Home-Grown Cereals Authority

Take-all in winter wheat

– management guidelines

Autumn 2006

HGCA

Introduction

Take-all is a serious soil-borne disease of cereals. It is estimated that half of UK wheat crops are affected and that they suffer average yield losses of 5–20%. More than half of the crop can be lost when disease is severe. The cost to farmers is estimated to be up to £60 million a year.

The take-all fungus, *Gaeumannomyces graminis* var. *tritici*, infects winter wheat roots (also barley, rye and triticale but not oats) in the autumn. Another strain of the fungus, var. *avenae*, affects oats as well as other cereals but is currently very rare.

The disease cannot be completely controlled but its severity can be managed. These guidelines summarise current knowledge, including information from recent research on fungicides and rotations.

Identifying take-all

Affected plants have black lesions on roots.

Early and severe infections can lead to uneven growth and occasionally plant death in spring or early summer. These visible symptoms and, later, premature ripening (whiteheads) usually occur in patches.

Grain yield and quality are reduced.

Understanding the disease

The fungus that causes take-all in wheat is ubiquitous in UK arable land. The disease reduces yield by blocking water and nutrient uptake in infected roots. Severity depends on weather and other factors including soil type.

Phases of infection

- **Primary** infection occurs in autumn from inoculum in the soil. There is usually very little inoculum after a non-susceptible crop, albeit sufficient to initiate infection of a susceptible crop.
- **Secondary** (root-to-root) infection occurs mostly in spring and summer. The disease spreads from infected seedling roots to developing crown roots. High levels of primary infection lead to increased secondary infection, especially when soils are warm and moist.

Disease progress in crop sequences

Figure 1 illustrates how take-all develops in successive wheat crops. Primary and secondary phases of infection, as well as relative yields, are shown for each year. Crop debris, which contains inoculum, starts to decay soon after harvest. The rate of decay is an important determinant of amounts of disease in second and subsequent crops.

'Take-all decline'

This occurs because microbial organisms antagonistic to the take-all fungus build up in soil, reducing the rate of secondary spread.

Once take-all decline has become established, less yield loss will occur, although yields will typically be lower than for first wheats.

Take-all decline can develop in successive crops of wheat, barley or triticale. The disease becomes most severe in winter wheat, and the consequent take-all decline is robust, conferring protection on wheat and the less susceptible cereals. However, where decline is built up under such crops, it will not protect winter wheat. Therefore, growing wheat after a barley (or triticale) crop often leads to severe take-all (Table 1).

Table 1. Wheat yields in fourth year of rotation

Rotation	W W W W	W W B W
Final take-all index	21.6	56.6
Yield t/ha @85% dm	8.7	5.6

W = wheat B = barley

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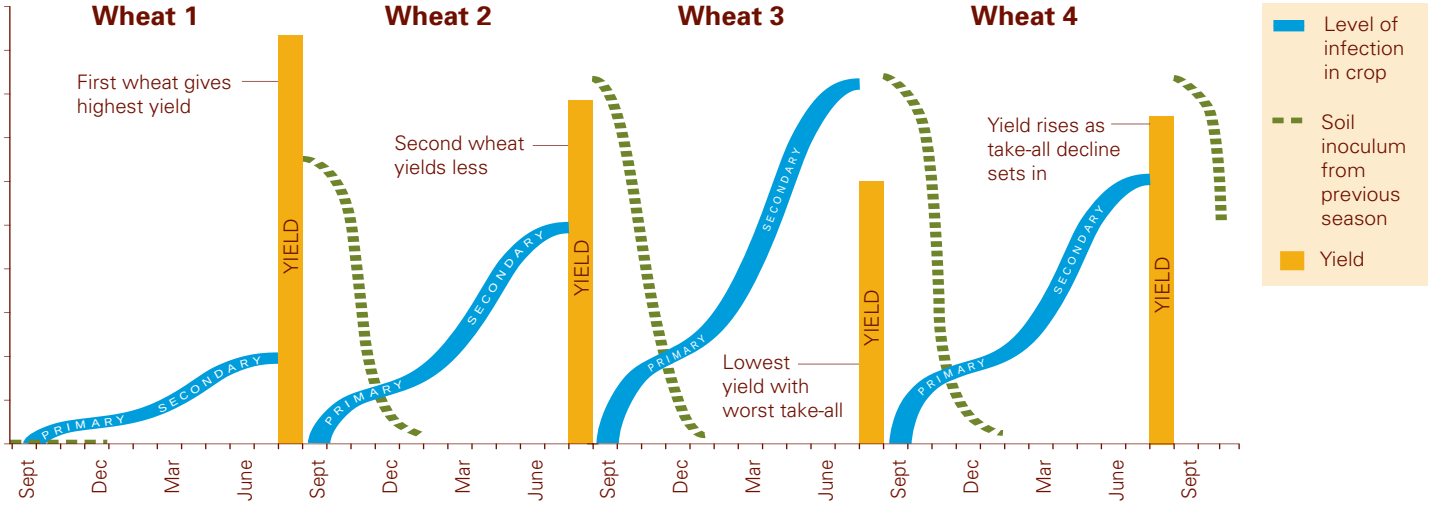
Effective take-all decline, established after a long run of susceptible crops, will not be completely lost after a one-year break or set-aside. Longer or frequently-repeated breaks will result in the complete loss of take-all decline.



Little inoculum in soil after a break results in few primary infections to initiate secondary infection. Thus, there is likely to be little disease during grain filling. However, high levels of take-all inoculum may be left in the soil.

Residual inoculum from 'wheat 1' leads to more primary, and hence secondary, infection, so second wheats can be severely diseased. There is also more inoculum to infect 'wheat 3'.

After two susceptible wheat crops, amounts of soil inoculum are higher than in 'wheat 2' resulting in more primary infection, which increases secondary infection.

The disease become less severe because 'take-all decline' reduces the rate of secondary infection.

Timing of decline is variable. It may not appear until the fifth crop.

Figure 1. Diagrammatic representation of take-all development in successive wheat crops, and relative yield effects

Factors influencing take-all

Environmental

Weather

Regional differences in take-all relate to weather, soil type and cropping systems. Take-all is most prevalent in eastern England, where cereal-dominated rotations are most common. Severe infections also occur in the west and south-west, but wetter weather during grain filling means the effects are often less severe.

Take-all development is encouraged by a warm winter followed by a wet spring/early summer. Yield loss is increased by dry conditions during grain filling, which exacerbate the damaging effects of the disease on root function (Figure 2).

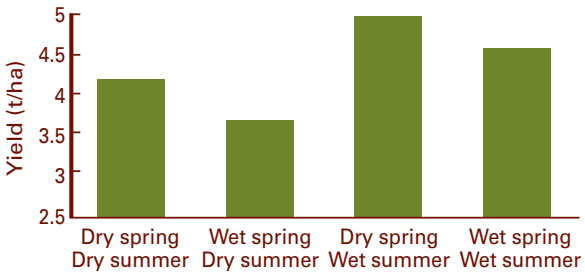


Figure 2. Effect of soil moisture on yield in a severe take-all epidemic

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A first wheat crop usually appears to remain healthy. However, moist soil during the growing season will encourage inoculum build-up. This will impact on following crops. Favourable weather for disease development in successive years leads to severe 'take-all years'. More rarely, runs of unfavourable weather over several years can result in crops in which take-all is almost absent.

Soil type

Crops on light soils (sand, sandy loams and loams), where the fungus spreads more easily, tend to have most disease. Yield loss is often greater on these soils, as well as chalky downland soil, which are more drought-prone, than on well structured and water retentive soils, eg chalky boulder clays.

Second wheats on fen peats can also be particularly severely affected by the disease, as can crops on other low pH soils.

However, risk can differ even within a soil series. For example, among chalky boulder clays, crops on the Ragdale series are more prone to take-all than those on the Hanslope series. Therefore, local knowledge is important when assessing risk.

Management

Crop rotation

A well-managed one-year break normally controls take-all in a following cereal. Any broad-leaved crop will form an effective break, as will oats, unless the rare oat-attacking strain of the fungus is present.

However, a one-year break does not eliminate the fungus. Where the preceding cereal crop suffered a lot of disease, significant inoculum may persist through the break. Cereal volunteers and grass carriers also undermine the effectiveness of a break.

A first wheat after set-aside is usually not affected by severe take-all, provided all green cover is effectively destroyed as soon as permitted. In a wheat/set-aside rotation the risk of severe take-all may increase with the number of cycles.

Preceding a short sequence of cereals with a two-year ryegrass ley encourages antagonistic fungi to develop. This usually delays the onset of severe take-all by a year, allowing an extra wheat crop to be grown with reduced risk of severe take-all. However, a one-year ryegrass cover may increase severity.

A catch crop of a nitrogen-demanding crop, eg white mustard, sown after the volunteers have been destroyed may further reduce take-all survival and increase the effectiveness of set-aside as a cereal break.

Cultivations

A firm seedbed discourages fungal growth. However, on heavy soils, over-compaction can hinder root growth and exacerbate the damaging effects of the fungus on root function.

Ploughing buries most of the take-all inoculum, which is in the top 10cm of soil at harvest, and brings less infective soil to the surface. This reduces early infection and gives the plant time to establish before its roots reach more infective soil. However, consolidation after ploughing is important to achieve a firm seedbed.

Minimum tillage of first wheat stubble leaves highly infective soil near the surface allowing a second wheat to be infected more rapidly but has the advantage that it leaves a firmer seedbed than ploughing.

Take-all in longer cereal sequences is not consistently affected by tillage method.

Volunteer cereals and grass weeds

Cereal volunteers (not oats in most of the UK) and some grass weeds, particularly couch and barren brome, carry the take-all fungus through break crops. In first wheats the risk of take-all increases in proportion to the density of volunteers or weeds.

Early destruction of volunteers (Figure 3) and grass weeds or grass covers on set-aside, reduces the risk to first winter wheats. Take-all may, however, survive or even multiply on couch rhizomes after foliage has been killed.

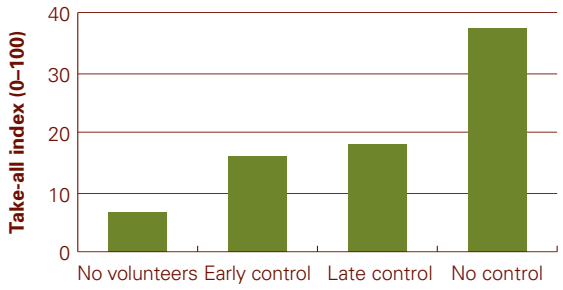

Figure 3. Take-all in first wheat after oilseed rape in which wheat volunteers were or were not controlled

Rothamsted Research

Take-all decline, like the fungus itself, diminishes during a break from wheat. Introducing a set-aside break into a relatively short run of cereals may result in loss of take-all decline, more so in the presence of some weed grasses, eg ryegrass, barren brome (Figure 4) or black-grass.

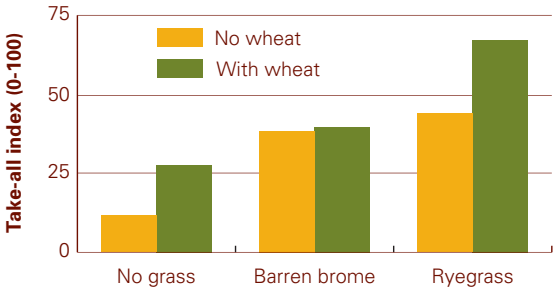

Figure 4. Effects of two grass species (grown with or without wheat after two wheat crops) on take-all in the following wheat crop

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Varieties

There is little evidence that the resistance of current wheat varieties to take-all differs.

However, some varieties suffer less yield loss than others when grown as second wheats; they may be better able to withstand the stress of root loss associated with the disease.

The relative yields of varieties differ depending on rotational position. For example, Savannah, Cordiale, Hyperion, Einstein, Gladiator and Ambrosia have higher relative yields as second wheats, while Robigus, Claire, Nijinsky and Mascot have relatively lower yields (Figure 5).

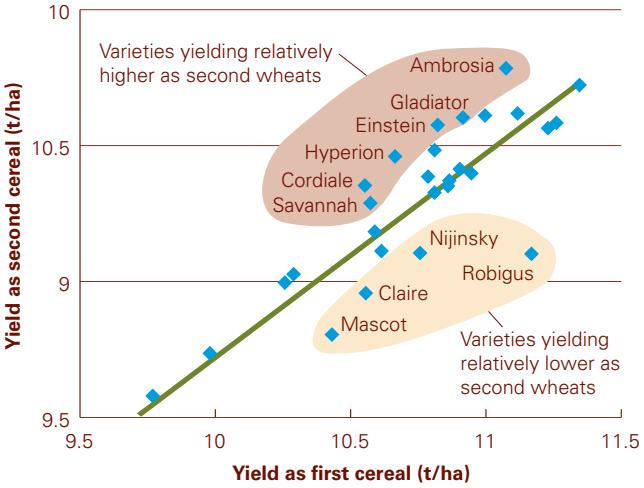

Figure 5. Yields of wheat varieties grown as first and second cereals

HGCA Recommended List, 2006/07

Up-to-date information can be found in the **HGCA Recommended List** for winter wheat, including first and second wheat performance in supplementary tables, and at www.hgca.com/varieties

Drilling date

Take-all inoculum starts to decrease soon after harvest. Therefore, risk to the next crop decreases as the interval between harvest and drilling lengthens, as shown diagrammatically in Figure 6. However, any benefit from later sowing may be lost if volunteers or susceptible grasses are allowed to grow between crops.

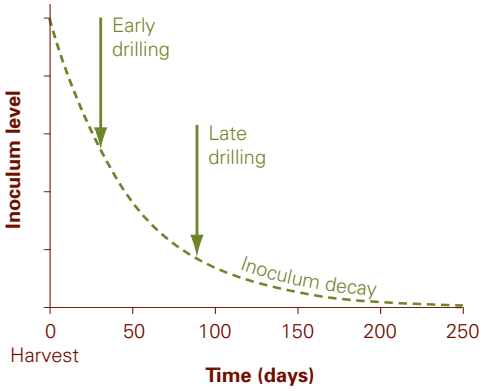

Figure 6. Inoculum level and driling date: later drilling = lower inoculum

Earlier drilling of first wheats increases the risk that damaging take-all will develop in second wheats.

Where possible, second wheats should not be sown before the second half of October (Table 2).

Table 2. How drilling date may affect take-all severity and yield of second wheat

	6 Oct	18 Oct	31 Oct	13 Nov
Final take-all index	52.5	46.0	44.0	21.1
Yield (t/ha)	6.0	6.8	6.9	6.2

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Drilling dates for continuous cereals should be the same as for second wheats.

Seed rate

Take-all can develop more quickly and become more severe at higher seed rates, which allow more primary and secondary infection because of greater root density. Reducing seed rates can increase yield where take-all is severe but this may not be practical with later-sown at-risk crops.

Crop nutrition

Maintaining correct nutrition is important in minimising take-all and its effects; deficiency of any nutrient should be avoided.

Nitrogen

Take-all destroys roots, reducing a crop's ability to take up nitrogen and other nutrients.

Timing of N applications is important. Nitrogen should be applied earlier to crops at risk of take-all than to first wheats. An early application (around 60kg N/ha) in February/March followed by the main dressing in April is better than a single dressing or later applications. Because uptake by crops with severe take-all is less efficient, the disease may increase leaching losses.

There is evidence that take-all is less severe with ammonium sulphate than with ammonium nitrate, urea or ammonium chloride fertilisers but in well-buffered UK soils the effect is small.

Phosphate

Phosphate-deficient soils (less than 15mg/kg of soil – Index 1 or less) favour take-all (Figure 7). Phosphate should be at 20mg/kg soil (Index 2) before the start of a cereal sequence and any deficiency rectified, ideally before the break crop, to reduce take-all risk in the second cereal.

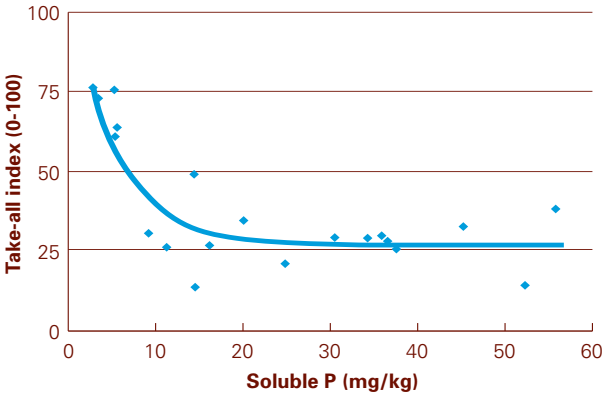

Figure 7. Effects of soil P on take-all in wheat

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Other nutrients

Manganese, potash and sulphur deficiencies have been linked to increased take-all severity. Manganese and potash deficiencies should be corrected before the crop is sown. However, severe take-all sometimes occurs even when supplies of these nutrients are adequate.

Seed treatment fungicides

Seed treatments are available based on two active ingredients: fluquinconazole (plus prochloraz as Jockey) and silthiofam (Latitude). Both treatments give only partial control of take-all and should be used along with other measures to minimise its effects (Table 3).

HGCA-funded trials have compared the seed-treatment fungicides (Table 4).

Table 3. When is seed treatment justified?

Crop sown	Treatment
First wheat	Treat only if there is a known risk, eg many cereal volunteers or much couch grass in preceding break crop.
Second wheat	Treat particularly if there is a known risk, eg – take-all regularly occurs in second wheats on the farm; – crop follows a first wheat sown very early.
Third wheat	Use seed treatment, but grow a crop only if second wheat appeared healthy during grain filling and yielded well. NB yields will still be reduced.
	Do not sow, with or without treatment, if second wheat appeared poor in July with distinct root blackening.
Continuous wheat *Making use of take-all decline*	At-risk crops entering a long run (second, third or even fourth wheat) may be treated to increase yield. In some circumstances this may delay establishment of effective take-all decline.

Table 4. Main features of take-all seed-treatment fungicides

Silthiofam	Fluquinconazole
Early acting against primary infection	Longer acting – provides suppression of primary and secondary infection
Yield benefit typically up to 1.0–2.0t/ha where take-all is moderate to severe	Yield benefit typically up to 0.5–1.5t/ha where take-all is moderate to severe
Take-all specific	Active against take-all and delays foliar diseases, eg yellow rust and Septoria
Often better than fluquinconazole when applied to successive crops in trials	Some evidence of detrimental effects when used as a repeat treatment

Foliar fungicides

Azoxystrobin (Amistar) used as a T1 spray at 1 litre product/ha sometimes increases yield through take-all control. Performance appears inconsistent and may be affected by weather at application. It sometimes enhances the effects of silthiofam.

Action summary

- **Plan rotations to avoid take-all risk, where possible.**
- **Correct any P, K and Mn deficiency in the years before a take-all susceptible crop.**
- **Control cereal volunteers and grass weeds in break crops.**
- **Destroy green covers on set-aside as soon as permitted.**
- **Avoid 'green bridge' between successive cereal crops.**
- **Consider a seed treatment for crops at risk.**
- **Avoid very early drilling of first wheat, if second wheat planned.**
- **Avoid poor second wheat varieties, using the HGCA Recommended List.**
- **Drill into a firm seedbed and possibly plough to reduce effectiveness of inoculum.**
- **Drill non-first wheats after mid-October where possible; if earlier, consider reducing seed rate.**
- **Apply adequate N sufficiently early.**
- **Consider using early-season foliar fungicide active against take-all.**

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Further information

Topic Sheets, Project Progress and HGCA Recommended Lists are free to HGCA levy-payers. Project Reports and Research Reviews are available from HGCA at cost. All HGCA publications are available on the HGCA website.

Topic Sheet 49 (2001) Take-all control in winter wheat: I Planning

Topic Sheet 50 (2001) Take-all control in winter wheat: II Agronomy

Research Review 20 (1991) Take-all disease of cereals

Project Report 255 (2001) Managing early-drilled second wheats to minimise the impact of take-all

Project Report 268 (2002) Take-all in winter wheat: Effects of silthiofam (Latitude)

Project Report 285 (2002) Effects of azoxystrobin on wheat take-all

Project Report 309 (2003) Strategies for fungicidal control of take-all

Project Report 342 (2004) Take-all control with silthiofam (Latitude); Economic implications from a six-year rotation experiment

Project Report 395 (2006) Optimising the performance and benefits of take-all control chemicals

Project Report 398 (2006) Developing a rationale to integrate take-all control measures, reduce disease impact and maximise wheat margins

BASF website:
www.agriCentre.co.uk

Monsanto website:
www.monsanto.co.uk

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