] Southern Farming Systems (SFS), Longford, TAS 7301

i) Cultivar resistance

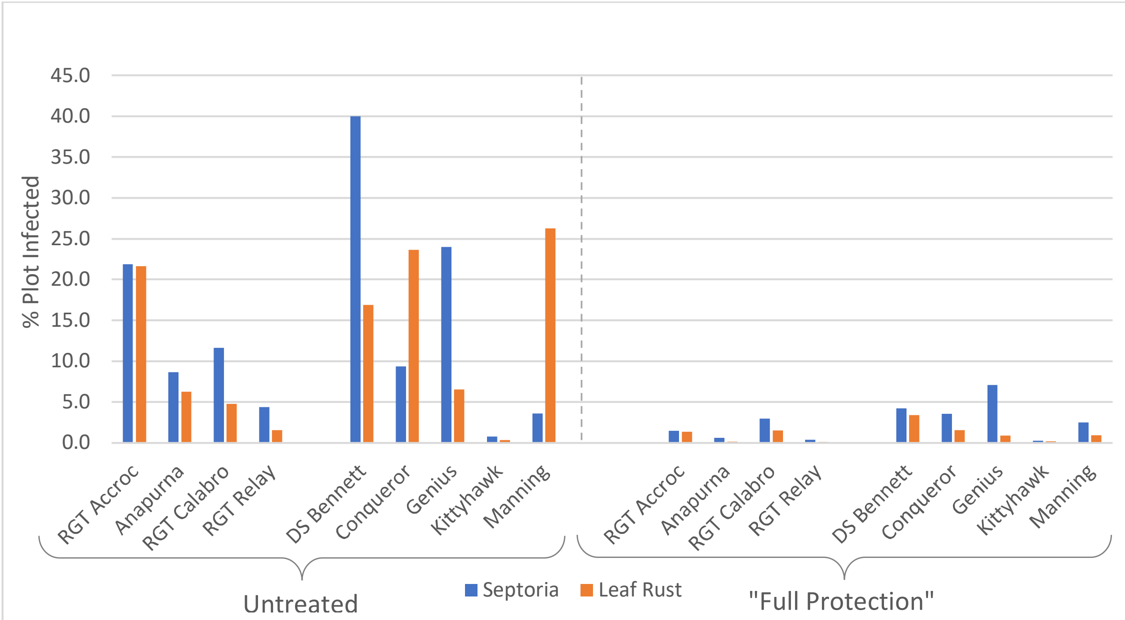
Irrigated Tasmanian cropping systems are one of the most disease prone in Australia by virtue of their environment. Irrigation not only keeps crops greener for longer but extends the period that crops are exposed to foliar pathogens. In addition, April sowing dates are invariably more disease prone than May sown crops making cultivar disease resistance in the Tasmanian environment of supreme importance. The principal wheat diseases encountered in the Hyper Yielding Cereal project were Septoria tritici blotch, leaf rust and stripe rust caused by the pathogens *Zymoseptoria tritici, Puccinia triticina and Puccinia striiformis*. Wheat Powdery Mildew (WPM) has only been present in Trojan, Beaufort and Kittyhawk in the screening conducted.

The HYC project identified a group of cultivars that performed strongly in the two years of screening conducted in 2016 and 2017 they were, **RGT Accroc, Manning, RGT Calabro, Anapurna** and **RGT Relay**. In 2018 and 2019 these cultivars were compared to **DS Bennett, Genius** (northern European line)**, Conqueror** (northern European line), **and Kittyhawk.** These cultivars were selected not purely for their yield potential but also their disease resistance and grain quality. The original disease screen was conducted on all the cultivar/lines tested in order to remove the very susceptible lines. In 2018 and 2019 the higher yielding performers were subject to in depth analysis plus and minus fungicide with all assessments conducted during grain fill.



2016 % Plot infection of Septoria tritici blotch (STB) and leaf rust (LR) in untreated plots

2019 % Plot infection of Septoria tritici blotch (STB) and leaf rust (LR) in untreated and full protection plots



Notes: Full protection was based on a seed treatment and three foliar fungicide applications at GS31, GS39 and GS59.

The primary disease in the untreated DS Bennett was stripe rust (data not shown).

Head to Head comparisons (irrigated Tasmanian environment - *% plot infection at grain fill in untreated plots 2 yr mean 2018 & 2019)*

Septoria tritici blotch

Leaf rust

*** RGT Relay has been noted to be very susceptible to late leaf rust infections due to its longer season length, though it is typically clean during stem elongation.***

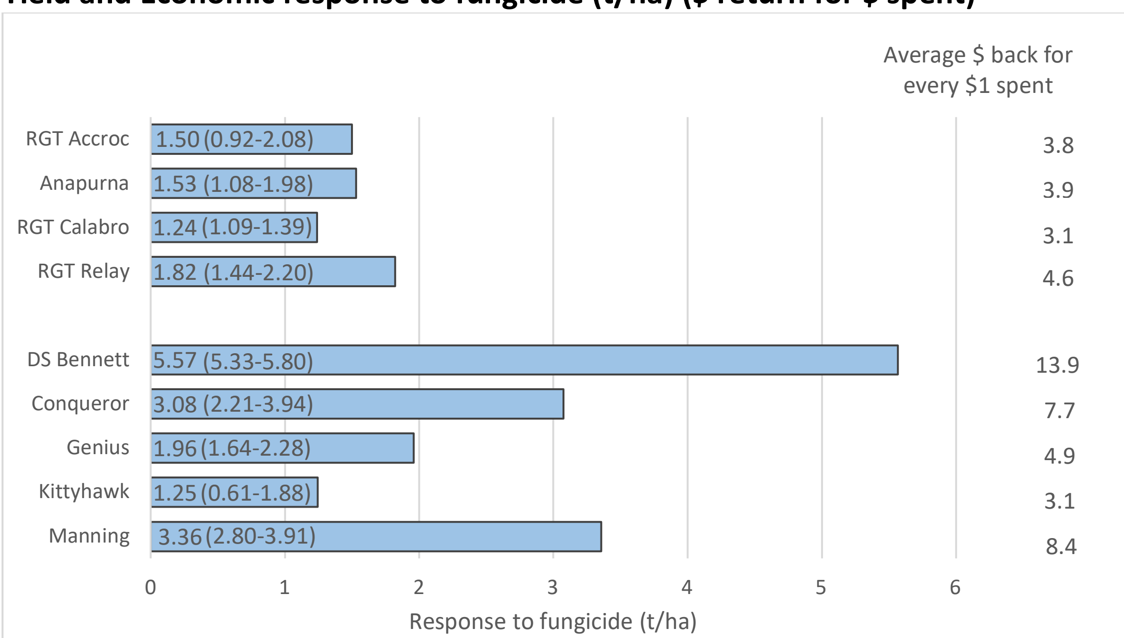
Stripe rust

DS Bennett was highly susceptible to stripe rust in 2019. Low levels of the disease were observed in Genius with traces in Kittyhawk.

ii) Response to fungicide (yield effect & economics)

The different susceptibility to diseases has resulted in the selected cultivars producing large differences in response to fungicide in this environment. The following comparison is the response to fungicide application and the economic return over the last two years. The effect of fungicide application was evaluated in terms of margin ($/ha) after chemical and application cost.

Yield and Economic response to fungicide (t/ha) ($ return for $ spent)



2018 and 2019 average response to fungicide (t/ha), sown late April (25th -26th April). Economic return from fungicide (two-year average of dollar back for every dollar spent) calculated based on $350/t price for feed wheat and costs of fungicide at $95/ha and applications at $45/ha.

“Erect Head” control in April sown wheat

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Over the last two seasons there have been a number of observations indicating that shortly before harvest wheat crops at our SA Crop Technology Centre (CTC) and the Hyper Yielding Cereals research site in Tasmania produce a number of erect heads with poor grain fill. These symptoms show up only 3 -4 weeks before harvest, before which the crop can appear generally healthy.

In 2018 it was noted that the cultivars Manning and DS Bennett had lower levels of these erect heads at harvest, suggesting that there was a genetic basis to their protection. There are a number of possible causes (frost effects, poor pollination, stem base disease) that Hyper Yielding Crops (HYC) research is investigating, however it is our understanding that Manning and DS Bennett are the only wheat cultivars with BYDV tolerance that are commercially available in Australia (formerly also MacKellar). In 2019, research was established in Tasmania and SA to look at this in more detail to pin down whether BYDV was linked to erect heads at harvest and whether BYDV tolerant wheat offered a significant advantage. Lower levels of BYDV at the SA CTC led to inconclusive results in 2019 but in Tasmania BYDV tolerance conferred dramatic effects with an early April sown Manning crop compared to a non-tolerant cultivar RGT Relay. In the non-tolerant cultivar where different insecticide regimes (Table 1) were employed, it was clear that where BYDV was fully controlled the number of erect heads at harvest was reduced (Figure 1). The effect of controlling BYDV and erect heads at harvest had significant effects on grain yield (Figure 2) indicating the value of this trait in wheat germplasm grown in the HRZ.

Table 1. Trial treatment list (ml/ha) conducted on BYDV tolerant (cv Manning) and non-tolerant (cv RGT Relay) cultivars.

TRT	Product and Rate (ml/ha)				
	Seed trt	**GS12**	**GS12+2 weeks**	**GS12+4 weeks**	**GS31**
1 & 10					
2 & 11		Karate Zeon 40	Transform 100	Dominex Duo 125	
3 & 12		Karate Zeon 40	Transform 100	Dominex Duo 125	Dominex Duo 125
4 & 13	Pontiac				
5 & 14	Pontiac		Transform 100		
6 & 15	Pontiac		Transform 100	Dominex Duo 125	
7 & 16	Pontiac		Transform 100	Dominex Duo 125	Dominex Duo 125
8 & 17	Pontiac	Karate Zeon 40	Transform 100	Dominex Duo 125	
9 & 18	Pontiac	Karate Zeon 40	Transform 100	Dominex Duo 125	Dominex Duo 125

Please note that the treatment list for this trial was established to identify whether viral issues were the cause of erect heads at harvest. This level of insecticide input was adopted purely for research purposes and presentation of results is not in any way a recommendation.

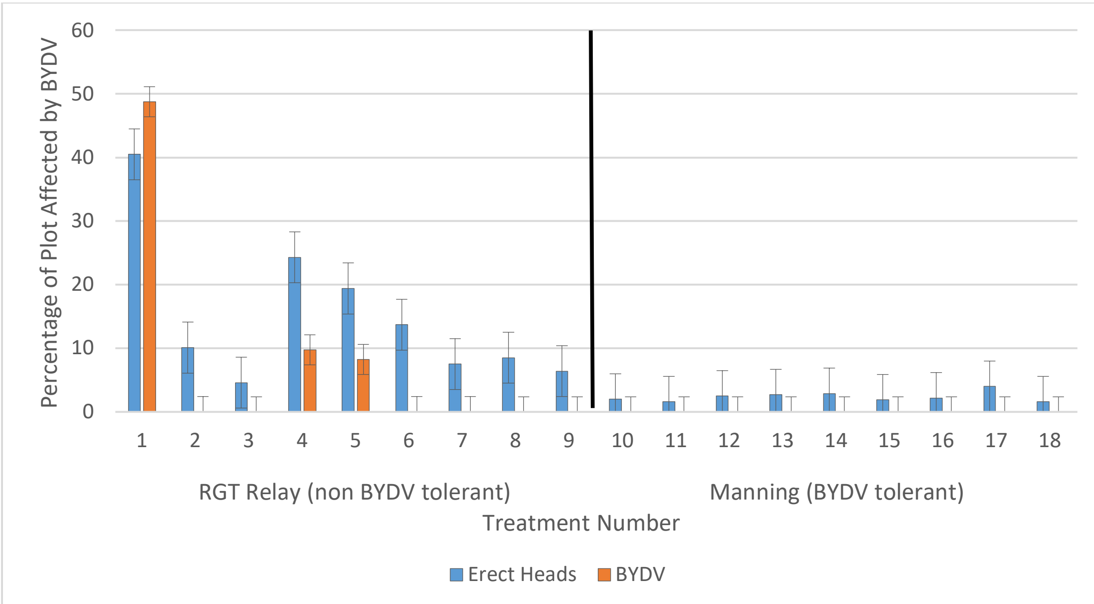


Figure 1. Percentage of plot showing erect heads at crop maturity (GS99) compared to plot BYDV infection, assessed on October 25 (GS37) - HYC Research site, Tasmania 2019.

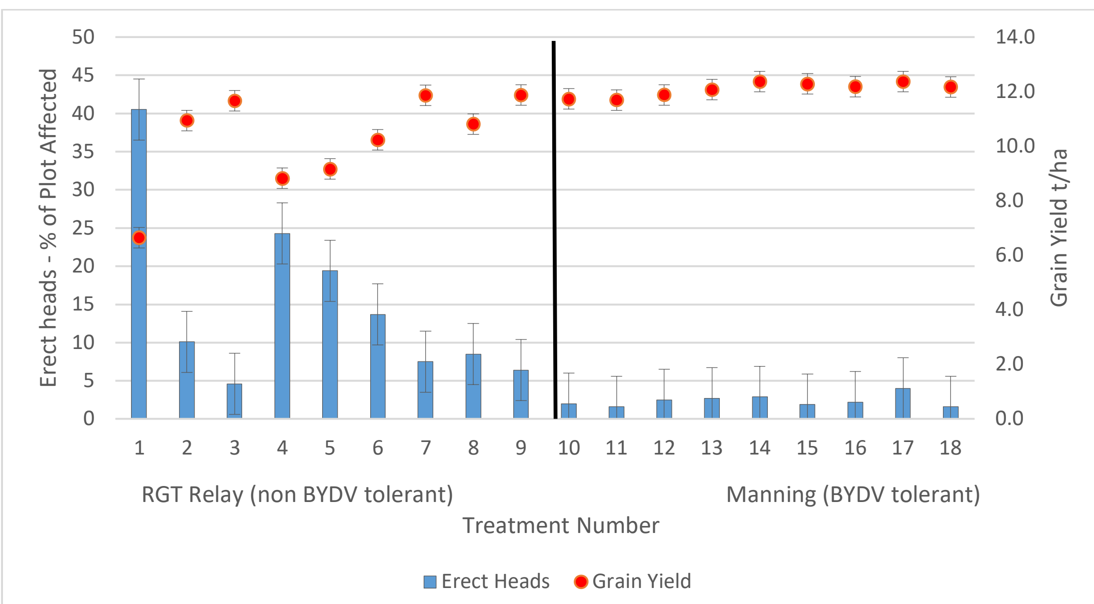


Figure 2. Percentage of plot showing erect heads at crop maturity (GS99) in relation to final grain yield (t/ha) – HYC Research site, Tasmania 2019.

With the introduction of BYDV tolerance into the UK with wheat cultivar RGT Wolverine (first European BYDV resistant cultivar to be released), it is ironic that the only other breeding programmes to achieve this anywhere else in the world was the CSIRO HRZ wheats' programme (now discontinued). The ban on neonicotinoid seed treatments in Europe has made this wheat trait even more important. It is our understanding that the technology used in Europe that has resulted in BYDV tolerance is the same as that originally developed here in Australia by CSIRO. The CSIRO BYDV tolerance involved translocating a genetic segment from *Thinopyrum intermedium* (a distant relative of wheat*)* containing Bdv2 onto a wheat chromosome, via a research line. Recent advances in molecular markers have fast tracked some of these developments. With the prevalence of the green bridge in HRZ regions this breeding trait is ideally suited to maximising HRZ grain production without the use of insecticides.

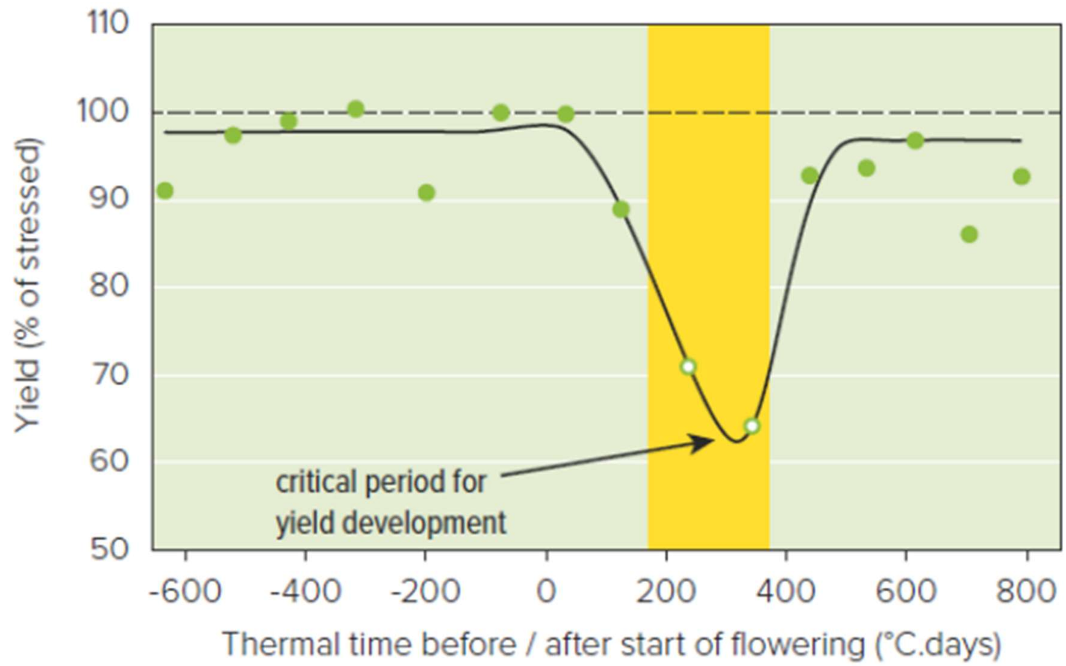
N.B. Please note that the high levels of insecticide usage in this experimentation was adopted to assess whether virus transmitted by aphids was indeed one of the principal causes of erect head issues in HRZ wheat production.

Hyper yielding canola

Rohan Brill, Brill Ag

The main aims of canola research in the Hyper Yielding Crops project is to determine how best to <u>build</u> crop yield potential, <u>convert</u> biomass into grain (harvest index) and <u>protect</u> crops from losing yield from disease (mostly blackleg and sclerotinia). The research focus in 2020 includes:

- Cultivar choice – a focus on identifying elite cultivars within variety groups. Choosing the right cultivar in Hyper Yielding Crop zones is imperative as this will have implications for biomass accumulation, conversion of biomass to grain and for disease management.
    - Winter hybrid canola will generally grow more biomass than spring canola in long season environments like Tasmania so will usually have higher yield potential. Grazing is also possible as vegetative growth is often more than what is required to maximise grain yield.
    - Winter hybrids are very slow European types; however newer hybrids like Phoenix CL, SF Nizza CL and Hyola Feast CL are several days quicker to flower than the commonly grown Hyola 970CL and SF Edimax CL.
    - All commercially available winter hybrids have Clearfield (imidazolinone) herbicide tolerance.
    - Spring canola can be hybrid or open-pollinated with no herbicide tolerance (conventional); triazine tolerance; glyphosate tolerance (GM) or Clearfield tolerant.
- Crop nutrition – a focus on managing nitrogen fertiliser so that the crop grows enough biomass for a high yield potential and at the right time to ensure a high harvest index.
    - A rule of thumb for canola is that crops require 72 kg/ha N per tonne of target grain yield (assumes a 50% efficiency of available N). A 5 t/ha canola crop requires 360 kg/ha N to be available through both the soil supply and fertiliser input.
    - The critical period for canola growth to set a high yield potential (high seed number) is in the period approximately 1 to 4 weeks after the start of flowering. The crop needs to have high nutrient availability during this period or yield potential will be compromised.



- Disease management – a focus on fungicide management and cultivar resistance (especially for blackleg).
    - Blackleg is the most widespread disease of canola production in Australia. It can infect seedling crops leading to crown canker and infect flowers, branches and pods during reproductive stages. Management is by sowing resistant cultivars, crop rotation, farm planning (e.g. block cropping), sowing/flowering date decisions and fungicides (seed/fertiliser applied and foliar).
    - Sclerotinia stem rot is generally more prevalent in warmer high yielding environments e.g. south-east NSW. It manifests as rotting of stems and is managed by crop rotation, sowing/flowering date and foliar fungicides.
    - Other diseases may become an issue in certain situations including the vegetative diseases downy mildew and white leaf spot and powdery mildew and Alternaria in the reproductive stages.

Finding the right germplasm and management for spring sown barley: a focus on crop development

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The Tasmania Hyper Yielding Crops (HYC) Research Centre builds on the platforms developed at the mainland HYC sites in NSW, Victoria, SA, and WA. The aim is to develop a new barley system to address the challenges and constraints associated with raising the yield frontier in barley.

The most common yield constraints to barley across all hyper yielding environments are disease, frost and heat stress, lodging, brackling and head loss. Yield increases in barley are possible but only likely to come from a combination of new management and genetic solutions such as different phenology patterns, row types, improved and sustainable use of fungicides, plant growth regulation (chemical and defoliation), increased nutrition and varieties better matched to sowing date.

Climatic constraints and opportunities for spring sown barley
The climatic conditions for spring sown barley are more favourable in Tasmania compared to other regions of Australia. However, there are some major constraints that will influence management and germplasm decisions.

1. Crop development is typically a lot faster and the growing season is considerably reduced relative to autumn and winter sown crops, this has implications for yield development, seeding rates and timings of fungicide.
2. Flowering and thus grain filling is likely to occur later than optimal in warmer and drier conditions than Autumn sown barley, this will require cultivars that can maintain grain weight under these conditions.

A key focus of the Tasmania Spring barley experiments is to identify germplasm adapted to this system and develop management practices that optimise the system. The obvious climatic differences between autumn/winter sown and spring sown barley are temperature, daylength and rainfall patterns (figure 1).

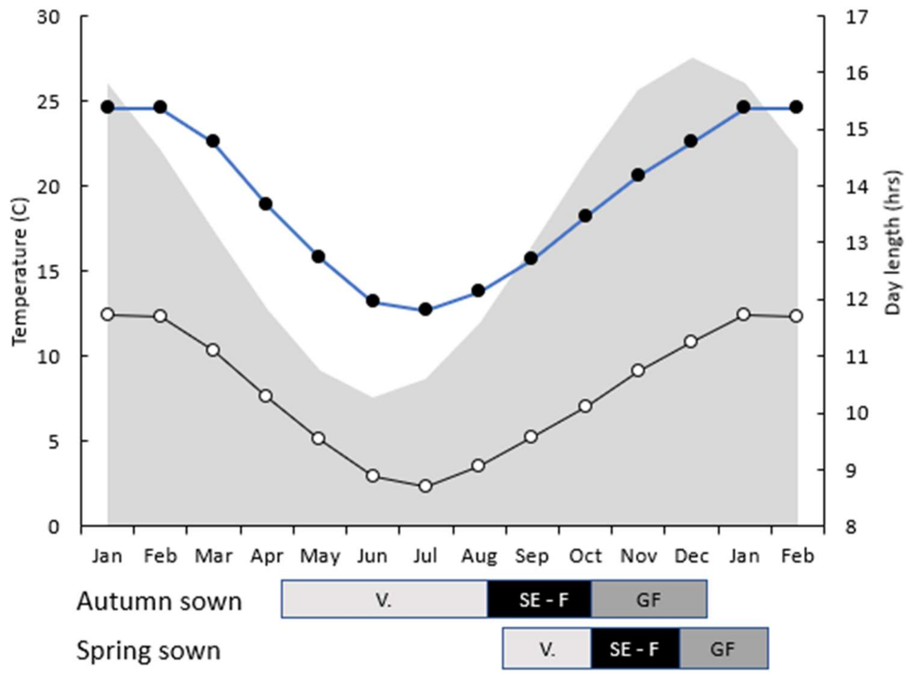

Figure 1. Schematic comparison of crop life cycle, vegetative (V), Stem elongation to flowering (SE-F), and grain filling in spring barley sown in Autumn and Spring. The mean max temperatures (●) and mean minimum temperatures (○) and shaded area represents the daylength (hrs) at Hagley Tasmania.

Finding adapted germplasm: Crop Development

Australian bred barley cultivars are unlikely to be suited to spring planting because they will develop too quickly during the critical periods for yield formation. This is due to strong breeding selection by Australian breeders requiring adaptation for autumn sown barley in the lower rainfall zones.

Variety responses to sowing date, temperature and photoperiod are likely to be vastly different under spring sowing scenarios. Using our current understanding of variety maturity rankings from Autumn plantings and describing a mean time to flowering for a variety is relatively meaningless unless the date of sowing and the location are presented.

Temperatures are warmer and daylengths are longer

Spring sown barley is sown into increasing day length and temperatures. Various combinations of genes are present which respond to changes in temperature and day length and work to either delay or promote flowering. Increased temperatures associated with spring barley will reduce the number of days to flower.

It is important to note plants do not measure time in the form of calendar days, but by thermal time, which can be measured as “degree days”. Thermal time is a way of measuring the physiological development of a plant by combining time and

temperature into a single number. In its simplest form it is the average temperature recorded during a day, accumulated over time.
Degree days = (Min Temp + Max Temp)/2

Typically estimating 'thermal time' requirements of all varieties for flowering and critical growth stages is not quite that simple as they respond differently to daylength (photoperiod) and vernalisation. Varieties differ in the degree in which they respond to day length. In very sensitive varieties, as the days lengthen, the crop requires fewer degree days to flower. Thus, a delay in sowing date, associated with an increase in mean photoperiod (Figure 1 and 2), will result in a reduction in the duration of the sowing-flowering period because of an increase in mean temperature as well as in mean photoperiod.

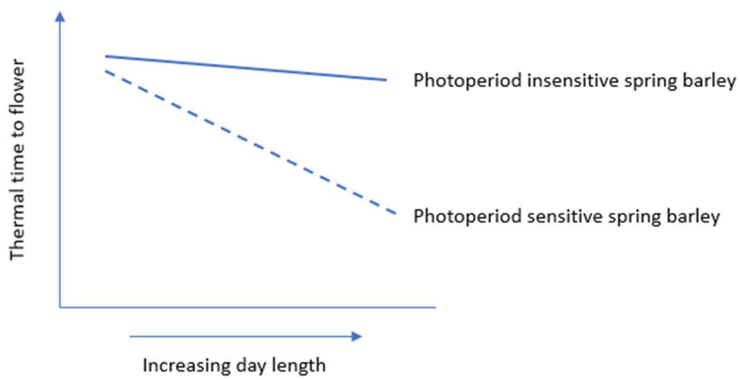

Figure 2. Schematic relationship between day length and thermal time to flower for a photoperiod responsive (sensitive) and non-responsive (insensitive) barley.

Once photoperiod or vernalisation requirements have been met there is still variation in maturity among varieties, commonly described as 'Earliness per se'. Australian bred cultivars typically have both increased sensitivity to photoperiod and a reduced thermal time requirement compared to European cultivars thus making them prone to rapid flowering under spring sown conditions.

If a variety is not sensitive to photoperiod, it should in theory take the same number of degree days to flower if it was planted in a shorter photoperiod as it would in a longer photoperiod (figure 2). This is typical of the European germplasm suited to spring barley plantings such as RGT Planet that will most likely be suited to spring planting.

What about vernalisation
Spring barley cultivars typically have little to no vernalisation responses. Vernalisation is the requirement by which exposure to low temperature (temperatures between 0 – 15^{0}C) promotes the advance to the reproductive stage. If a cultivar has a strong sensitivity to vernalisation, exposure to temperatures above approximately 15^{0}C will result in a delay in flowering. May to August are usually more than cold enough to satisfy any vernalisation requirement in Tasmania, but later plantings will take much longer to satisfy their vernal requirements and flowering would occur under suboptimal conditions. For these reasons, cultivars with a strong vernalisation requirement are unlikely to be suited to spring planting.

Implications for crop management and yield

The relationship between crop development and yield is different for spring sown barley. Spring barley has a much shorter life cycle – this has implications for yield development and crop management.

Vegetative phase and tiller production

After emergence, barley initiates leaves and tillers in its vegetative phase before transitioning into the early reproductive phase where it begins to develop potential spikelets. The transition occurs as early as the 3-4 leaf growth stage in fast developing cultivars like varieties like Rosalind. One of the key features of spring sown crops is that they spend less time in their vegetative phase (Figure 1) because temperatures are warmer and daylengths are much longer due to factors mentioned above. This means there are less tillers initiated, and yield potential is reduced. Cultivars that are less responsive to photoperiod will spend longer in their vegetative phase and have increased tillering, other management techniques such as increased N availability at sowing, and increased seeding rates will be important and are being investigated.

Achieving more grains per spike

In the early reproductive phase, barley continues to produce potential spikelets until awn structures begin to appear on the developing spike (awn primordium appearance), at which point maximum grain yield potential is determined. This occurs near the onset of stem elongation and marks the transition to the late reproductive phase (labelled SE – F in figure 1). This will happen very quickly under spring sown conditions remembering that the phase up until flowering is the critical period for determining grain number in barley because a proportion of the reproductive structures fail to survive to form grain. The length of the critical period can be manipulated by varietal differences in developmental genes but will become shorter with spring planting, in addition, leaf area during this period will need to be protected from disease to ensure all available resources are utilised for spike development.

Lengthening the critical period (duration stem elongation to flowering) has been shown as a possible mechanism to improve the number of grains per spike by increasing spikelet survival and hence increased grain number. There is a lack of up to date information on developmental patterns for well-adapted barley genotypes grown under field conditions to address this issue.

Grain fill and improving grain size

European varieties are likely to offer the best development type to maximise yield potential and crop cycle length, however the conditions during grain fill are still relatively warm compared to other spring barley production zones in Europe even with the benefit of irrigation. There are likely to be challenges in achieving acceptable grain size and maintaining grain weight under these conditions and Australian cultivars may be better suited if their development pattern is acceptable.

2020 Tasmania Hyper Yielding Research Centre, Hagley, Tasmania

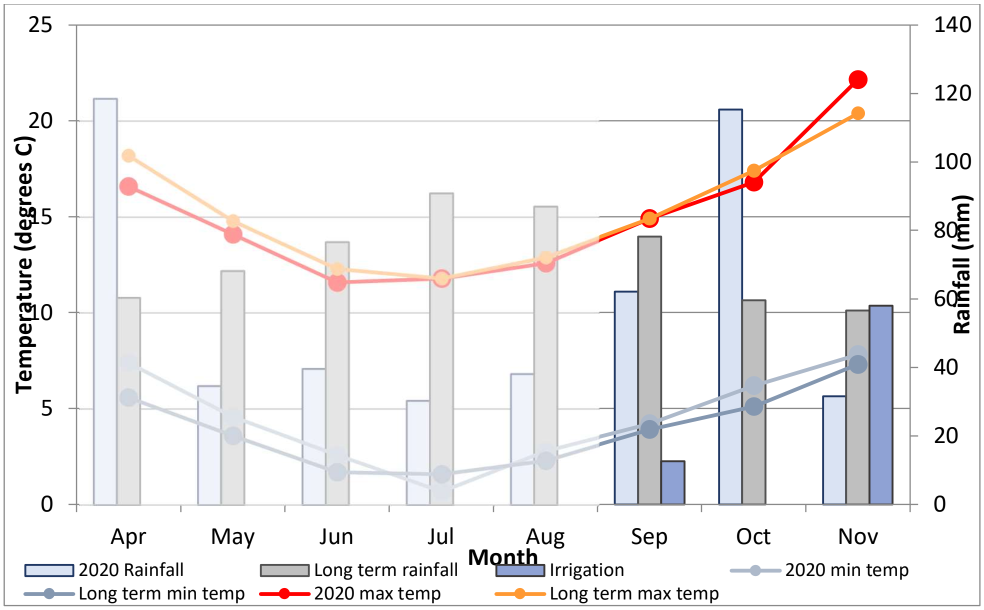

Figure 1. 2020 growing season rainfall and long term rainfall (1978-2020) (recorded at Westbury (Birralee Road)), 2020 min and max temperatures and long term min and max temperatures recorded Cressy Research Station (1999-2020) for the growing season so far (April-November). *Rainfall and irrigation September to November= 279.0mm.*

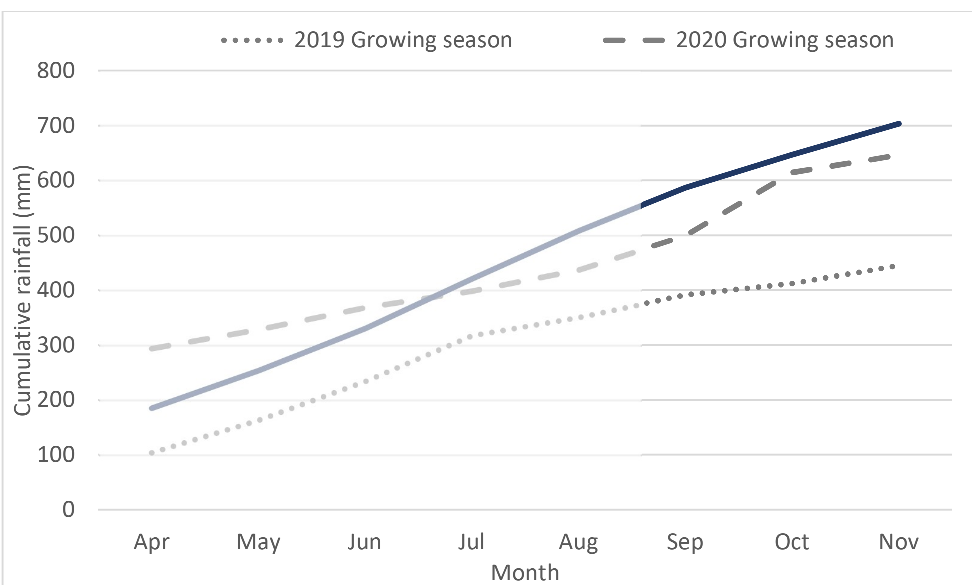

Figure 2. Cumulative growing season rainfall for 2019, 2020 and the long-term average for the growing season so far (April-November).

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