RYEGRASS & CEREAL DISCUSSION GROUPS 2020

Friday 11 September
Courtesy of Tom Webster, Darfield
Courtesy of David Birkett, Leeston

Wednesday 16 September
Courtesy of Hugh Wigley, Makikihi

Friday 18 September
Courtesy of Andy Innes, Barrhill
Courtesy of Angus McKenzie, Eiffelton
SIRC members:
RYEGRASS

Closing date

Weed control and herbicide resistance

Late heavy rolling from GS31

Plant Growth Regulator Trinexapac-ethyl (TE)

Application of nitrogen (N) fertiliser

Fungicides

Irrigation

Light seed

Harvest and harvest loss

CEREALS

Nitrogen management in milling wheat crops

Using a partial nutrient balance as a measure of nitrogen use efficiency

Disease control in autumn sown wheat

Latest fungicide programmes for disease management in autumn sown wheat

Managing BYDV in cereals sustainably – insect identification and IPM

Disease control in autumn sown barley

Latest fungicide programmes for disease management in autumn sown barley
Ryegrass 3000 meetings
Phil Rolston, Richard Chynoweth (FAR) and Murray Kelly (PGGW Seeds)

Closing date
- **Perennial ryegrass (PRG).** Nui flower date - optimum closing date ca. 1-5 October. This can be 3 to 5 days later around Methven and South Canterbury if irrigated.
- **Later flowering PRG (Nui + 1 to 21 days).** Closing delayed by the approximate difference in heading date.
- **Later flowering cultivars (Nui 21+ days).** Closing dates have not been well defined for these later heading dates, but appear to be more variable in their response. Unless there is specific information, delay closing by the relative number of days to Nui if irrigated.
- **Italian/Annual ryegrass.** Closing date between 20-30 October (Two farmers trials delaying closing from farmers date (10-18 Oct) by 10 to 12 days added 830 and 1275 kg/ha). 2019/20 trial with two cultivars showed that October defoliation increased seed yield by 90% compared to nil. This compared to a 31% increase in seed yield by applying PGR.
- **Not enough sheep/no sheep?** Your options are 1. silage (cut high 6+ cm, keeping wheel traffic on same lines as damage from wheels is similar to heavy rolling and causes earlier close than if grazed with sheep); 2. top (but better to top twice than once if the crop is too tall, to reduce the amount of herbage shading regrowth, and/or use TE early in a split application (Growth stage GS 31 and again GS 32/33).
- **Closed early?** Be prepared to use higher PGR rates.

Weed control and herbicide resistance
- **Top 5 weeds in perennial ryegrass seed lots:** A survey of 2019 PandG Certificates show *Vulpia* hairgrass (42% of seed lots); field madder (*Sherardia arvensis*) (20%); Poa annua (19%); soft brome (*Bromus hordeaceus*) (11%); and lesser canary grass (*Phalaris minor*) 9% are the most prevalent weeds.
- **Managing Vulpia hairgrass and volunteer cereals without Teedal®:** Delay autumn sowing to encourage weeds, crop volunteers and cereals to germinate. Trials on hairgrass control suggest the use > 3.5 L/ha of ethofumesate pre-emergence followed by atrazine or prometryn is effective on seedling hairgrass. This research is continuing.
- **New broadleaf herbicide Paradigm™ (Group B+O) for ryegrass.** Apply between 2 tillers (GS22) and GS 30 (but not later). Note 7-day withholding period.
- **Wild oat control:** This year Stratos® and Crusader™ (flamprop-based products) are in very short supply; fenoxprop products (Puma® etc) have a 42-day withholding period.
• **Herbicide resistant ryegrass:** In a 2020 survey, in South Canterbury 2/3 of cereal crops had ryegrass plants in them and over 50% of the ryegrass found at harvest in these crops contained plants that were resistant to Group A herbicides (especially haloxyfop and pinoxaden – Twinax®) and Group B herbicides (idosulfuron – Hussar® or pyroxsulam – Rexade™). These ryegrass plants have the potential to enter into ryegrass seed crops and require active management.

**Late heavy rolling from GS31**
• Don’t. Seed yields can be reduced by 25% (especially for >10 T rollers).

**Plant Growth Regulator Trinexapac-ethyl (TE) (Moddus® and other generic TE products)**
• **TE rate is critical.** Every day’s delay in the crop reaching 50% lodging adds 23 to 40+ kg seed/ha.
• **Moddus® Evo and Optimus® are the only TE product registered for use at rates higher than 200 g TE/ha (800 mL/ha).** They have a label rate of 400 g TE/ha (2.3 L/ha of Optimus® 175 EC) and 600 g TE (2.4 L/ha Moddus® Evo).
• **Early flowering perennial (Nui 0 to+14 days) and turf ryegrass.** One application at GS32 at 1.6 L/ha (400 g TE/ha).
• **Late flowering perennial forage (Nui >+14 days).** Split application 2 or 3 times TE alone or TE + CCC (chlormequat – Cycocel®). 0.8 L/ha TE + 2 L/ha CCC starting 5 to 7 days after closing (Table 1).
• **Late flowering, very bulky crops.** Optimum TE is higher (1.9-2.4 L/ha) compared with lower bulk crops. Annual ryegrass - optimum 1.2 to 1.6 L/ha; perennial ryegrass usually 1.6 L/ha (more if closed early, too much bulk at TE application >3500 kg DM/ha; Late closed (end October-early Nov) no advantage with split, but earlier closed (mid-October) showed an advantage with a triple split (see Table 1 - 2016/17 trial with cv ‘Hogan’ triple split application 3 x 0.8 L/ha TE in 2017/18 Table 2).
• **Late season cultivars (21+ days).** A two or three application split is useful for maximising seed yield.
• **Turf:** Optimum 1.2 L/ha for four cultivars (2 NZ and 2 Danish).
• **Tall fescue:** 300 g/ha (1.2 L/ha) TE resulted in a 350% seed yield increase (in 2011/12). In earlier closed bulky crops, there can be a seed yield advantage using Cycocel®-CCC (1.5 L/ha) + TE at 1.2 L/ha followed by TE at 1.2 L/ha.
• **Cocksfoot:** Cycocel®-CCC (1 L/ha) + TE (0.4 L/ha) is applied twice (GS32 and GS38/39) (seed yield response was 50 to 130% in 4 trials).
• **Fungicide with PGR:** 1/3 to ½ full label rate added for GS 32 application. Trials that have compared different fungicide types suggest no difference between using a triazole, SDHI or strobilurin with the PGR.
• **Wild oat control:** Need 12 days between wild oat spray and TE application.
Table 1. Machine-dressed seed yield (MD SY) (main effects average across two closing dates) for perennial ryegrass cv. Base after different TE Moddus® plant growth regulator treatments. The trial was located at Leeston in the 2016/17 season.

<table>
<thead>
<tr>
<th>Trinexapac-ethyl (L/ha)</th>
<th>MD SY (kg/ha)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>nil</td>
<td>1240 e</td>
</tr>
<tr>
<td>0.8</td>
<td>1890 d</td>
</tr>
<tr>
<td>1.6</td>
<td>2220 c</td>
</tr>
<tr>
<td>2.4</td>
<td>2380 bc</td>
</tr>
<tr>
<td>3.2</td>
<td>2370 bc</td>
</tr>
<tr>
<td>2.4 (Split x2)</td>
<td>2560 b</td>
</tr>
<tr>
<td>2.4 (Split x3)</td>
<td>2840 a</td>
</tr>
<tr>
<td>LSD (p=0.05)</td>
<td>268</td>
</tr>
</tbody>
</table>

*Note: different letters denote treatments with statistically different machine-dressed seed yields

Table 2. Machine-dressed seed yield (MD SY) of annual ryegrass cv ‘Hogan’ following Moddus® plant growth regulator treatments, at Tinwald in the 2017/18 season.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Date and growth stage of crop at time of PGR (L/ha) treatment</th>
<th>MD SY (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>16.11.17</td>
<td>27.11.17</td>
</tr>
<tr>
<td></td>
<td>GS 31</td>
<td>GS 32</td>
</tr>
<tr>
<td>1</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>2</td>
<td>-</td>
<td>0.8</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>1.2</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>1.6</td>
</tr>
<tr>
<td>5</td>
<td>-</td>
<td>2.4</td>
</tr>
<tr>
<td>6</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>7</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>8</td>
<td>0.8</td>
<td>0.8</td>
</tr>
<tr>
<td>9</td>
<td>0.8</td>
<td>0.8</td>
</tr>
</tbody>
</table>
|           | LSD 5%   |          |         | 297          
**Application of nitrogen (N) fertiliser**

- The general rule of thumb for ryegrass (based on 28 field experiments)

  \[
  \text{applied } N/\text{ha} = 172 - \text{mineral } N (0-30 \text{ cm})
  \]

- Reduce applied N calculated above by ~20 kg N/ha for soils with mineral N plus mineralizable N values that are between 100 to 150 kg N/ha and by ~30 kg N/ha if incubation N >150 kg N/ha.

- **Timing of N is not critical** provided there is not a serious N deficiency, although too much N too early can cause earlier lodging and this will depress seed yield.

- **Better to delay final N until TE /Moddus® applied to reduce lodging.**

- Agrotain® additive to urea (SustaiN®/ N-Protec®) increased seed yield 6% (average of 11 trials) compared with urea alone. The extra cost for N was $15/ha.

- **Plant uptake of N is similar in Oregon and NZ.** Above ground seed + straw holds 175 to 220 kg N/ha.

- **Several growers have made the transition to using liquid N as an alternative to granular urea.** This allows wider tramlines.

- **Browntop N inputs.** Apply spring N at ~190 kg N/ha applied when soil mineral N was 15 kg N/ha.

- **Cocksfoot spring N.** Apply spring N at ~ 110 kg N/ha when soil mineral N was 30 kg/ha (0-30 cm).

**Fungicides**

- **New fungicides for stem rust,** especially in the SDHI space, are being evaluated by several companies. An Elatus™ Plus (Syngenta) (SDHI family) label extension will include ryegrass and will have a 14 day withholding period; Caley® Iblon® (Bayer) (SDHI + triazole) with 35 days withholding; Vimoy® Iblon® (Bayer) (SDHI) with 35-day withholding.

- **Stem rust is the major disease and is driven by leaf-wetness at sunrise, and by warm temperatures.** The prediction model for severity of stem rust infection based on the Oregon model was evaluated over the past two years and looks promising.

- **Previous trials showed a combined triazole + strobilurin/SDHI, especially at head emergence, gives seed yields that are > or = to triazole alone.**

- **Forage (NZ bred).** 1/3 rate fungicide with PGR + one application at head emergence; or 2 applications, head emergence and late flowering.

- **Turf and overseas bred forage.** May require 3 or 4 fungicide applications.
**Figure 1.** Number of lesions per 100 stems for the untreated control and treatment two (Proline® 0.4 + Seguris Flexi® 0.6 L/ha on 10 December, followed by Proline® 0.4 + Amistar® 0.7 L/ha on 23 December) for both dryland and irrigated turf ryegrass trials with standard deviations (bars). The trial was located at Chertsey, 2019/20. The fungicide schedule was created using the modified Oregon STEM RUST_G model adapted for Canterbury. Fungicides were applied as recommended by the model defaults.

**Figure 2.** Stem rust progression on perennial ryegrass cultivar Arena following treatment with four fungicide products applied once at full head emergence, grown near Methven in the 2009/10 growing season.
- **Blind seed disease management**: Triazole + carbendazim applied at flowering and carbendazim 500 ml/ha at 5-day intervals if wet weather.

- **Ergot management**: Fungicides commonly used for stem rust control in ryegrass reduced the incidence of ergots by between 50 and 100%. Over two trials (2018 and 2019) the combination of Comet® + Proline® (0.8+0.8 L/ha) applied at the start of flowering and 10 days later resulted in control levels of between 74 and 100%. Other stem rust fungicide combinations were also effective.

- **Check product withholding periods and consider cutting date as the timeframe to calculate withholding periods.** The products with the shortest withholding period (14 days) are carbendazim, Seguris Flexi® and Elatus™ Plus.

- **Endophyte management**: Discuss with your seed company rates and timings of fungicides recommended for their endophyte strains.

### Irrigation

- **Moisture deficit and seed yield**: Any moisture deficit (either before flowering or during seed fill) reduces seed yield. Five experiments containing early, late and annual ryegrass showed the same response to moisture stress, where early stress reduced head numbers and late stress reduced seed size. Late season cultivars have greater potential for increased stress and yield loss.

**Figure 3.** Relative seed yield of ryegrass under moisture stress when compared to the fully irrigated control (%). The data are from five trials sown at Chertsey between 2008/9 and 2016/17. Critical deficit at which a yield reduction can be expected is ~70 mm.
**Light seed**

Is take-all/ fusarium disease causing light seed? Appears to be a problem in some multi-year year crops. Need to look at non-grass options in the rotation along with grass control in these crops. A trial using *Trichoderma* as a bio-control agent was evaluated in Darfield (2019/20). Both seed treatment and prills direct drilled into a 2nd year ryegrass crop markedly lowered take-all damage. There was a trend in the prills for increased seed yield. The trial is being repeated at Ashton for 2020/21.

**Harvest and harvest loss**

- **Average harvest loss in ryegrass seed crops is 500 kg/ha.**
- No advantage in seed yield using Podlock™ or ReTain®.
- **Windrow losses < mowing losses.** Loss is largely associated with divider or outside disc head. A wider mower will reduce loss, but windrow better. Windrow swath has more bulk to retain seed that shakes loose.
- **The JD Windrower Platform Legacy front.** Faster windrow cutting times and seed yields similar to standard windrowers and both are better than disc mowers (Table 3).
- **Crop standing at harvest (direct heading).** No increase in seed loss; BUT NW winds were not severe.
- **Use of desiccant to manage regrowth through swath.** In a trial with strong regrowth Diquat 2 L/ha provided easier harvesting than Buster 3 L/ha. Glyphosate 3 L/ha treatments in comparison were ‘ropy’ and is not recommended. No apparent effect on seed germination and no effect on AR37 endophyte viability. Don’t undercut – a desiccant is a safer option.

**Table 3.** Comparison of seed yield of ryegrass with different cutting/windrowing equipment in four trials over three years.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Year</th>
<th>Legacy Windrower</th>
<th>Standard Windrower</th>
<th>Disc Mower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shogun (hybrid)</td>
<td>2016/17</td>
<td>3200</td>
<td>2990</td>
<td>2640</td>
</tr>
<tr>
<td>DLF 46-600 (turf)</td>
<td>2017/18</td>
<td>3110</td>
<td>2830</td>
<td>n/a</td>
</tr>
<tr>
<td>Bokser (turf)</td>
<td>2017/18</td>
<td>2920</td>
<td>2680</td>
<td>2660</td>
</tr>
<tr>
<td>Hustle (perennial)</td>
<td>2019/20</td>
<td>3000</td>
<td>2830*</td>
<td>2640</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>3060</td>
<td>2830</td>
<td>2650</td>
</tr>
<tr>
<td>LSD 5%</td>
<td></td>
<td></td>
<td></td>
<td>160</td>
</tr>
</tbody>
</table>

*Grasshopper windrower.
Nitrogen management in milling wheat crops
Rob Craigie, Jo Drummond (FAR)

Key points

• This field experiment investigated the effect of nitrogen (N) on the grain yield and quality of May sown crops of two milling wheat cultivars, Discovery and Griffin with or without irrigation.
• Under irrigation, total N (applied N plus soil mineral N) of 350 kg/ha produced the maximum yield for the two milling wheat cultivars.
• With a low soil mineral N content in spring, and no water limitation, applied N can double the grain yield.
• Under dryland conditions in a dry season (with low yield potential) the optimal total N was 200 kg N/ha.
• The margin over N cost (MONC) was greatest at approximately the N rate that maximised yield.
• The N required to maximise yield also gave a protein content that met the flour milling company specification.
• The protein content was not significantly reduced for either cultivar when all of the N was applied through stem extension without a fourth N application at ear emergence.
• The grain yield was not significantly reduced with the delay in the first N application from GS30 to GS32.
• Agronomic knowledge of the effect of nitrogen and sulphur on milling wheat grain yield and quality is good. However, there is a gap in knowledge of the effect on the quality of the resulting flour and baked goods.

FAR developed N application guidelines for farmers in the 2000s from a series of milling wheat N response trials with the cultivars Amarok and Conquest. Over time these cultivars have become less commercially popular. The current trial follows a similar trial in 2018 and investigates the effect of applied N rate and timing on the grain yield and quality of two current commercial milling wheat cultivars, Griffin and Discovery. Griffin is a premium grade milling wheat cultivar and cv. Discovery is medium grade.

There was an average 90% increase in yield from increasing total N to approximately 350 kg/ha (including soil mineral N) for the irrigated trial for both cultivars (Figure 1). The MONC was also maximised at approximately the N rate that maximised yield (Figure 1). For the dryland trial, there was about a 25% increase in yield for both cultivars, from increasing total N to about 200 kg/ha (including soil mineral N).

The N required to maximise yield for both the irrigated and dryland trials also gave a protein content above the minimum acceptable content for both premium and medium grade milling wheat cultivars for the flour mill (i.e. above 10.5% protein for Discovery and 11% protein for Griffin) (Tables 1 and 2). Greater N rates increased the protein content of the grain further.
However, it was not cost-effective to apply additional N to increase protein content above the N rate that maximised yield. Neither the addition of sulphate or micronutrients to the fertiliser mix increased grain yield.

![Graph showing yield, protein and margin over N cost (MONC) of milling wheat cultivars Griffin and Discovery in response to nitrogen (N) with and without irrigation at Chertsey, mid-Canterbury.](image)

**Figure 1.** Yield, protein and margin over N cost (MONC) of milling wheat cultivars Griffin and Discovery in response to nitrogen (N) with and without irrigation at Chertsey, mid-Canterbury. Grain price: from a 2019-20 milling wheat contract. Urea price: $1.34/kg N. Ammonium sulphate $2.50/kg N.

The N rate treatments received four N applications, three through stem extension (GS30-39) and one at ear emergence (GS59). Like previous trials, the 2019 trial showed that if sufficient N was applied through stem extension to maximise yield, an ear emergence application for increased protein was not necessary ([FAR Cropping Strategies Issue 1, 2011](#)).

In the dryland trial the yields were so low and protein content so high it does not make sense to make this comparison.

In the irrigated trial delaying the first N dose until GS32 did not result in a lower yield. This was despite the low spring soil mineral N content of only 42 kg/ha. In this trial, the soil mineral N test may have underestimated the capacity of the soil to supply N under irrigation or sufficient N may have mineralised in the soil up to GS 32 to ensure no yield loss.
Using a partial nutrient balance as a measure of nitrogen use efficiency
Lauren McCormick, Jo Drummond, Diana Mathers (FAR)

Key points

- Improved efficiency does not constrain productivity – efficient, productive systems keep farmers in business and are good for the environment.
- Nitrogen fertiliser is the biggest single cost within cropping variable costs. With slim cropping margins, it is important to achieve the best possible return on money invested in nitrogen fertiliser.
- Sustainable N management is indicated when the PNB is between 0.7-1.0. When the PNB is below 0.5, it is likely that the plant hasn’t met the planned yield so there is N left over. When PNB is over 1.0, the plant is taking up more N than what is being supplied by the fertiliser this means the plant is using N from the soil.
- Partial nutrient balance (PNB) was calculated for cultivar performance trials (CPT) from 2017-2019. Results showed most irrigated crops had a PNB between 0.7-1.0 which indicates sustainable management.
- PNB is a useful efficiency indicator which can alert growers that a change in management should be considered to reduce economic and environmental losses from the farm system.

Nitrogen use efficiency (NUE) is a measure of how efficiently nitrogen is used by a crop. To calculate NUE, information about the total supply of N for the crop is required but often information about the soil supply is missing. A partial nutrient balance is an alternative NUE indicator which uses information that is readily available to farmers, yield and fertiliser inputs. It is the ratio of the N supplied by the fertiliser to the N removed at harvest. N removed at harvest is in the grain or seed and the straw and crop residues that aren’t being returned to the soil.

A low PNB (less than 0.5) indicates that more N is being applied than what is being removed, this could represent an environmental hazard from the remaining, unused N. When a PNB is greater than 1.0 the plant is taking up more N than what is being supplied by the fertiliser and the plant is drawing on the soil supply. Utilising the soil supply is good practice but care must be taken so that the soil N supply does not become depleted. Sustainable N management is indicated when the PNB is between 0.7-1.0. Values outside this range flag that there are things to be considered for N management, particularly for those who are managing their systems to strict N limits. Whether your PNB value comes back high or low the next step would be to do a soil mineral N test. This would ensure that the fertiliser plan for the next crop is an informed decision. Efficient use does not need to constrain productivity – a well managed 15 t/ha wheat crop will be more profitable and better for the environment than a poorly managed 8 t/ha crop.
Partial nutrient balances were calculated for Canterbury irrigated and dryland CPT crops from 2017-2019. As the N content of the straw is low we excluded the straw N component from the PNB calculations. For other crops, e.g. ryegrass seed, where the N content in the crop residue is a significant component of the N removal, the residue yield should be included in the calculation.

In 2017 PNB for dryland feed wheat ranged from 0.31-0.39 (Figure 1) this may have been caused by below average rainfall between October and December. In 2018 the PNB for dryland and irrigated trials were similar, as water was not yield limiting for the dryland trial. In 2019 the PNB under irrigation ranged from 0.96-1.09, this indicates more N was removed than what was supplied. Water was limiting in the dryland trial, where the PNB ranged from 0.52-0.63 (Figure 1) indicating more N was supplied than removed. This shows how weather conditions can affect PNB from season to season.

Partial nutrient balance (PNB) was calculated for dryland feed wheat CPT at St Andrews from 2017-2019. In 2019, more N was removed from the system than supplied (Figure 2). A PNB range of 0.96-1.20 indicates management change could be considered in the 2020-21 season to prevent depletion to the soil N supply.

Partial nutrient balance (PNB) was calculated for irrigated milling wheat CPT at Dorie and Winchester from 2017-2019 (Figure 3-4) In 2017 the PNB ranged between 0.56-0.67 and 0.61 and 0.67 at Dorie and Winchester respectively.

![Figure 2. Partial nutrient balance (PNB) for irrigated and dryland feed wheat cultivars at Chertsey, 2017-2019.](image-url)
Figure 3. Partial nutrient balance (PNB) for dryland feed wheat cultivars at St Andrews, 2017-2019.

Figure 4. Partial nutrient balance (PNB) for irrigated milling wheat cultivars at Dorie, 2017-2019.
Figure 5. Partial nutrient balance (PNB) for irrigated milling wheat cultivars at Winchester, 2017-2019.

A PNB works on a mass balance approach between N supply and crop demand and can demonstrate how well N is being managed. It can be used as a tool in helping farmers with management decisions as its information that is routinely collected by farmers. Remember nitrogen can never be 100% efficient, but by understanding the efficiency levels at a crop, farm and sector level, we can identify where improvements can be made.
**Disease control in autumn sown wheat**

*Jo Drummond (FAR)*

**Key points: Septoria tritici blotch (STB)**

- Cultivar resistance provides a foundation for disease control.
- Yield response to fungicide in 2019-20 under low-moderate disease pressure conditions was lower than in 2018-19, and economic returns were only observed when using fungicide programmes on more susceptible cultivars.
- In 2019-20, lower disease pressure gave fungicide programme flexibility, even when using a variety with a moderately resistant to moderately susceptible rating such as Starfire.
- Sensitivity shifts of Septoria tritici blotch (STB) to SDHI fungicides have been detected in New Zealand, however, SDHI chemistries still have field efficacy against this pathogen in NZ, but provide a reminder that resistance may be an emerging threat in our wheat crops.
- FAR is part of a new seven-year Sustainable Food and Fibre Futures programme *A Lighter Touch*, which will develop lighter touch protection strategies for wheat.

**Wheat cultivar x fungicide**

*Low-moderate disease pressure provided greater flexibility in fungicide programme choice and reduced overall yield response to fungicide.*

In the 2019-20 season, lower disease pressure in some areas saw lower yield losses attributable to fungal disease pressure under irrigated and dryland conditions at Chertsey as well as dryland conditions at St Andrews and Clinton using the 'Starfire (moderately resistant to moderately susceptible – MRMS), Reflection – (moderately resistant – MR) and Graham (moderately resistant – MR). Average yield losses without fungicide across all trials were 0.6, 1.8 and 2.5 t/ha for 'Reflection', 'Graham' and 'Starfire' (Table 1). This represented average yield losses without fungicide of 7% 11% and 22% and revenue losses of $228, $684 and $950 for ‘Reflection’ ‘Graham’ and ‘Starfire’, respectively.

The data from these trials also suggested selection of at least a moderately STB resistant cultivar could provide greater flexibility in the spray window if application time was not optimal because of poor weather conditions or another factor. This was demonstrated in Clinton in 2019, where application timings were compromised by challenging weather conditions at GS32 and GS39 spray timings.

Under low disease pressure in 2019-20 under dryland conditions at Clinton and St Andrews and Chertsey and irrigated conditions at Chertsey, there was no financial benefit to applying fungicide to moderately resistant Reflection’ and ‘Graham’ (Table 3-4). The greatest economic returns for the moderately susceptible to moderately resistant ‘Starfire’ were achieved with a reduced input fungicide programme. These data demonstrated that although economic returns were marginal, they were not compromised through use of lower input fungicide
programmes. This was important as it showed that a balance can be achieved between effective disease control, resistance management and economic returns.

Overall, these trials continue to highlight the value of cultivar resistance as the foundation for disease control. Under high or low disease pressure conditions, selection of a resistant cultivar can reduce the potential for yield loss, especially if fungicide timings are not optimal due to the lack of spray windows. Under low-moderate disease pressure conditions, selection of a resistant cultivar can also offer greater flexibility in fungicide programme choice. This can be a potential cost saver and allows for stewardship of at-risk chemistry, which will become an integral part of a new, seven-year Sustainable Food and Fibre Futures (SFFF) programme *A Lighter Touch*, which focuses on the development of lighter touch crop protection strategies for wheat.

**Table 1.** Average yield (t/ha) and revenue loss without fungicide in cultivar x fungicide programme trials in 2019. Wheat process $380/ha, NZ Grain and Feed Index.

<table>
<thead>
<tr>
<th>Cultivar (resistance rating)</th>
<th>Chertsey (irrigated)</th>
<th>Chertsey (dryland)</th>
<th>St Andrews (dryland)</th>
<th>Clinton (dryland)</th>
<th>Mean (all trials)</th>
<th>Revenue loss ($/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflection (MR)</td>
<td>0.9</td>
<td>0.3</td>
<td>0.3</td>
<td>0.9</td>
<td>0.6</td>
<td>228</td>
</tr>
<tr>
<td>Graham (MR)</td>
<td>3.9</td>
<td>0.7</td>
<td>1.5</td>
<td>1.0</td>
<td>1.8</td>
<td>684</td>
</tr>
<tr>
<td>Starfire (MRMS)</td>
<td>4.5</td>
<td>1.0</td>
<td>2.1</td>
<td>2.2</td>
<td>2.5</td>
<td>950</td>
</tr>
</tbody>
</table>

**New active ingredients**

A number of new active ingredients will enter the New Zealand market in spring 2020 (Table 2) and will increase the options available to growers for disease management in cereals. However, since they are SDHIs (Group 7 fungicide) and QIs (Group 21 fungicide) and these come with a moderate-high risk of resistance development, they should be carefully stewarded to ensure their continued use. In the UK, new to market SDHIs have been over exploited resulting in loss of efficacy in the field.

**Table 2.** New products, their active ingredients and registered rates that will be available from spring 2020.

<table>
<thead>
<tr>
<th>Product</th>
<th>Active ingredient</th>
<th>Mode of action</th>
<th>FRAC fungicide group</th>
<th>Registered rate (L/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Questar®**</td>
<td>fenpicoxamid</td>
<td>QI</td>
<td>21</td>
<td>1.5 - 2</td>
</tr>
<tr>
<td>Vimoy® Iblon®**</td>
<td>isoflucypram</td>
<td>SDHI</td>
<td>7</td>
<td>1.5</td>
</tr>
<tr>
<td>Caley® Iblon®</td>
<td>Isoflucypram + prothioconazole</td>
<td>SDHI + Triazole</td>
<td>7 and 3</td>
<td>1.5</td>
</tr>
<tr>
<td>Revystar®</td>
<td>mefentrifluconazole + fluxapyroxad</td>
<td>Triazole + SDHI</td>
<td>3 and 7</td>
<td>1.5</td>
</tr>
</tbody>
</table>

*Products must be applied in a mixture with a partner(s) from a different mode of action which also provides control of STB.*
Table 3. Septoria tritici blotch severity (% leaf area affected), yield (t/ha) and fungicide revenue – cost ($/ha) for autumn sown wheat cultivars with different STB ratings, ‘Starfire’ (moderately resistant to moderately susceptible - MRMS), ‘Graham’ (moderately resistant - MR) and ‘Reflection’ (moderately resistant - MR) under irrigated and dryland conditions at Chertsey. Irrigated disease assessed on the top three leaves (% leaf area affected) at GS 75-80, dryland disease assessed on leaves 3-4 at GS 65, 2019-20.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>GS30-31</th>
<th>GS32</th>
<th>GS39</th>
<th>GS65</th>
<th>Irrigated</th>
<th>Dryland</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>%LAA</td>
<td>Yield</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>by STB</td>
<td>(t/ha)</td>
</tr>
<tr>
<td>Reflection</td>
<td>Untreated</td>
<td></td>
<td></td>
<td></td>
<td>13.7</td>
<td>12.2</td>
</tr>
<tr>
<td>Reflection</td>
<td>Prosaro* 1.0</td>
<td>Adexar* 0.62 +Opus* 0.45</td>
<td>Opus* 0.25 + Amistar® 0.25</td>
<td>12.1</td>
<td>13.1</td>
<td>5046</td>
</tr>
<tr>
<td>Reflection</td>
<td>Proline® 0.6</td>
<td>Adexar* 1.0 + Opus* 0.25</td>
<td>Opus* 0.75 + Comet® 0.4</td>
<td>10.4</td>
<td>13.0</td>
<td>4957</td>
</tr>
<tr>
<td>Reflection</td>
<td>Proline® 0.6 + Phoenix® 1.5</td>
<td>Adexar* 1.0 + Opus* 0.25 + Opus® 0.75 + Comet® 0.4</td>
<td>8.8</td>
<td>13.0</td>
<td>4913</td>
<td>5.4</td>
</tr>
<tr>
<td>Reflection</td>
<td>Aviator Xpro® 1.0</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus* 0.75 + Comet® 0.4</td>
<td>5.8</td>
<td>13.2</td>
<td>5012</td>
</tr>
<tr>
<td>Reflection</td>
<td>Opus® 1.0</td>
<td>Aviator Xpro® 1.0</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
<td>3.5</td>
<td>13.3</td>
</tr>
<tr>
<td>Graham</td>
<td>Untreated</td>
<td></td>
<td></td>
<td></td>
<td>25.2</td>
<td>10.0</td>
</tr>
<tr>
<td>Graham</td>
<td>Prosaro® 1.0</td>
<td>Adexar® 0.62 +Opus® 0.45</td>
<td>Opus® 0.25 + Amistar® 0.25</td>
<td>19.0</td>
<td>13.5</td>
<td>5203</td>
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<tr>
<td>Graham</td>
<td>Proline® 0.6</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
<td>18.0</td>
<td>13.9</td>
<td>5309</td>
</tr>
<tr>
<td>Graham</td>
<td>Proline® 0.6 + Phoenix® 1.5</td>
<td>Adexar® 1.0 + Opus® 0.25 + Phoenix® 1.5</td>
<td>Opus® 0.75 + Comet® 0.4</td>
<td>17.2</td>
<td>14.0</td>
<td>5293</td>
</tr>
<tr>
<td>Graham</td>
<td>Aviator Xpro® 1.0</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
<td>9.0</td>
<td>14.1</td>
<td>5373</td>
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<tr>
<td>Graham</td>
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<td>Aviator Xpro® 1.0</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
<td>10.0</td>
<td>13.9</td>
</tr>
<tr>
<td>Starfire</td>
<td>Untreated</td>
<td></td>
<td></td>
<td></td>
<td>51.4</td>
<td>8.5</td>
</tr>
<tr>
<td>Starfire</td>
<td>Prosaro® 1.0</td>
<td>Adexar® 0.62 + Opus® 0.45</td>
<td>Opus® 0.25 + Amistar® 0.25</td>
<td>25.5</td>
<td>12.8</td>
<td>4948</td>
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<tr>
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<td>Proline® 0.6</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
<td>18.6</td>
<td>13.0</td>
<td>4949</td>
</tr>
<tr>
<td>Starfire</td>
<td>Proline® 0.6 + Phoenix® 1.5</td>
<td>Adexar® 1.0 + Opus® 0.25 + Phoenix® 1.5</td>
<td>Opus® 0.75 + Comet® 0.4</td>
<td>16.9</td>
<td>12.7</td>
<td>4773</td>
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<tr>
<td>Starfire</td>
<td>Aviator Xpro® 1.0</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
<td>12.6</td>
<td>13.1</td>
<td>4954</td>
</tr>
<tr>
<td>Starfire</td>
<td>Opus® 1.0</td>
<td>Aviator Xpro® 1.0</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
<td>6.5</td>
<td>13.3</td>
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<tr>
<td>Mean</td>
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<td>15.8</td>
<td>12.8</td>
</tr>
<tr>
<td>Fpr</td>
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<td></td>
<td></td>
<td></td>
<td>&lt;0.001</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>LSD (p=0.05)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5.4</td>
<td>0.6</td>
</tr>
<tr>
<td>CV (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>17.6</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Opus® = epoxiconazole, Prosaro® = prothioconazole + tebuconazole, Proline® = prothioconazole, Aviator Xpro® = bixafen + prothioconazole, Phoenix® = folpet, Adexar® = fluxapyroxad + epoxiconazole, Amistar® = azoxystrobin, Comet® = pyraclostrobin
Table 4. Septoria tritici blotch severity (% leaf area affected), yield (t/ha) and fungicide revenue – cost ($/ha) for autumn sown wheat cultivars with different STB ratings, ‘Starfire’ (moderately resistant to moderately susceptible - MRMS), ‘Graham’ (moderately resistant - MR) and ‘Reflection’ (moderately resistant - MR) under dryland conditions at St Andrews, South Canterbury and Clinton, South Otago. Disease assessed on the top three leaves (% leaf area affected) GS 83-85 at St Andrews and GS 75-80 at Clinton, 2019-20.

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Growth Stage (GS) and fungicide treatment (L/ha)</th>
<th>Clinton</th>
<th>St Andrews</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%LAA</td>
<td>Yield (t/ha)</td>
<td>Revenue – fung. cost ($/ha)</td>
</tr>
<tr>
<td>Reflection</td>
<td>Untreated</td>
<td>35.8</td>
<td>10.4</td>
</tr>
<tr>
<td>Reflection</td>
<td>Prosaro® 1.0</td>
<td>Adexar® 0.62+Opus® 0.45</td>
<td>Opus® 0.25 + Amistar® 0.25</td>
</tr>
<tr>
<td>Reflection</td>
<td>Proline® 0.6</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
</tr>
<tr>
<td>Reflection</td>
<td>Proline® 0.6 + Phoenix® 1.5</td>
<td>Adexar® 1.0 + Opus® 0.25 + Phoenix® 1.5</td>
<td>Opus® 0.75 + Comet® 0.4</td>
</tr>
<tr>
<td>Reflection</td>
<td>Aviator Xpro® 1.0</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
</tr>
<tr>
<td>Reflection</td>
<td>Opus® 1.0</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
</tr>
<tr>
<td>Graham</td>
<td>Untreated</td>
<td>44.3</td>
<td>11.2</td>
</tr>
<tr>
<td>Graham</td>
<td>Prosaro® 1.0</td>
<td>Adexar® 0.62+Opus® 0.45</td>
<td>Opus® 0.25 + Amistar® 0.25</td>
</tr>
<tr>
<td>Graham</td>
<td>Proline® 0.6</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
</tr>
<tr>
<td>Graham</td>
<td>Proline® 0.6 + Phoenix® 1.5</td>
<td>Adexar® 1.0 + Opus® 0.25 + Phoenix® 1.5</td>
<td>Opus® 0.75 + Comet® 0.4</td>
</tr>
<tr>
<td>Graham</td>
<td>Aviator Xpro® 1.0</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
</tr>
<tr>
<td>Graham</td>
<td>Opus® 1.0</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
</tr>
<tr>
<td>Starfire</td>
<td>Untreated</td>
<td>82.4</td>
<td>8.5</td>
</tr>
<tr>
<td>Starfire</td>
<td>Prosaro® 1.0</td>
<td>Adexar® 0.62+Opus® 0.45</td>
<td>Opus® 0.25 + Amistar® 0.25</td>
</tr>
<tr>
<td>Starfire</td>
<td>Proline® 0.6</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
</tr>
<tr>
<td>Starfire</td>
<td>Proline® 0.6 + Phoenix® 1.5</td>
<td>Adexar® 1.0 + Opus® 0.25 + Phoenix® 1.5</td>
<td>Opus® 0.75 + Comet® 0.4</td>
</tr>
<tr>
<td>Starfire</td>
<td>Aviator Xpro® 1.0</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
</tr>
<tr>
<td>Starfire</td>
<td>Opus® 1.0</td>
<td>Adexar® 1.0 + Opus® 0.25</td>
<td>Opus® 0.75 + Comet® 0.4</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>25.1</td>
<td>11.2</td>
</tr>
<tr>
<td></td>
<td>Fpr</td>
<td>&lt;0.001</td>
<td>0.009</td>
</tr>
<tr>
<td></td>
<td>LSD (p=0.05)</td>
<td>9.7</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>CV (%)</td>
<td>12.2</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Opus® = epoxiconazole, Prosaro® = prothioconazole + tebuconazole, Proline® = prothioconazole, Aviator Xpro® = bixafen + prothioconazole, Phoenix® = folpet, Adexar® = fluxapyroxad + epoxiconazole, Amistar® = azoxystrobin, Comet® = pyraclostrobin
Figure 6. An IPM approach control STB in wheat. This approach balances disease control with resistance management, which will help protect high risk active ingredients.

Choosing a programme based on an IPM approach

Once cultivar selection, cultural control and weather conditions have been considered, a decision can be made on what chemical control programme maximises economic returns for your system (Table 5). The appropriate programme for an early sown, susceptible cultivar grown under irrigation in Mid Canterbury (high disease pressure) may look very different to a programme for a later sown, resistant cultivar under dryland conditions in South Canterbury (low disease pressure). An example of low disease pressure is a later sown STB resistant cultivar in a dry season. Remember to make full use of effective fungicides with different modes of action in alternate sprays or mixtures and make sure never to exceed the maximum number of applications or total dose stipulated on the label. If trying the new active ingredients available from spring 2020, make sure to use them as part of a balanced mixture.
**Table 5.** Examples of fungicide programmes based on an IPM approach and disease pressure to controlling STB in wheat. It is important to choose a programme based on your system.

<table>
<thead>
<tr>
<th>Low Disease Pressure</th>
<th>Moderate Disease Pressure</th>
<th>High Disease Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0: GS30-31</td>
<td>None</td>
<td>T0: GS30-31 Triazole</td>
</tr>
<tr>
<td>T1: GS32</td>
<td>Triazole + multi-site</td>
<td>T1: GS32 Triazole + multi-site or appropriate rate SDHI + multi-site</td>
</tr>
<tr>
<td>T2: GS39</td>
<td>Triazole + appropriate rate SDHI + multi-site</td>
<td>T2: GS39 Appropriate rate SDHI + triazole + multi-site</td>
</tr>
<tr>
<td>T3: GS59-65</td>
<td>Triazole</td>
<td>T3: GS59-65 Triazole + Strobilurin</td>
</tr>
</tbody>
</table>
Latest fungicide programmes for disease management in autumn sown wheat

**Fungicide application – timing, products and rates**

**T0 – GS30 (end of tillering/start of stem elongation)**

A fungicide application at GS30 for STB control has been traditionally used as a holding spray until GS32 or as insurance against a delayed GS32 application. Typically yield response to this fungicide timing and economic returns are low at best. It should not be regarded as a routine spray for all wheat crops since later sown crops with no rust issues develop more quickly and the flexibility afforded by this spray is not needed. Whilst a T0 is considered important for stripe rust control, it is important to moderate use of triazole fungicides due to their declining activity against STB. The aim is to reduce STB exposure to this chemistry where possible.

Where strip rust is present or early (late March/early April) sowing has encouraged high levels of STB, consider the Group 3 fungicide epoxiconazole (e.g. Opus®, Stellar®, Accuro™ 125SC, Agpro Epoxiconazole, Epoxi 125, Fortify™ 125) at 25 – 50% doses for stripe rust control and 100% doses for STB control.

- **Stripe rust**: Opus® (0.25 – 0.50 L/ha)
- **STB**: Opus® (1.0 L/ha)

The best approach is to treat the crop in response to developing disease, so if there is no significant pressure at the time, a GS30 application is unlikely to be beneficial.

**T1 – GS31-32 (1st – 2nd node on main stem)**

The nodal growth stages GS31-32 traditionally coincide with leaf 3 emergence (the leaf two leaves below the flag). This is the first of the important top three leaves to emerge in the crop canopy. At this spray timing, use balanced mixtures and only include a Group 7 fungicide (SDHI) if the disease risk warrants its use. You may wish to consider including new chemistry that will be available in 2020.

**Low disease pressure**

Where later sowing, drier weather or a resistant cultivar has reduced disease pressure, solo Group 3 triazoles such as epoxiconazole (for rusts) or prothioconazole (e.g. Proline®, Pilot™ 250 EC, Vitalis®, Agpro Thiozole (for STB) can be applied. However, for greater efficacy, consider products that include a second triazole such as tebuconazole (e.g. Prosaro® or Kestrel®). Note that Prosaro® and Kestrel® applied at 1.0 L/ha contain 50% and 75% rates of prothioconazole, respectively.

Consider basing applications on at least 75% dose rates of triazole (e.g. Opus® 0.75 L/ha or Proline® 0.6 L/ha). To protect the new active ingredient fenpicoxamid (Questar™), apply with an appropriate mixing partner that has good efficacy against the target pathogen.
You could consider the addition of the multi-site Group 4 fungicide folpet (Phoenix®) as a triazole partner to assist with the control of triazole insensitive strains of STB at T1 and T2 timings at a range of disease pressures. In principle, this is a sound anti-resistance strategy, although results with folpet in FAR wheat trials to date have shown reduced STB severity, but variable economic returns in wheat crops. It is important to note that folpet has a label recommendation for a maximum of two applications up to GS39 and must be mixed with an alternative mode of action fungicide. From spring 2020 a label extension has been sought to extend the folpet label to GS65 in wheat and to remove cereal silage restrictions. Do not apply more than two applications of folpet.

- **Opus** (0.75 – 1.0 L/ha), **Bolide** (2.0 L/ha), **Proline** (0.6 – 0.8 L/ha) or **Prosaro** (1.0 L/ha) or **Kestrel** (1.0 – 1.25 L/ha)
- **Questar** (1.5 L/ha) + **Proline** (0.6 – 0.8 L/ha) or **Prosaro** (1.0 L/ha) or **Kestrel** (1.0 – 1.25 L/ha)
- **The treatments listed above + Phoenix** (1.5 L/ha)

**Moderate disease pressure**
Consider mixtures of at least 75-100% triazoles with an appropriate SDHI rate e.g. 50% dose rate of SDHI for STB or with a 50% dose rate of a strobilurin (Group 11 fungicide) for rust control. In these situations, consider bixafen + prothioconazole (Aviator Xpro®) (0.5 L/ha) topped up with at least 0.32 L/ha prothioconazole (Proline®) to ensure a minimum of a 75% dose of prothioconazole. With fluxapyroxad + epoxiconazole (Adexar®) at 0.62 L/ha ensure a top-up of 0.45 L/ha epoxiconazole (Opus®) to give a 75% dose rate of epoxiconazole. With benzovindiflypur (Solatenol™ - Elatus™ Plus), ensure to mix with a 75-100% rate of triazole.

- **Aviator Xpro** (0.5 L/ha) + **Proline** (0.32 L/ha) or **Adexar** (0.62 L/ha) + **Opus** (0.45 L/ha)
- **Elatus** Plus (0.375 L/ha) + **Opus** (0.75 – 1.0 L/ha) or **Proline** (0.6 – 0.8 L/ha) or **Prosaro** (1.0 L/ha) or **Kestrel** 1.0 – 1.25 L/ha
- **Aviator Xpro** (0.5 L/ha) + **Proline** (0.32 L/ha) or **Adexar** (0.62 L/ha) + **Opus** (0.45 L/ha) + **Phoenix** (1.5 L/ha)
- **Questar** (1.5 - 2.0 L/ha) + **Proline** (0.6 – 0.8 L/ha) or **Prosaro** (1.0 L/ha) or **Kestrel** (1.0 – 1.25 L/ha)
- **The treatments listed above + Phoenix** (1.5 L/ha)
High disease pressure
Where disease pressure is high as a result of early sowing, cultivar susceptibility and/or wet weather, consider topping up the triazole component to better complement the SDHI (e.g. add prothioconazole (Proline®) at 0.2 L/ha to the lower label rate of bixafen + prothioconazole (Aviator Xpro®) or add epoxiconazole (Opus®) at 0.25 – 0.15 L/ha to fluxapyroxad + epoxiconazole (Adexar®) depending on whether 1.0 – 1.25 L/ha is used). The reason that this may be required is that the dose rate of triazole in these pre-formulated mixtures is less than a full label rate for the triazole alone. Aviator Xpro® at 0.7 L/ha contains the equivalent of 0.4 L/ha Proline® and Adexar® at 1.0 L/ha contains approximately 0.5 L/ha Opus®. Note: the fungicide Elatus™ Plus is a solo SDHI product and must be applied in mixture with a triazole.

- **Aviator Xpro® 0.7 L/ha + Proline® 0.2 L/ha to Aviator Xpro® 1.0 L/ha**
- **Adexar® 1.0 L/ha + Opus® 0.25 L/ha to Adexar® 1.25 L/ha + Opus® 0.15 L/ha**
- **Elatus™ Plus 0.75 L/ha + Opus® 0.75 – 1 L/ha or Proline® 0.6 – 0.8 L/ha or Prosaro® 1.0 L/ha or Kestrel® 1.0 – 1.25 L/ha**
- **Questar™ 2.0 L/ha + Proline® 0.6 – 0.8 L/ha or Prosaro® 1.0 L/ha or Kestrel® 1.0 – 1.25 L/ha**
- **Revystar® 1.5 or Caley® Iblon® 1.5 or Vimoy® Iblon® 1.5 + Proline® 0.6 – 0.8 L/ha or Prosaro® 1.0 L/ha or Kestrel® 1.0 – 1.25 L/ha**
- **The treatments listed above + Phoenix® 1.5 L/ha**

Note: The new products (isoflucpyram + prothioconazole) Caley® Iblon® and (isoflucpyram) Vimoy® Iblon® may only be used only **once** in a season!

In general, where rusts have been absent and the principal disease is STB, Proline® has performed better than Opus®, particularly in South Canterbury and Southland.
Managing BYDV in cereals sustainably – insect identification and IPM
Jo Drummond and Lauren McCormick

Key points

- Monitoring the paddock using sticky traps and direct searching for aphids and beneficial predators and parasitoids forms the foundation for an IPM approach and can be used to guide decision making.
- When starting out, it can be wise to use the following steps:
  - Start small. Monitor a paddock or two.
  - Keep an eye on weather conditions that lead to rapid increases in aphid numbers.
  - Pay attention to your crops during their vulnerable growth stages.
  - Gain experience in identifying aphid and beneficial species. This can be challenging, as insects on sticky traps can be difficult to decipher.
  - Become comfortable with how monitoring best suits your schedule.
  - Identify what chemistry can be integrated into an IPM approach by monitoring pests and beneficials after using an insecticide.

For more information see FAR Focus 12 Integrated Pest Management (2015). An updated 2020 version will be available online before the end of September.
Bird cherry oat aphid (*Rhopalosiphium padi*)

Rose grain aphid (*Metopolophium dirhodum*)

**Figure 7.** How to identify aphids on sticky traps
Figure 8. How to identify Hoverflies, parasitic wasps and brown lacewings on sticky traps
Disease control in autumn sown barley
Jo Drummond

Key points

- Plant & Food Research identified three SdhC mutations that impact the performance of SDHIs against *Ramularia* in barley in New Zealand.
- Microplate assays performed in 2019 found a further shift in resistance of *Ramularia* to the SDHIs, with 100% of SdhC isolates collected insensitive to this chemistry.
- The multi-site fungicide Phoenix® has shown control of *Ramularia* when mixed with Proline.
- Ongoing research is monitoring *Ramularia* sensitivity to fungicides, identifying effective management programmes and investigating the importance of seed-borne and airborne inoculum, as well as cultivar resistance.

Laboratory tests carried out by Plant & Food Research in 2017 identified three SdhC mutations which impact the performance of SDHI fungicides on the pathogen *Ramularia collo-cygni*, that causes Ramularia leaf spot (RLS). In 2018, a further shift was detected, with 96% of SdhC isolates collected being insensitive to SDHIs. By 2019, 100% of SdhC isolates collected were insensitive to SDHIs.

In addition to isolate testing, Plant & Food Research surveyed farm-saved seed collected from across New Zealand and which contained many cultivars and sowing dates (Figure 1). Samples were tested for *Ramularia* DNA and compared to historical samples dating back to the late 1960s. Testing of 29 survey samples identified all but one was positive for *Ramularia*. None of the historical samples tested positive for *Ramularia*.

Over the last three seasons, fungicide trials have been set up in autumn sown barley crops at Geraldine and Milford. *Ramularia* infected both these crops. Disease assessment data from these trials showed the multi-site fungicide folpet (Phoenix®, Group 4 fungicide) gives good control of *Ramularia* when used in a mix with prothioconazole (Proline®, Group 3 fungicide) (Table 1). In FAR trials, the new triazole-SDHI co-formulated product mefentrifluconazole + fluxapyroxad (Revystar®) achieved at least similar levels of RLS control and yields compared to existing products. Look out for this product in 2020-21 trials. The economic impact of RLS depends on when symptoms appear in crops. The later symptoms appear, the lower the impact. Harvest results, along with samples of leaves collected from these trials and across New Zealand to test for *Ramularia* mutants with reduced sensitivity, will help identify effective fungicide programmes, monitor *Ramularia* insensitivity to fungicides and investigate the importance of seed-borne and airborne inoculum and cultivar resistance.
Figure 9. Dot histograms for each cultivar of estimated *Ramularia* DNA quantity (pg RCC/100 mg seed). Plant & Food Research, 2019.
Table 6. Influence of selected fungicide treatments on Ramularia leaf Spot (RLS) and yield relative to the untreated in autumn sown barley in South Canterbury in 2018-19 and 2019-20.

<table>
<thead>
<tr>
<th>Fungicide treatment (L/ha) and growth stage (GS)</th>
<th>Milford 2018-19 cv. Cassia</th>
<th>Geraldine 2019-2020 cv. Cassia</th>
</tr>
</thead>
<tbody>
<tr>
<td>GS31</td>
<td>%LAA by RLS</td>
<td>Yield (t/ha)</td>
</tr>
<tr>
<td>Nil</td>
<td>Nil</td>
<td>49.6</td>
</tr>
<tr>
<td>Proline® 0.4</td>
<td>Proline® 0.4</td>
<td>35.6</td>
</tr>
<tr>
<td>Seguris Flexi® 0.6*</td>
<td>Seguris Flexi® 0.6*</td>
<td>43.7</td>
</tr>
<tr>
<td>Proline® 0.4 + Seguris Flexi® 0.6</td>
<td>Proline® 0.4 + Seguris Flexi® 0.6</td>
<td>33.1</td>
</tr>
<tr>
<td>Proline® 0.4 + Seguris Flexi® 0.6 + Phoenix® 1.5</td>
<td>Proline® 0.4 + Seguris Flexi® 0.6 + Phoenix® 1.5</td>
<td>-</td>
</tr>
<tr>
<td>Proline® 0.4 + Phoenix® 1.5</td>
<td>Proline® 0.4 + Phoenix® 1.5</td>
<td>16.6</td>
</tr>
<tr>
<td>Revystar® 1.5 + Phoenix® 1.5</td>
<td>Revystar® 1.5 + Phoenix® 1.5</td>
<td>-</td>
</tr>
<tr>
<td>Mean</td>
<td>Mean</td>
<td>35.7</td>
</tr>
<tr>
<td>LSD (p=0.05)</td>
<td>LSD (p=0.05)</td>
<td>6.1</td>
</tr>
</tbody>
</table>

* Experimental treatment only

Phoenix has a label recommendation for control of scald and Ramularia in barley, with a maximum of two applications up to GS39 – a label extension to GS 59 with the removal of cereal silage restrictions has been sought.

Proline® = prothioconazole, Seguris Flexi® = isopyrazam, Phoenix® = folpet, Acanto® = picoxystrobin, Revystar® = mefentrifluconazole + fluxapyroxad
Latest fungicide programmes for disease management in autumn sown barley

Fungicide application – timing, products and rates

Disease susceptible scenarios
Generally, autumn sown barley tends to be more susceptible to diseases than spring sown barley. This is due to the longer growing season and the tendency for wet weather diseases such as scald (*Rhynchosporium*) to build up over winter. FAR research trials have found that under these conditions, autumn sown barley benefits from at least two foliar fungicide applications.

Therefore, consider centring an autumn sown barley strategy on at least two spray applications from the start of stem elongation GS 30-31, even if fluxapyroxad (Systiva® seed treatment has been used.

Seed Treatment – Systiva® based on the SDHI fungicide fluxapyroxad
Limited data show that foliar fungicide programmes should not be reduced through the use of fluxapyroxad (Systiva®). However, if fluxapyroxad (Systiva®) has been used, remember it counts toward the two SDHI applications allowed per season, thus limiting you to one SDHI based foliar fungicide application in-crop. If SDHI seed treatment has been used, FAR would envisage T2-T3 (GS 39-59) as the optimum timing window to add a foliar SDHI to the mix, due to the activity of these fungicides against leaf rust.

Ramularia is seed borne but is not controlled effectively by seed treatments. Care should be taken with farm-saved seed, especially where high levels of RLS were reported in the field.

T0 - GS29 (late tillering)
FAR trials conducted since 2014 did not justify a fungicide at late tillering (Table 3). However, when high scald pressure is present early in the spring, consider applying a lower cost “holding” spray prior to the two sprays at GS 30-31 and GS 39-49 timings. Options would include prothioconazole 0.2 L/ha (Proline®, Pilot™, 250 EC, Vitalis®, Agpro Thiozole) + carbendazim 0.5 L/ha (Protek®, Agpro Carbendazim, Chief®, Goldazim® 500 SC) or picloxystrobin 0.25 L/ha (Acanto®). Do not omit the other two sprays if the T0 (pre GS30) is applied. This holding spray has tended to be most important in dryland crops on lighter soils where early leaf loss is relatively more important (since there is less green leaf retention later in the season). The two most likely scenarios for needing an early tillering spray are where barley is grown following barley or where barley is sown early.

T1 - GS30-GS31 (pseudostem erect - first node)
Prothioconazole + folpet (Proline® + Phoenix®) has given superior control of RLS over other triazole + SDHI options and the highest margin over fungicide cost in 2018 and 2019 FAR trials
when additional rust protection was included. This mix should also be effective on scald although this disease was not present in the trials.

**Folpet (Phoenix® (multi-site protectant) and Ramularia control**: Since 2017 FAR trials, folpet (Phoenix®) mixed with prothioconazole (Proline®) has given superior control of Ramularia and high yields compared with triazole plus SDHI treatments. Folpet (Phoenix®) could also assist in controlling *Rcc* strains with reduced sensitivity to the SDHIs. A change to the label is currently being sought to extend the folpet (Phoenix® label to GS 59 in barley and for the removal of cereal silage restrictions. Once the new label claim is approved, growers may consider:

- **Proline® 0.4 L/ha + Phoenix® 1.5 L/ha**

Prothioconazole + folpet (Proline® + Phoenix) has a weakness against leaf rust. Leaf rust has been present in only one of six FAR autumn sown barley trials over recent years. However, if rust is present or the cultivar has a susceptibility to rust consider:

- **Proline® 0.4 L/ha + Acanto® 0.25 L/ha + Phoenix® 1.5 L/ha**
- **Proline® 0.4 L/ha + Seguris Flexi® 0.3 – 0.6 L/ha + Phoenix® 1.5 L/ha**

In lower disease pressure scenarios, such as a dry spring or more disease resistant cultivars, the lower rate in the range may be more appropriate.