Disease and Fungicides: Lessons Learnt from 2017, Messages for 2018

Fiona Burnett and Neil Havis, SRUC
Setting the scene

• Backdrop to 2017 data presented today
• Disease management in wheat, barley and oilseed rape
• Specific fungicides and key messages for programmes
• Issues for 2018
• IPM and stewardship
Every season special in its own way…. 2017

- Early drilled crops
- Warm autumn and winter
- Exceptionally dry spring
- Relatively low disease burden
- Susceptible varieties widely grown
- Declining efficacy in some fungicides
- Variable yields and quality
2017 season past had a warm start and plenty of overwintering disease.
Exceptionally dry spring knocked back early disease
Harvest from hell in some areas
Growth stages vary widely between seasons: Crops started early and grew rapidly after the drought.
Wheat – dry spring so generally lower disease than previous year
AHDB (HGCA) Fungicide Performance trials

Since 1994
The wheat trial locations

- Septoria tritici
- Yellow rust
- Brown rust
- Fusarium
Trial methods

• Each trial is sprayed just once
• 4 rates of application tested
  – (25%, 50%, 100%, & 200% of full label rate) per fungicide + untreated

Activity observed on each leaf layer and categorised as:

• Eradicant,
  – if a leaf emerged before fungicides were applied

• Protectant
  – if a leaf has just emerged or is still emerging, when fungicides were applied
Septoria protection 2017 (n=6)

Percentage of full label rate

% disease

0% 50% 100% 150% 200%

0% 50% 100% 150% 200%

Elatus Era
AscraXpro
Librax
Bravo
Proline
Ignite
Vertisan
Vertisan
Imtrex
Septoria curative activity 2017 (n=3)

% disease

Percentage of full label rate

Elatus Era
AscraXpro
Librax

Proline
Ignite
Vertisan
Imtrex

Percentage of full label rate

AHDB CEREALS & OILSEEDS
2017 Septoria yields (n=5)

Yield (t/ha) vs. Percentage of full Label rate for different treatments:
- Elatus Era
- AscraXpro
- Librax
- Bravo
- Proline
- Ignite
- Vertisan
- Imtrex
Rusts 2017

- Dry spell checked yellow rust development
- Promoted brown rust in south
- UKCPVS 2017 shows stable pathotypes compared to 2016 shifts so varietal ratings should stand up as expected

Yellow rust

- Susceptible: - Zulu (5), Myriad (4), Viscount (6), Leeds (6)
- Resistant: - KWS Jackal (9), KWS Barrel (8), Elation (9), LG Mowtown (9), LG Sundance (9), Revelation (9), KWS Siskin (9)
Brown rust 2017 (inoculated)

- **% disease**
  - Proline
  - Elatus Era
  - Vertisan
  - Caramba 90

- **Yield (t/ha)**
  - Proline
  - Elatus Era

Percentage of full label rate
Yellow rust efficacy - 3 year mean (2015-2017)
Fusarium efficacy - 3 year mean (2015-2017)
Fusarium DNA and Mycotoxins 2015-2017

**DON ppb**

- Caramba 90
- Folicur
- Ignite
- Proline 275
- Untreated

**Fusarium DNA (pg/ng)**

- Caramba 90
- Folicur
- Ignite
- Proline 275
- Untreated
Azole - septoria activity (full dose)

Protectant

Curative

Mean value for all sites in FP trials in each year for % control from 2001 to 2017

% Variance accounted for = 65.6

% Variance accounted for = 65.7
Bold lines show the mean response in each year, dotted lines the highest and lowest % control achieved.
SDHI’s - Vertisan
Septoria tritici control 2013 – 2017
(protectant situations)

Bold lines show the mean response in each year, dotted lines the highest and lowest % control achieved.
Are we selecting for less sensitivity?
(2017 treatments in FP trials)

Bixafen sensitivity (post treatment application)

Cumulative frequency (%)

EC50 (μg ml-1)

untreated
Ignite
Imtrex

Single site from 2017 – data courtesy of Bart Fraaije, Rothamsted
Septoria sensitivity to Bixafen (lab tests)  
(Early spring 2017)

Data courtesy of Bart Fraaije – Rothamsted
SDHI sensitivity (laboratory) Ireland 2011 - 2017

Data courtesy of S. Kildea Teagasc
SDHI mutant strains (3 UK trials, 2017)
Sampled after treatment. Non-SDHI treatments applied at T0 and T3

<table>
<thead>
<tr>
<th></th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatments</td>
<td>- SDHI</td>
<td>- SDHI</td>
</tr>
<tr>
<td>with one SDHI</td>
<td>Azole</td>
<td>SDHI</td>
</tr>
<tr>
<td>Azole</td>
<td>SDHI</td>
<td>Azole</td>
</tr>
<tr>
<td>MS</td>
<td>SDHI</td>
<td>MS</td>
</tr>
<tr>
<td></td>
<td>SDHI</td>
<td>SDHI</td>
</tr>
<tr>
<td></td>
<td>Azole</td>
<td>Azole</td>
</tr>
<tr>
<td></td>
<td>MS</td>
<td>MS</td>
</tr>
</tbody>
</table>

Mutant strain frequency (%)

- Mutant strain frequency (X): 0, 10, 20, 30, 40, 50
- Treatments: SDHI, Azole, MS
- 2x SDHI, 2 x plus multisite
Wheat summary

• **Septoria tritici**
  – SDHIs highly active, but some evidence of decline in efficacy
  – Elatus Era, Librax and Ascra comparable for protection
  – Use azoles and multisites to slow resistance development

• **On rusts**
  – Epoxiconazole highly effective in curative situations.
  – Pyraclostrobin showed good activity (esp on yellow rust).
  – New SDHI Elatus Era, highly effective on yellow and brown rust

• **Fusarium**
  – Prothioconazole leads, metconazole, tebuconazole, and epoxiconazole close behind.
How can we take advantage of low risk situations?

IPM wheat trial SRUC - East Lothian

Early and Late sowing
• 30th Sep and 20th Oct

Low and high seed rates
• 200 and 360/m²

Varietal resistance
• Revelation (6)( white post)
• JB Diego (5)
• Santiago (4)

January 2017 - plant population v good, mild dry winter. Septoria on all varieties, mildew at low levels.
SRUC East Lothian site

<table>
<thead>
<tr>
<th>Month</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Rainfall (mm)</td>
<td>7.4</td>
<td>18.4</td>
<td>176.9</td>
<td>60.8</td>
</tr>
</tbody>
</table>
Reduced fungicide inputs to wheat?

<table>
<thead>
<tr>
<th>Trt</th>
<th>T0</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Amistar 0.5 l/ha*</td>
<td>Untreated</td>
<td>Untreated</td>
<td>Untreated</td>
</tr>
<tr>
<td>2</td>
<td>Amistar Opti 1.0 l/ha</td>
<td>Bravo 1.0 l/ha</td>
<td>Bravo 1.0 l/ha</td>
<td>Folicur 0.75 l/ha</td>
</tr>
<tr>
<td>3</td>
<td>Amistar Opti 1.0 l/ha</td>
<td>Brutus 1.5 l/ha + Bravo 1.0 l/ha</td>
<td>Brutus 2.25 l/ha + Bravo 1.5 l/ha</td>
<td>Folicur 0.75 l/ha</td>
</tr>
<tr>
<td>4</td>
<td>Amistar Opti 1.0 l/ha</td>
<td>Brutus 1.5 l/ha + Bravo 1.0 l/ha + Imtrex 1.0 l/ha</td>
<td>Brutus 2.25 l/ha + Bravo 1.5 l/ha + Imtrex 1.5 l/ha</td>
<td>Folicur 0.75 l/ha</td>
</tr>
</tbody>
</table>
Less septoria in late sown and resistant variety
Less disease in low seed rates...

L2 Septoria at T2 + 3-4 weeks

Fungicide P=<0.001
Seed Rate P=0.023
Variety P=0.01
Fungicide.Variety P=0.029

% Leaf area with S. triciti

- Untreated
- Low
- Medium
- High
Late sown, resistant and high inputs kept green leaf longer
In less dense plots there was less of a case for high fungicide inputs...

Yield responses larger in higher risk scenario
Winter wheat – how can we judge risk?

• Low rainfall in spring resulted in low septoria pressure
• Clear disease and yield response to fungicide treatments
• Varietal differences reflected susceptibility to septoria
• Higher levels of septoria in early sown plots (not always reflected in yield)
• Higher levels of septoria in higher plant population plots
Fungicide performance - Barley
“The first commandment is: Thou shalt not shoot the messenger.”
Rhynchosporium 2017 protectant data (n=2)

Percentage of full label dose

Siltra Xpro
Elatus Era
Priaxor

Proline
Comet
Imtrex
Vertisan

% Disease

Percentage of full label dose
Rhynchosporium protectant data 2015 - 2017

Percentage of full label dose

- Siltra Xpro
- Elatus Era
- Priaxor

Percentage of full label dose

- Proline
- Comet
- Imtrex
- Vertisan

% Disease

0% 50% 100% 150% 200%

0 2 4 6 8 10 12 14 16

Percentage of full label dose
Rhynchosporium trial yields 2015 - 2017

Yield (t/ha) vs. Percentage of full label dose

- Siltra Xpro
- Elatus Era
- Priaxor

Yield (t/ha) vs. Percentage of full label dose

- Proline
- Comet
- Imtrex
- Vertisan

Percentage of full label dose
QoI (strobilurin) efficacy on Rhynchosporium (2001–2017)

Data based on efficacy of Comet (pyraclostrobin)
Ramularia leaf spot

- The 5 R’s
- Reddish brown spots
- Rectangular
- Restricted to veins
- Right through the leaf
- Ring of chlorosis
Ramularia leaf spot

- Avoid confusion with other symptoms
Ramularia leaf spot

- Epidemics reported across the UK in 2017 in winter and spring crops
- Project is just finishing investigating the influence of many crop and environmental factors on epidemics

AHDB RLS risk regions
Previously on Ramularia....
2011-2015 (n=3)

Percentage of full label dose

% Disease

0% 50% 100% 150% 200%

Siltra Xpro
Bontima
Adexar

Proline
Imtrex
Zulu
Ignite
Bravo
Ramularia 2017 (Midlothian)

Midlothian 2017 (mean of two leaves)
SRUC Ramularia - additional trial (Lanark)

Note: All fitted lines are the same except Bravo

Disease (%) vs. Percentage of full label dose

- Siltra Xpro
- Treoris

Disease (%) vs. Percentage of full label dose

- Proline
- Imtrex
- Zulu
- Vertisan
We had early warning from 2016 data
Fungicide sensitivity testing results
Net blotch - changes in protective activity
single active products

2014+2015 trials (n=2)
0% 50% 100% 150% 200%
% Disease
Percentage of full label dose

2016+2017 trials (n=3)
0% 50% 100% 150% 200%
% Disease
Percentage of full label dose
Net blotch - changes in protective activity – mixtures

2014+2015 trials (n-2)

- Siltra Xpro
- Elatus Era
- Priaxor

2016+2017 trials (n-3)

- Siltra Xpro
- Elatus Era
- Priaxor

<table>
<thead>
<tr>
<th>Percentage of full label dose</th>
<th>% Disease</th>
<th>Percentage of full label dose</th>
<th>% Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>6</td>
<td>0%</td>
<td>5.5</td>
</tr>
<tr>
<td>50%</td>
<td>3.5</td>
<td>50%</td>
<td>4.5</td>
</tr>
<tr>
<td>100%</td>
<td>2.5</td>
<td>100%</td>
<td>3.5</td>
</tr>
<tr>
<td>150%</td>
<td>1.5</td>
<td>150%</td>
<td>2.5</td>
</tr>
<tr>
<td>200%</td>
<td>0.5</td>
<td>200%</td>
<td>1.5</td>
</tr>
</tbody>
</table>

Disease percentage for 2014+2015 trials (n-2) and 2016+2017 trials (n-3) for different percentages of full label dose.
Mildew control 2017

- Siltra Xpro
- Elatus Era
- IZM+PTZ

- Proline
- Imtrex
- Vertisan
- Cyflamid
- Talius

Percentage of full label dose vs. % Disease

Percentage of full label dose:
Tan spot in spring barley
Tan spot  
*(Pyrenophora tricti-repentis)*

- Noted to be on increase across Europe
- Yield loss in wheat ranges from 3-50%
- Rise in min cultivation is blamed for inoculum increase.
- Fungicides reported to be active against pathogen but QoI and SDHI mutants recorded
IPM spring barley trial (Midlothian)
Differences in varieties evident

### Tan spot GS73 17 Jul 17

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% surface area infected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concerto</td>
<td>2.65</td>
</tr>
<tr>
<td>Laureate</td>
<td>2.35</td>
</tr>
</tbody>
</table>

- **Tan spot L3**
- **Tan spot L4**
IPM spring barley trial (Midlothian)

More consistent control from QoI + azole mixture

Tan spot GS73 17 Jul 17

% surface area infected

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Tan spot L3</th>
<th>Tan spot L4</th>
</tr>
</thead>
<tbody>
<tr>
<td>UT</td>
<td>3.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Fandango T&amp;2</td>
<td>2.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Siltra T1&amp;T2</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>Siltra T2 only</td>
<td>3.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>
IPM spring barley trial (Midlothian)

Slightly more disease in denser plots

Tan spot GS73 17 Jul 17

% surface area infected

Low seed rate | High seed rate

- Low seed rate: 2.5
- High seed rate: 3

- Tan spot L3
- Tan spot L4
RESAS funded IPM trials
Barley 2017

• Combine new biological seed treatments into an IPM programme with either a conventional fungicide programme or elicitor + reduced rate programme

• SRUC trials have demonstrated the potential for elicitor and reduced rate fungicides to reduce disease and protect yield
RESAS funded IPM trials
Concerto 2017

S Barley (cv Propino)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ram audpc</th>
<th>Yield (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No fung</td>
<td>150</td>
<td>6</td>
</tr>
<tr>
<td>Full fung</td>
<td>100</td>
<td>7</td>
</tr>
<tr>
<td>Elic+ fung</td>
<td>50</td>
<td>8</td>
</tr>
<tr>
<td>No fung</td>
<td>200</td>
<td>6</td>
</tr>
<tr>
<td>Full fung</td>
<td>250</td>
<td>7</td>
</tr>
<tr>
<td>Elic+ fung</td>
<td>200</td>
<td>8</td>
</tr>
<tr>
<td>No fung</td>
<td>300</td>
<td>8</td>
</tr>
<tr>
<td>Full fung</td>
<td>250</td>
<td>7</td>
</tr>
<tr>
<td>Elic+ fung</td>
<td>200</td>
<td>8</td>
</tr>
</tbody>
</table>

Means of 2 replicated trials

Untreated seed
elicitor seed treatment
biological seed treatment

Treatment
- Ram audpc
- Yield (t/ha)
Barley summary

Rhynchosporium:
- Good control from Proline or Imtrex
- Better control Priaxor, Elatus Era, Siltra Xpro
- Trend for a decline in activity of Comet observed.

Net blotch:
- Reduced sensitivity to SDHI’s now confirmed
- Mixture products gave best efficacy.
- Comet still adds usefully to efficacy

Ramularia:
- Chlorothalonil still effective
- SDHI and azoles gave poor efficacy in 2017 trials in the UK

Mildew:
- Cyflamid most effective of specific mildwicides
- Prothiocanazole effective
- SDHIs add something to efficacy
Barley programmes for 2018

• Mixtures essential in the face of changes in rhyncho, net blotch and ramularia
• T0 should only be necessary in winter crops and can use diversity of chemistry
• T1 timing retains tillers and hence grain sites so builds yield potential - use strongest mixtures at rates that factor in your main risks
• T2 keeps a lid on any earlier disease and protects against ramularia
• Chlorothalonil at T2 will be important especially in spring crop
Light leaf spot
Light leaf spot trials in 2017: disease control and fungicide application timing (across 3 sites)*
40% disease control from autumn and spring spray

*Overspray applied in November 2016 and stem extension treatments in early March 2017
Significant yield response from the November overspray compared to the untreated control (3 sites)

Pre/at stem extension sprays reduced stem and pod disease severity

Yield response (t/ha)

- November overspray only
- November overspray + March application*

*Overspray applied in November 2016 and stem extension treatments in early March 2017, typically at GS30 (rosette stage: beginning of stem extension)
Light leaf spot control across years – 5 trials in 2015 and 2016*

*Orius in harvest year 2015 only, all other products in both years
Light leaf spot trials: summary for 2017

• November sprays were important for light leaf spot control at the trial sites
• Spring epidemic was not as severe as previous years which was unusual
• Both November and later applications (before or at stem extension) are important for good control
• Later applications reduced stem and pod disease severity
Sclerotinia stem rot
Performance of sclerotinia fungicides across 5 sites (2015 to 2017)

Cross site analysis: 5 sites 2015 to 2017
Sclerotinia stem rot: summary

- Infection risk dependent on weather during flowering
- Fungicides protectant activity only
- Previous history on farm can increase risk
- Higher doses (0.75 of recommended rate and above) provide 3 weeks protection
- Range of active ingredients available
- No resistance to sclerotinia fungicides reported in UK
- Application timing important for good control
2018 strategies

• Earlier sown crops more at risk of LLS
• Lesions in November in SRUC trials
• Both azole and non-azole products provide control in the trials
• Practice anti-resistance management strategies i.e. alternate actives where possible at flowering
• Scottish FP sites show yield benefits with higher doses
• Take account of regional and local risk
• Monitor crops in new year and treat promptly if seen
Fighting disease the clever way….

Integrated Pest Management (IPM) takes a whole farm approach to managing the land which:

- Maximizes the efficiency of crop production
- Minimizes negative effects on the environment
What are the key components of integrated crop health?

- Protection and enhancement of important beneficial organisms
- Crop rotations
- Resistant varieties
- Cultural controls
- Healthy seed
- Monitoring/forecasting
- Thresholds and diagnostics
- Use of biological, physical and other non-chemical methods
- Understanding how pathogens reduce yield
- Targeted application of pesticides (optimised timings, best products)
- Stewardship and anti-resistance strategies
On-line planning IPM tool for Scotland

Integrated Pest Management Plan for Scottish Growers

Overview
This plan has been adapted from the National Farmers Union Integrated Pest Management (IPM) plan, promoted by the Voluntary Initiative, to help Scottish farmers meet their legal obligation to take reasonable precautions to protect human health and the environment when using pesticides. Completing an IPM plan will help the landowner/contractor to make the best possible and most sustainable use of all available methods for controlling pests, weeds and diseases.

What is Integrated Pest Management (IPM)?
Integrated pest management is a site specific, whole farm approach to maximising the efficiency of production whilst minimising negative effects on the environment. This should involve minimising pest, weed and disease risks and includes the use of crop rotations, appropriate cultivation techniques, the use of resistant varieties, tailored and efficient use of artificial inputs such as fertilisers, pesticides and fossil fuels and the enhancement of wildlife habitats. Pest monitoring and the use of thresholds for treatment are a component in reducing reliance on pesticides.

Contact
christian.storstein@gov.scot

Key Dates
Status: Open
Runs from 11 May 2016 to 14 Jun 2022

Other Information
Audience:
People of Scotland

Interests:
Farming

What are the benefits of completing an IPM plan?

• Gives you an idea of what is currently done on-farm that is considered to be IPM
• Helps reduce reliance on pesticides
• Maximises the effectiveness of all crop protection methods
• Assists with long-term plans to reduce the pest burden on farm
• Lets you tailor annual inputs to the in-season risks
• Reduce waste and improve business practice and productivity
• Improves pesticide stewardship
• Recommendation in SQC certification
Cereals: Accumulating resistance issues

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Diseases affected to some degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strobilurins</td>
<td>mildew (wheat and barley), septoria, net blotch, tan spot, ramularia, rhynchosporium, M. nivale</td>
</tr>
<tr>
<td>Azoles</td>
<td>mildews, septoria, ramularia, rhynchosporium</td>
</tr>
<tr>
<td>MBCs</td>
<td>eyespot, septoria, M. nivale, ramularia</td>
</tr>
<tr>
<td>Quinoxyfen</td>
<td>wheat mildew, barley mildew</td>
</tr>
<tr>
<td>SDHI</td>
<td>net blotch, septoria, ramularia</td>
</tr>
<tr>
<td>Metrafenone</td>
<td>wheat mildew, barley mildew</td>
</tr>
<tr>
<td>Chlorothalonil</td>
<td>None</td>
</tr>
<tr>
<td>Folpet</td>
<td>None</td>
</tr>
</tbody>
</table>
Case study 1: Wheat / Septoria

- History of high yielding but susceptible varieties
- Multiple applications of limited number of chemical groups
- Anecdotal reports of less than ideal practice

- Resistance to QoIs since 2003
- Declines in azole sensitivity
- Issues with SDHIs emerging
- New chemistry is limited and 2-3 years away
Case study 2: Barley

- Multiple disease targets
- Greater number of active groups
- Issues with net blotch, mildew and rhynchosporium

Ramularia – evolving picture
- QoI resistance since 2002
- MBC resistance (2 forms)
- Emerging issue with SDHIs 2014
- 2017 Fall off in field performance
What information is out there?

Fungicide Resistance Action Group – UK

• Gathers and interprets reports of fungicide resistance issues and arrives at UK consensus view
• Promotes practical guidelines on status and management of fungicide resistance in UK

• Website
• Guidelines
• UK regulatory authority – recommendations for label restrictions / changes

https://cereals.ahdb.org.uk/frag
What can help our decisions?

- Best practice advice not followed
- Anti-resistance advice is not getting through to all parts of the industry

- More information?
- More engagement?
- More specific practical information?
- Simple messages?
- Higher profile?
- Fewer mixed messages?

**New initiative →**
Fungicide Futures

• Combine anti-resistance management information, developed and published by FRAG-UK, with the power of AHDB’s communications channels

• Stronger anti-resistance advice

• Consistent messages

• Focus on converting anti-resistance science into on-farm practice

• Putting anti-resistance at the heart of fungicide programme planning futures

• FF guidance will be published on the AHDB website at https://cereals.ahdb.org.uk/fungicidefutures

• The first major activity will be just prior to T0 next year
How can we apply principles in practice?

High level anti-resistance strategies

- Use all available methods to reduce pressure on chemistry
- Follow IPM principles and use pesticides in targeted and sustainable ways
- Range of chemical groups and modes of action
- Use balanced mixtures of products
- Try to alternate products
- Avoid multiple repeat dose programmes
- Utilise low risk multisites
Winter wheat – how can we find the win:wins?

- Make use of multisites
- Extra timings add cost and fuel resistance
- Do you need a T0 if you have robust rust rating?
- Do you need an SDHI at T1
Best practice in Barley 2018

- Use range of actives - azoles, SDHIs, cyprodinil, spiroxamine, QoIs, CTL
- Use balanced mixtures to control rhynchosporium and net blotch
- Alternate actives between spray timings, tailored to main disease risks
- Include multisite where ramularia control is needed
Summing up slide: Protecting chemistry

- Do everything to reduce disease risk….rotation, variety, certified seed, sow date, monitoring, surveillance, crop walking, tailored sprays
- Value varietal resistance
- Don’t play fast and loose with any actives
- Take the risk of resistance in existing chemistry seriously
- Adhere to guidelines and, obviously, to statutory limits

- Keep abreast of developments and follow the best, technical advice
- Skating close to the edge puts you at risk so there are genuine win: wins.
- If we can extend the life of SDHIs for a couple of seasons we could bridge to new chemistry
Thank you