Technical Note TN607

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Winter Wheat Disease Control

SUMMARY

Many factors influence the types and severity of diseases, which affect your crops including:-

- **Variety**
- **Weather conditions**
- **Crop rotation**
- **Cultivation**
- **Sowing date**
- **Fungicides**

This technical note describes how these factors can influence the severity of foliar, stem base and root diseases in wheat and how you can use them to manage disease in an integrated disease programme.

The common names for the key wheat diseases in the north of Britain are listed in Table 1 along with their relevance in Scotland.

Table 1: Common names of diseases in winter wheat in Scotland

	Incidence	Potential risk of yield loss
Foliar diseases		
Septoria tritici	Present every year.	High. Currently most damaging foliar disease.
Powdery mildew	Common in early sown crops and susceptible varieties. Common in North East.	Variable. Lower yield loss than Septoria tritici High levels of mildew do not necessarily cause high loss of yield.
Yellow rust	Common in susceptible varieties e.g. Robigus.	Potentially high yield loss once disease established in cool wet season.
Brown rust	Becoming more common, particularly in Alchemy.	Currently a moderate risk loss in north of Britain, but can be severe in warm summers.
Septoria nodorum	Currently less severe than Septoria tritici, but regularly found in crops.	High if it attacks the flag leaf and head late in season.
Root diseases		
Take-all	Common in second wheats.	High risk of yield loss in second wheats.
Stem base diseases		
Common eyespot	Common in many crops, particularly early sown crops, second wheats and 1st wheats following 1 year break from cereals.	Moderate loss of yield but this can increase if crop lodges as a result of disease.
Sharp eyespot	Common in North East Scotland.	Low loss of yield unless disease causes crop to lodge.

Variety

Varieties can vary in their susceptibility to disease and the information is available in the HGCA recommended List. Table 2 shows scores for varieties recommended in 2008. The current system uses a 1 – 9 scale where a low number represents poor genetic resistance and a high number good resistance.

Although the main criteria for choosing a variety will be the market, you can make good use of these tables to determine which diseases are likely to cause concern in a specific variety.

Table 2: Disease resistance ratings for wheat varieties HGCA Recommended List 2008

Variety	Nabim group	Mildew	Yellow rust	Brown rust	Septoria nodorum	Septoria tritici	Fusarium ear blight	Diversification Group (DG) for yellow rust
Xi 19	1	7	9	6	6	5	6	1
Solstice	1	5	9	4	6	5	6	1
Mascot	1	6	5	5	7	5	5	10
Malacca	1	6	8	6	7	5	5	1
Hereward	1	6	5	5	7	5	5	7
Einstein	2	6	6	5	6	5	7	10
Battalion	2	7	8	9	(9)	6	(4)	11
Cordiale	2	7	6	4	5	5	6	4
Marksman	2	7	7	8	(8)	5	(4)	11
Soissons	2	7	8	4	5	6	7	0
Zebedee	3	6	9	3	5	6	(5)	1
Robigus	3	6	3	6	7	7	5	7
Deben	3	6	9	4	6	6	6	1
Claire	3	4	9	5	8	6	7	1
Nijinsky	3	6	8	5	6	5	7	1
Consort	3	6	7	3	4	4	5	7
Riband	3	6	6	3	4	3	6	3
Oakley	4	6	6	6	(8)	5	(4)	10
JB Diego	4	5	9	4	(7)	5	(6)	1
Duxford	4	6	7	5	(5)	5	(6)	-
Glasgow	4	6	4	5	4	5	6	0
Istabraq	4	5	9	5	8	5	7	1
Humber	4	5	8	7	(6)	6	(5)	1
Brompton	4	3	8	7	6	5	5	1
Alchemy	4	7	9	4	9	6	(6)	1
Ambrosia	4	6	6	7	5	4	3	10
Gladiator	4	6	8	8	6	5	5	1
Timber	4	8	9	9	(9)	7	(5)	1
Welford	4	6	7	6	6	5	5	10
Gatsby	4	7	9	8	9	7	(6)	1

1 - 9 where higher number represents better disease resistance
( ) – limited data

Diversification of varieties

It is possible to minimise disease spread by diversifying varieties. Yellow rust in wheat is a good example of this. There are many races of yellow rust of wheat and they may not all attack the same varieties. Varieties are placed in different diversification groups (Table 2). Future information on these different Diversification Groups (DG) can be found in the SAC Crop Clinic website at www.sac.ac.uk/crops.

Severe infections may result if yellow rust spreads between varieties susceptible to the same races of the pathogen. This risk is reduced if varieties with good resistance are grown. The spread of disease can be

further limited by growing different varieties in neighbouring fields, provided that the varieties are not susceptible to the same races of yellow rust. Robigus is very susceptible to the same race of yellow rust that affects Consort. The Diversification Scheme (Table 3) can be used to choose varieties to grow adjacent to one another.

Choosing varieties to grow together

1. Select first-choice variety and locate its Diversification Group (DG).
2. Find this DG under 'Chosen DG' down the left hand side of the table.
3. Read across the table to find the risk of disease spread for each companion DG.
   + = low risk of spread of yellow rust
   Y = high risk of spread of yellow rust
   y = moderate risk of spread of yellow rust
4 Wherever possible choose combinations of varieties marked '+'. A combination marked 'y' is a lesser risk than one marked 'Y'.

Table 3: Diversification table for wheat yellow rust

	Companion DG					
Chosen DG	**1**	**3**	**4**	**7**	**10**	**0**
1	+	+	+	+	+	+
3	+	Y	+	y	y	Y
4	+	+	Y	+	+	Y
7	+	y	+	Y	+	Y
10	+	y	+	+	Y	Y
0	+	Y	Y	Y	Y	Y

Varieties in DG1 have good resistance to all races and can therefore be used to diversify with varieties in any DG, including others in DG1

Weather conditions

Weather can have a major influence on disease. Each major disease can tolerate a wide range of weather conditions, but they may become more severe where the weather conditions are most suitable.

Septoria tritici requires wet conditions for the spores to spread from one plant to another or from one leaf to newly emerged leaves higher up the canopy. Septoria tritici can also spread through the canopy if the crop is wet from dew and there is a light breeze. Once the disease has infected the plant, symptom development is reliant upon temperature. It will develop faster inside the leaf during warm weather. This is why Septoria tritici develops faster during the summer when the weather is wet and warm, whilst it rarely kills out crops in the winter since the temperatures are lower so the disease develops at a slower rate in the crop.

Septoria nodorum requires wet weather to infect a plant but it develops faster at higher temperatures than Septoria tritici. This is one reason why it may become most serious on the heads in the height of summer.

Powdery mildew requires some moisture to infect the crop, but since it spreads via wind blown spores, very wet weather may slow down disease development. Warm and humid weather conditions (not wet) suit the disease best.

Yellow rust prefers wet and cool weather to develop. It is most likely to be found in the early spring when weather conditions are ideal for disease spread, but when crops may be unsprayed.

Brown rust prefers warm temperatures and high humidity. The disease is increasing in importance in the north of Britain, particularly on the variety Alchemy.

Common Eyespot prefers mild winters and wet, cool conditions around stem extension that favour the retention of lower leaves around the stem base and give time for lesions to penetrate the stem. Dry weather at this timing allows older leaves to senesce and fall away, reducing the risk.

Crop rotation

Crop rotation has most influence on soil and trash borne disease, for example take-all and other diseases, which are spread through trash from previous crops e.g. common eyespot.

Take-all rarely causes severe damage in a first wheat crop where there has been a year's break from all cereals and where grasses and volunteer cereals have been controlled. Take-all is generally common in a second, third or fourth consecutive wheat crop as the fungus builds up in the soil and/or roots. Continuous wheat crops may experience 'take-all decline'. This occurs when natural antagonistic organisms build up in the soil and help control the disease. Take-all levels can be severe in second wheats sown inlight soils. Well structured heavy clay soils can be affected to a lesser extent, but poor soil structure in any soil type can lead to high levels and poor yields. Factors such as compaction or acidity that restrict root growth will increase the effects of take-all. White heads resulting from take-all will be more evident in water limiting dry summers.

Common Eyespot is present in trash from previous cereal crops so it is worse in second wheat crops. A years break from cereals is insufficient to remove trash so the risk is high in these crops too. There is also an airborne phase to the pathogen which means that there is still a risk of eyespot developing in first wheat crops following a long break from other cereals.

Foliar diseases including mildew and yellow rust are generally less affected by crop rotation, but continuous wheat crops can maintain a 'green bridge' where the disease spreads from the first crop, survives on volunteers, and subsequently infects the second wheat crop.

Cultivation

Minimum tillage is being used in some areas in order to save cultivation costs. This approach can lead to more crop trash in seedbeds, which can harbour diseases. Crops are also sown earlier which can also increase the risk of diseases such as eyespot, take-all and foliar diseases. Take-all may not be able to survive as effectively in a minimum tillage situation where the seedbed is firm compared to a seedbed produced following ploughing. Where conditions are too compact however, this will have a detrimental effect on root development allowing take-all to attack the roots more readily. Although eyespot is predominantly trash borne, eyespot risk is actually reduced in minimum tilled crops while ploughing increases the risk. Fusarium will however increase in importance in minimum tilled crops. The ergot risk may be higher in minimum tillage if grass weed volunteers are not well controlled.

Sow date

Early sown crops tend to have greater yield potential than late sown crops. They also have a greater risk of disease. Since the interval between harvest and sowing is short, it allows many diseases to survive from one crop to the other on trash or via the 'green bridge'.

Early sown crops generally become better established in the autumn so they are also able to tolerate disease better than later sown crops. Disease in a late sown backward crop can potentially cause more damage than disease in a well established crop in the autumn.

Fungicides

Fungicides remain an effective method to protect crops from disease, but integrating them with agronomic factors can help you use them cost effectively. Timing of fungicides are listed in Table 4.

Table 4: Main fungicide timings in winter wheat

Timing	Growth stage	Comment
Seed	0	Seed treatments can protect crops from seed borne diseases, foliar diseases and take-all.
T0	GS25-30 Tillering	Required in early sown crops if mildew levels or yellow/brown rust risk is high. Early septoria protection in new growth.
T1	GS31-32 Stem extension	First fungicide timing for most crops to control eyespot and to protect developing leaves from Septoria tritici, mildew and rusts.
T2	GS39 Flag leaf fully emerged	Key fungicide timing to protect upper leaves from Septoria tritici and control mildew and rusts if present.
Head & Shoulders	GS45-53 Boot stage – early ear emergence	Not required if T2 applied but sometimes seen as a compromise to a T2 and T3 spray for lower input systems and resistant varieties.
T3	GS59-61 Head fully emerged	Continues to protect the flag leaf from foliar diseases and the head from diseases including Fusarium and sooty moulds.

Table 5: Seed treatments for use on winter wheat

Winter wheat seed treatment	Septoria nodorum	Seedborne Bunt	Microdochium	Yellow rust	Take-all	BYDV via aphid control	Wireworm	Wheat bulb fly
Anchor	+	+	+	-	-	-	-	-
Austral plus	+	+	+	-	-	-	+	+
Tripod	+	+	(+)	P	-	-	-	-
Secur / Tripod plus	+	+	(+)	P	-	+	Reduction	-
Beret Gold	+	+	+	-	-	-	-	-
Deter*	-	-	-	-	-	+	+	-
Epona	+	+	+	P	-	-	-	-
Evict*	-	-	-	-	-	-	+	+
Galmano	+	+	(+)	P	PP	-	-	-
Galmano plus	+	+	+	P	PP	-	-	-
Jockey	+	+	+	P	PP	-	-	-
Kinto	+	+	+	-	-	-	-	-
Latitude	-	-	-	-	PP	-	-	-
Panoctine	+	(+)	+	-	-	-	-	-
Premis	+	+	+	-	-	-	-	-
Redigo	+	+	+	-	-	-	-	-
Redigo Deter	+	+	+	-	-	+	+	-
Redigo Twin	+	+	+	-	-	-	-	-

+ Good control in normal situations
(+) Less effective in high disease pressure situations
P Good protection of early foliar disease
PP take-all reduction
- Not recommended
* For disease control, these seed treatments should be co-applied with a single purpose fungicide seed treatment.

Seed treatments

Seed treatments primarily control seed borne diseases e.g. bunt and Microdochium nivale, but some broad spectrum seed treatments will protect plants from foliar and root diseases.

Bunt

Bunt is not covered by seed certification standards, but all the fungicide seed treatments will provide adequate control in most situations. Bunt is currently rare in Scotland, but if you have a history of bunt on your farm, and suspect soilborne bunt was the problem, you should consider a seed treatment which has activity against soilborne bunt, in particular Sibutol, Tripod, Beret Gold or Premis.

Fusarium (*Microdochium nivale*)

Fusarium (*Microdochium nivale*) is not covered by seed certification standards, and it can cause severe losses, particularly where seed is sown late in cold wet soils. If you sow early in good conditions all seed treatments will provide effective control. If you sow late, or seed has high levels of infection (20% or more) then it is best to avoid Tripod. Tripod should also be avoided for late sown crops because it can delay emergence which has caused problems in some late sown crops.

Take-all

Latitude (silthiofam), Jockey and Galmano (fluquinconazole + prochloraz) will both provide some reduction from take-all. Latitude is specific to the disease and can be used in high risk situations whilst Jockey or Galmano will provide protection from seedborne diseases and yellow rust early in the season.

T0 Timing GS25 – 30

Treatment at this stage may be required where disease pressure is high. This is most likely to occur in early sown crops, susceptible varieties and second wheat situations.

Powdery mildew can be controlled with fenpropidin (e.g. Tern), spiroxamine (e.g. Torch extra) or fenpropimorph (Corbel). The crop can be effectively protected from mildew using metrafenone (e.g. Flexity) or proquinazid (Talius). Cyflamid will offer both protection + knock down.

For yellow rust, triazole fungicides (e.g. tebuconazole, cyproconazole or epoxiconazole) will provide good protection.

Septoria tritici is more likely to require controlling at T1, but new growth can be protected using the triazole fungicide epoxiconazole (e.g. Opus) or prothioconazole (e.g. Proline) or chlorothalonil (e.g. Bravo).

T1 Timing GS31-32

Control of eyespot, Septoria tritici, rusts and mildew is important here. For eyespot, products like prothioconazole (Proline) or boscalid in mixture with epoxiconazole (Tracker) will give best control. Unix, Flexity or Poraz also offer some control. The risk of eyespot occurring at levels that will give a cost effective response to treatment can be assessed using a cumulative risk score (table 6). Early sown, ploughed crops and second wheat crops are most at risk. Thresholds are an unreliable method to determine whether eyespot control is required. Presence of disease now or at T0 can result in high levels later. Visual absence of disease does not however mean the crop is at low risk.

Table 6. Eyespot accumulated risk score

Factor	Level	Risk points
Sowing date	on or after 6 October before 6 October	0 5
Eyespot infection @ GS 31-32	less than or equals 7% more than 7%	0 10
Cumulative rainfall (mm) in March / April / May	less than or equals 170 mm more than 170 mm	0 5
Tillage	Minimum tillage Plough	0 10
Soil type	Light Medium Heavy	0 1 5
Previous crop	Non-cereal Other cereal Wheat	0 10 15

For an accumulated eyespot risk score of 29 points or more, fungicide treatment for eyespot is likely to give a cost effective yield recovery. In seasons of high grain prices or on farms with historically high levels of eyespot a score of 20 is likely to give cost effective response.

For Septoria tritici control, a triazole fungicide is required e.g. prothioconazole (Proline) or epoxiconazole (Opus). For more effective disease control and to protect the triazole chemistry against further resistance shifts, this should be applied in a mixture with a protectant fungicide with an alternative mode of action like chlorothalonil (i.e. Bravo).

Mildew can be effectively protected against or controlled with the fungicides listed for mildew at T0. Pay attention to label requirements or mix mildewicides which are there to reduce resistance risk. Proline will also offer mildew protection, but in high risk mildew situations one of the alternative mildewicides should be used.

Strobilurin fungicides can be applied at T1 but resistance developments mean that they will not give effective Septoria protection. They can increase the protection against rusts. Options include the addition of pyraclostrobin (Comet 200) or azoxystrobin (Amistar), or using co-formulated products with a triazole and strobilurin component e.g. Fandango, Firefly or Landmark.

T2 Timing GS39

The key fungicide mixture is triazole + chlorothalonil fungicide at T2 to ensure good control of Septoria tritici. The chlorothalonil component improves protection against Septoria tritici and also serves to protect the triazole fungicides against further resistance shifts. If the flag leaf spray is delayed however a higher dose of the triazole component will give better eradication and the protective effect of chlorothalonil is less useful. Septoria tritici is now resistant to strobilurin fungicides so strobilurins applied to the flag leaf will only give a low, if any, degree of Septoria protection. They are presently still effective against rusts and this combined with their physiological effects means that they tend to add 0.25 – 0.3 t/ha to yield when applied at this timing and later with the head spray. The physiological effects are similar for all strobilurin fungicides. Examples of strobilurin fungicides include trifloxystrobin (Twist), azoxystrobin (Amistar), picoxystrobin (Galileo),

pyraclostrobin (Comet 200), kresoxim methyl + epoxiconazole (Landmark), pyraclostrobin + epoxiconazole (Opera), fluoxastrobin + prothioconazole (Fandango and Firefly). If mildew levels are high, fenpropidin, fenpropimorph, cyflamid or spiroxamine may be required to eradicate it.

Head and shoulders

If you are delayed in applying the T2 fungicide, fungicides used at T2 should be used at this time. If new varieties become available with good resistance or tolerance to the major diseases, this timing could potentially replace the T2 and T3 spray timings. Very susceptible varieties like Consort and Robigus will not perform best with a combined head and shoulder spray but it is more possible to do successfully on a variety like Timber, provided rust is not prevalent in the area and the current resistance ratings for septoria tritici and mildew remain. There is an increased risk of head diseases with this approach in a wet summer +/- a delayed harvest.

T3 Timing GS59-61

The 'head spray' can be extremely important in high disease years. Wheat crops in Scotland tend to have a long ripening period, and a head spray helps to make the most of this. A mixture of triazole plus chlorothalonil will provide additional protection from the Septoria diseases and also protect the heads from head moulds and Fusarium.

Most strobilurins will offer protection from sooty moulds and Fusarium, but Amistar will control Microdochium nivale and can increase the risk of Fusarium species developing on the heads.

Mildew can develop on the heads in some years. If you have been unable to control the disease up to now, you are unlikely to be successful now.

As with all pesticides, read the label for important information on environmental and operator safety issues, maximum total doses, latest times of application and number of treatments permitted.

Crop monitoring

SAC monitors crops regularly for disease as part of The Scottish Government Rural Directorate funding in Crop Health. The information is published at www.sac.ac.uk/crops and alongside advice in the Crop Protection Reports. The information on disease development can help you decide on the potential risks of diseases throughout the season.

Septoria tritici
(*Mycosphaerella graminicola*)

Septoria nodorum
(*Leptosphaeria nodorum*)

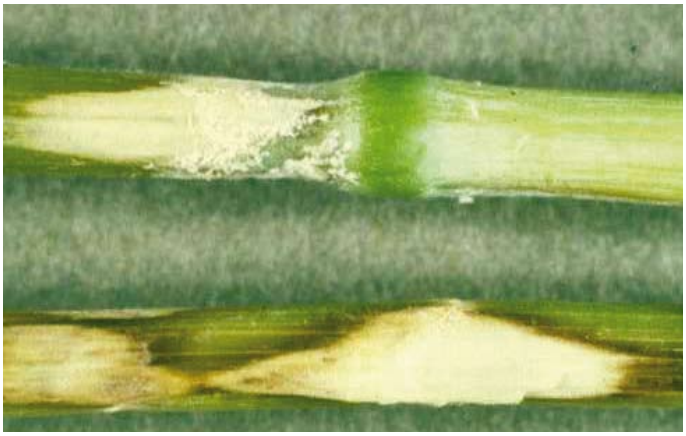
Powdery mildew (*Blumeria graminis*) ©SAC

Yellow rust (*Puccinia striiformis*) ©SAC

Brown rust (*Puccinia recondita*) ©SAC

Common eyespot (Oculimacula acuformis, O. yallundae) ©SAC

Take-all (*Gaeumannomyces graminis*) ©SAC



Sharp eyespot (*Rhizoctonia cerealis*) ©SAC

Table 6: Summary of agronomic factors to reduce disease risk

Situation / Disease	1st wheat 1 year cereal break	1st wheat 2 years cereal break	2nd wheat	Variety choice	Adjacent wheat crop	Early sown	Late sown	Manganese deficient site	Fungicide seed treatment
Take-all	Low risk	Low risk	High risk	Robigus +Alchemy do not do well as 2nd wheat	No difference	High risk	Lower risk	Affects rooting so high risk	Latitude, Jockey or Galmano will give reduction
Eyespot	High risk trash will be present from two years ago	Lower risk but eyespot can come from adjacent stubble	High risk	Choose stiff straw variety	Unknown pos-sible risk of eyespot spreading	High risk	Lower risk	No difference	None effective
Sharp eyespot	No differ-ence rotations don't reduce disease	No difference	No difference	Choose stiff straw variety	No difference	High risk	Lower risk	No difference	None effective
Mildew	No difference assuming no volunteers	No difference	High risk if volunteers	Some more resistant. Note Claire susceptible	High risk if variety susceptible	High risk	Lower risk	Unknown	Minimal effect from broad spec-trum treatments
Yellow rust	No difference assuming no volunteers	No difference	High risk if volunteers	Some more resistant e.g. Timber. Robigus is susceptible	High risk if variety susceptible Diversify varieties	High risk	Lower risk	Unknown	Early protection from Tripod, Jockey, Galma-no
Septoria tritici	High risk	High risk	High risk	Some more resistant e.g. Alchemy	High risk	Little difference later in season	Little difference later in season	Unknown	Early protection from Jockey or Galmano + Tripod
Over wintering	No difference	No difference	No difference	Choose variety suitable for your region	No difference	Low risk of winter kill	High risk of winter kill	High risk of winter kill	Most improve establishment & crop development

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