



PROJECT REPORT No. 306

**THE VALUE OF TRITICALE IN THE 2ND/3RD CEREAL
POSITION IN CROP SEQUENCES**

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by

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Abstract

Plots of triticale (cv Fidelio) were sown alongside plots of winter wheat and winter barley (cv Consort and Regina respectively), in second or third cereal rotation positions at three sites over three years. Each crop was treated with take-all seed treatments in comparison with standard treatments, in order to monitor any differential response to these in the three crops. The triticale plots were also treated with either a strobilurin-based or triazole-based fungicide programme, in order to assess the response to strobilurins in this relatively disease-resistant crop.

Take-all reached severe levels in only one of the trials (Warwickshire), but here the winter wheat suffered higher levels of this disease than the triticale, and gave larger yield responses to the take-all seed treatments (Latitude and Jockey) than the triticale. However these yield increases did not make up the deficit in yield between these two crops, the triticale, even without a take-all seed treatment, still giving over 1 t/ha higher yield than the best wheat yield.

Trials at the site in Lincolnshire showed winter wheat to be consistently the best crop choice in terms of gross margin, though take-all levels were always low at this site. In the Warwickshire trial in 2000 (in contrast to the above trial in 2002), take-all was absent and wheat was also the most profitable crop.

At the third site (Gloucestershire), on thin brash soils, despite varying take-all levels, winter wheat was not the most profitable crop choice in any of the three years. In 2000, barley was the best choice, whilst in 2001 and 2002 triticale gave the best margins.

Yield responses to strobilurin fungicides in the triticale crop, where noted, were small and in most cases the extra expenditure involved in these was not cost-effective.

The results of this project underline the traditional view of triticale as a better option than wheat on marginal land or where take-all pressure is high. With no take-all, wheat was consistently the better option, but with moderate to high take-all pressure, or light land with low fertility, triticale out-performed wheat. Its true viability as a commercial crop will depend on market opportunities, either attracting a premium or selling at a discount to wheat (in this project triticale grain was priced at the feed wheat value), however if the market can be assured, it will be worthy of consideration as an alternative to wheat in low-yielding second cereal positions.

Summary

Introduction

The move towards more cereal-orientated rotations following the Agenda 2000 reforms meant that growers once again became familiar with the problems of long-run cereals, in particular second and third wheats. However whilst these are usually low-yielding, in stark comparison to the first wheats grown immediately before, there may still be scope to achieve better margins in these rotation positions without reverting back to break crops. Other cereal species may perform better than wheat in these situations, and this project evaluated triticale and winter barley in particular as alternatives to wheat. Triticale has been known as a cereal suited to low fertility or low yield potential situations, and whilst the market for it is not particularly well-developed in the UK, it may still be a more profitable crop in second cereal positions.

This project evaluated winter wheat, winter barley and winter triticale in second or third cereal positions at three sites in England. The husbandry was as required by each crop, with the exception that take-all seed treatments were compared on each, mainly to evaluate the response to these in barley and triticale, and the triticale trials were treated with both strobilurin and non-strobilurin (triazole-based) fungicide programmes. Gross margins were calculated for each crop at each site.

The aim of the project was to determine which of the three cereal species tested would be the most cost-effective option for a second or third cereal.

Methods

Trials were conducted as replicated, small plot trials at three locations:

	Soil type
Cirencester, Gloucestershire	343a Elmton (limestone brash)
Caythorpe, Lincolnshire	343a Elmton (limestone brash)
Hatton, Warwickshire	711m Salop (slowly permeable reddish clay loam)

Previous crops in each year of the project were winter wheat for Cirencester and Hatton, and spring barley for Caythorpe. In 2000 the Cirencester trial was in a third cereal position, all other trials were second cereals.

Due to difficult weather conditions in autumn 2000, the 2000/01 trial at Hatton failed to establish.

Cultivars: Triticale – Fidelio
 Wheat – Consort
 Barley – Regina

Seed treatments: Standard: Sibutol (wheat and triticales), Raxil S (barley)

Take-all treatments: a) Latitude (silthiofam)
 b) Jockey (fluquinconazole) (wheat and triticales only)

Seed rates: wheat and triticales 400 seeds/m², barley 350 seeds/m².

Wheat and barley plots received appropriate strobilurin-based fungicide programmes. The triticales was treated with two fungicide programmes, as follows:

Strobilurin: GS31/32 – Amistar (azoxystrobin) 0.5 l/ha, + Opus (epoxiconazole) 0.5 l/ha
 GS39 – Amistar 0.75 l/ha + Opus 0.5 l/ha

Triazole: GS31/32 – Opus 0.5 l/ha + Tern (fenpropidin) 0.3 l/ha
 GS39 - Opus 0.75 l/ha + Tern (fenpropidin) 0.3 l/ha

Key results

Examples of results from the three years of the project.

1. Take-all levels

Take-all was seen in triticales and barley as well as wheat, though in the majority of cases wheat showed the highest levels of infection, as in the 2000 trials:

Take-all index

Crop	Seed trt	Cirencester	Caythorpe
Triticales	Sibutol	6	17
	Sib+Latitude	1	13
	Jockey	3	20
Wheat	Sibutol	25	21
	Sib+Latitude	28	26
	Jockey	14	26
Barley	Raxil S	24	3
	Raxil S+Latitude	9	2

Severe take-all would give index figures of 50 or above, so the figures recorded here could only be described as moderate. However there are differences between the cereal species, but little, if any, reduction from the take-all seed treatments.

Low take-all levels were common in this project; however at the Hatton site in 2002, significantly higher levels were recorded:

Take-all index (root infection) GS75 (2002)

Crop	Seed trt	Cirencester	Caythorpe	Hatton
Triticale	Sibutol	2	0	33
	Sib+Latitude	4	0	28
	Jockey	2	0	24
Wheat	Sibutol	8	0	67
	Sib+Latitude	7	0	59
	Jockey	7	0	59
Barley	Raxil S	25	0	42
	Raxil S+Latitude	14	0	19

Levels were exceptionally low at Cirencester (with the highest levels on barley) and the disease was completely absent at Caythorpe. However it reached severe levels at Hatton, though there was still more on the wheat than on the triticale. Once again the seed treatments reduced take-all only slightly, for wheat and triticale, though there was a reduction on the barley of over 50% through the use of Latitude.

2. Yields

(i) 2000

Yield (t/ha)

Crop	Seed treatment	Cirencester	Caythorpe	Hatton	Mean
Triticale (triaz.)	Sibutol	6.86	8.23	9.04	8.04
	Sib.+Latitude	7.04	8.15	8.19	7.79
	Jockey	6.88	7.98	8.95	7.94
Triticale (strob.)	Sibutol	7.09	8.84	8.96	8.30
	Sib.+Latitude	7.42	8.61	8.65	8.22
	Jockey	7.38	8.56	8.90	8.28
Wheat	Sibutol	7.43	9.83	9.53	8.93
	Sib.+Latitude	7.17	9.77	9.48	8.81
	Jockey	6.81	9.74	9.52	8.69
Barley	Raxil S	7.05	8.80	8.19	8.01
	Raxil+Latitude	6.96	8.83	8.38	8.06

LSD (t/ha)	triticale	0.34	0.64	0.36
	wheat	0.46	0.14	0.40
	barley	1.21	0.70	0.38

Wheat tended to give the higher yields, though at Cirencester the triticale was comparable. There were no positive responses to the take-all seed treatments in any of the trials, a reflection of the low levels of the disease, and the variable control mentioned earlier. In fact the only statistically significant yield effects

were reductions in yield, from Jockey on the wheat at Cirencester, and on triticale (triazole programme) at Hatton. The three-site mean figures illustrate this lack of response well.

At Cirencester, strobilurin fungicides gave the higher yields on triticale, these responses being statistically significant in two of the three comparisons. However of the same comparisons at the other two sites, only one significant response was noted i.e. where Latitude was used.

(ii) 2002

Yield (t/ha)

Crop	Seed treatment	Cirencester	Caythorpe	Hatton	Mean
Triticale (triaz.)	Sibutol	8.12	8.67	7.40	8.06
	Sib.+Latitude	7.87	8.57	8.11	8.18
	Jockey	7.73	8.71	7.93	8.12
Triticale (strob.)	Sibutol	8.01	8.65	8.07	8.24
	Sib.+Latitude	8.12	9.07	8.37	8.52
	Jockey	8.22	8.86	8.36	8.48
Wheat	Sibutol	7.57	10.08	5.31	7.65
	Sib.+Latitude	7.84	10.14	6.09	8.02
	Jockey	7.47	10.06	6.33	7.95
Barley	Raxil S	6.02	9.20	3.86	6.36
	Raxil+Latitude	6.27	8.84	4.68	6.60

LSD (t/ha) triticale	0.52	0.45	0.48
wheat	0.49	0.51	0.39
barley	1.76	0.66	0.90

The largest responses to the take-all seed treatments were seen at the Hatton site, which, as seen earlier, had the highest take-all infection. As a result of the latter, the wheat was outyielded by the triticale at this site.

With a triazole-based fungicide programme, the responses to Latitude and Jockey were comparable to those in the wheat, as well as being greater than the same responses where strobilurins had been used. There were no statistically significant yield responses to take-all seed treatment at either of the other two sites, reflecting the lower levels of the disease.

Of the nine comparisons between strobilurin and non-strobilurin programmes, only two showed a statistically significant yield response to the strobilurin programme.

3. Gross margins

The following tables show the three-year mean gross margins for each of the three sites:

Cirencester **Gross margin (£/ha)**

Crop	2000	2001	2002	Mean
Winter wheat	230	274	178	227
Triticale (+ strobilurins)	230	313	201	248
Triticale (+ triazoles)	228	354	215	266
Winter barley	253	162	120	178

Triticale has performed well at this site, giving the highest margins in two of the three years. The three-year mean shows it to be more profitable than wheat or barley with either fungicide programme, though the non-strobilurin (triazole) programme was more cost-effective.

Caythorpe **Gross margin (£/ha)**

Crop	2000	2001	2002	Mean
Winter wheat	404	395	417	405
Triticale (+ strobilurins)	344	334	309	329
Triticale (+ triazoles)	332	331	316	326
Winter barley	391	295	291	326

Wheat has consistently been the most successful crop at this site (despite the similar soil type to Cirencester), with triticale and barley giving similar returns over the three years. As at Cirencester, there has been no financial benefit from strobilurins on triticale.

Hatton **Gross margin (£/ha)**

Crop	2000	2002	Mean
Winter wheat	383	118	251
Triticale (+ strobilurins)	332	237	285
Triticale (+ triazoles)	349	236	293
Winter barley	334	48	191

With only two years' data the figures should be treated with reserve. There is a contrast in results over the two years, with wheat being the most successful second cereal in 2000, when take-all was absent from the

trial, but in 2002 with high take-all levels triticale became the best option. This latter result was the more influential in that the two-year mean still shows triticale to be the most profitable crop.

Conclusions and implications

The relative performance of the three crops differed across the three sites. In the Lincolnshire trials at Caythorpe, take-all was never recorded at high levels and consistently wheat was the most profitable crop. This was also the case at Hatton in 2000, where take-all was absent, but in 2002 this site developed the highest take-all levels seen in the project, and as a result the triticale, which suffered from take-all but to a much lesser extent than wheat, was the more profitable crop.

The results from Cirencester, however, did not follow the same trend. Frequently take-all was at low levels, and it never reached the levels seen at Hatton in 2002. However triticale was the most cost-effective crop choice at this site in two of the three years, with barley the most profitable in the other year. Despite similar soil types, therefore, in this project wheat was never the best crop choice at Cirencester, but was consistently the best at Caythorpe.

Generally, take-all seed treatments (Latitude or Jockey) did not give significant yield responses unless the levels of this disease were severe. In such situations, triticale outyielded wheat due to higher levels of take-all on the latter. At the Hatton trial site in 2002, where these effects were noted, using Latitude or Jockey on the wheat increased yield significantly, but did not bring its yield up to that of triticale.

However, despite lower take-all levels on triticale, it still on occasion showed statistically significant yield responses to take-all seed treatments.

Some of the higher responses to Latitude were seen in the winter barley trials, but only where its yield was exceptionally low (less than 5 t/ha). These low yields and seed treatment responses corresponded with reasonably high take-all levels, but similar levels in other trials did not elicit such responses. However it is clear that barley can suffer from take-all, in some trials more so than wheat (e.g. Cirencester 2001 and 2002).

Out of eight possible comparisons, triticale gave notably higher margins with strobilurin programmes than with non-strobilurin programmes on only one occasion (Caythorpe 2000). Yield responses to the strobilurin programme were not uncommon, but these were rarely sufficient to be cost-effective on this crop.

This project has confirmed that triticale has a role where yield potential is low, due to low fertility or take-all pressure. In such situations wheat suffers more than triticale which can as a consequence give higher yields. Based on the assumptions made here, that triticale would trade at the same price as wheat, it would also be a more cost-effective choice for a second cereal position. With higher take-all pressure, Latitude and Jockey have produced significant yield responses in wheat, but since such responses, albeit smaller, were also seen in triticale in the same situations, these seed treatments have not made up the yield deficit between these two crops.

With small and inconsistent responses to strobilurin fungicides, triticale is also likely, in this respect, to be cheaper to grow than wheat.

However, without the constraints of low yield potential and/or take-all, wheat has consistently outperformed triticale. Barley has been the best crop choice in only one year at one site, and, although it has responded to take-all seed treatment, has done so in response to high take-all pressure giving very low yields (4-5 t/ha).

Technical Report

Introduction

The Agenda 2000 reforms had a general effect of raising the proportion of cereal crops in rotations, with fewer break crops. This focuses the grower's attention on precisely which cereal should be grown in the extra rotation positions, bearing in mind the poor performance of consecutive wheat crops compared to that of a first wheat. Wheat and barley have traditionally occupied the second and third cereal slots after a break, but in order to have a wider choice, some growers would consider triticale.

The total area of triticale at the start of this project was fairly small compared to other European countries (around 8000 ha), but it is grown on a large number of farms. It has always been considered as a crop suited to certain soil types, and whilst it cannot be expected to replace significant amounts of wheat acreage, on the poorer, lighter soils it may be more profitable and therefore may have a niche on many farms. It is known to be fairly disease-resistant, and less susceptible to take-all than wheat, though traditionally triticale varieties have been weak-strawed. This latter point has been overcome to some extent by the advent of new varieties with shorter, stiffer straw.

This project aimed to compare the agronomic and economic performance of triticale, wheat and barley, grown as second or third cereals, at a number of sites across England. The crops were grown with optimum management including evaluation of take-all seed treatments, and for triticale, strobilurin fungicides. Gross margin comparisons were used to assess the relative performance of the three crops.

Materials and methods

Trials were conducted as replicated, small plot trials at three locations:

Cirencester, Gloucestershire	343a Elmtun (limestone brash)
Caythorpe, Lincolnshire	343a Elmtun (limestone brash)
Hatton, Warwickshire	711m Salop (slowly permeable reddish clay loam)

Previous crops in each year of the project were winter wheat for Cirencester and Hatton, and spring barley for Caythorpe. In 2000 the Cirencester trial was in a third cereal position, all other trials were second cereals.

Due to difficult weather conditions in autumn 2000, the 2000/01 trial at Hatton failed to establish.

Cultivars: Triticale – Fidelio
 Wheat – Consort
 Barley – Regina

Each cereal was sown with a standard seed treatment (Sibutol on triticale and wheat, Raxil S on barley), Latitude (silthiofam), added to the standard treatment, and Jockey (fluquinconazole, wheat and triticale only). In addition, the treatments above for triticale were repeated with both a strobilurin-based and conventional, triazole-based foliar fungicide programme. Wheat and barley plots received appropriate strobilurin-based fungicide programmes.

Seed rates: wheat and triticale 400 seeds/m², barley 350 seeds/m².

Wheat and barley plots received appropriate strobilurin-based fungicide programmes. The triticale programmes were as follows:

Strobilurin: GS31/2 – Amistar (azoxystrobin) 0.5 l/ha, + Opus (epoxiconazole) 0.5 l/ha
 GS39 – Amistar 0.75 l/ha + Opus 0.5 l/ha
Triazole: GS31/2 – Opus 0.5 l/ha + Tern (fenpropidin) 0.3 l/ha
 GS39 - Opus 0.75 l/ha + Tern (fenpropidin) 0.3 l/ha

Wheat programme: as strobilurin programme for triticale.

Barley programme: GS31 – Amistar 0.5 l/ha + Opus 0.3 l/ha
 GS45 - Amistar 0.25 l/ha + Opus 0.3 l/ha

Assessments were made of:

Take-all levels – root infection at GS75, and whitehead populations.

Foliar disease levels (for the two fungicide programmes on triticale) GS75

Yield (tonnes/ha)

Specific weight

Lodging at harvest (if present)

In addition, grain protein levels were analysed following the 2001 harvest, to compare the relative nutritional value of wheat and triticale.

Gross margins for all crop/treatment combinations were also calculated.

Results

2000

1. Take-all infection

Take-all index (root infection) GS75

Crop	Seed trt	Cirencester	Caythorpe	Hatton
Triticale	Sibutol	6	17	0
	Sib+Latitude	1	13	0
	Jockey	3	20	0
Wheat	Sibutol	25	21	0
	Sib+Latitude	28	26	0
	Jockey	14	26	0
Barley	Raxil S	24	3	0
	Raxil S+Latitude	9	2	0

No take-all infection was found in any of the plots at Hatton.

In both the Cirencester and Caythorpe trials the highest levels of take-all were seen in the wheat crop, with the barley at Cirencester showing high levels also. However there are no consistent effects of the take-all seed treatments. Latitude reduced root infection in the barley at Cirencester, but levels on this crop at Caythorpe were too low to show any differences, whilst on wheat Latitude had no effect on the disease. Jockey appeared to reduce take-all levels on wheat at Cirencester, but had no such effect at Caythorpe.

2. Foliar disease on triticale

% *Septoria tritici* (whole plant)

Cirencester:

	Sibutol	Sibutol +Latitude	Jockey
Triazole programme	6	7	6
Strobilurin programme	3	3	4

Disease levels, on a whole-plant basis, were low, but there were still differences between the two fungicide programmes, the strobilurin programme giving the slightly cleaner crop.

Disease levels at the Hatton and Caythorpe sites were very low, with no more than trace levels of any disease in either programme.

3. Yields

Yield (t/ha)

Crop	Seed treatment	Cirencester	Caythorpe	Hatton	Mean
Triticale (triaz.)	Sibutol	6.86	8.23	9.04	8.04
	Sib.+Latitude	7.04	8.15	8.19	7.79
	Jockey	6.88	7.98	8.95	7.94
Triticale (strob.)	Sibutol	7.09	8.84	8.96	8.30
	Sib.+Latitude	7.42	8.61	8.65	8.22
	Jockey	7.38	8.56	8.90	8.28
Wheat	Sibutol	7.43	9.83	9.53	8.93
	Sib.+Latitude	7.17	9.77	9.48	8.81
	Jockey	6.81	9.74	9.52	8.69
Barley	Raxil S	7.05	8.80	8.19	8.01
	Raxil+Latitude	6.96	8.83	8.38	8.06
LSD (t/ha)					
triticale		0.34	0.64	0.36	
wheat		0.46	0.14	0.40	
barley		1.21	0.70	0.38	

There were no positive responses to the take-all seed treatments in any of the trials, a reflection of the variable take-all control. In fact the only statistically significant yield effects were reductions in yield, from Jockey on the wheat at Cirencester, and on triticale (triazole programme) at Hatton.

At Cirencester the triticale gave similar yield to the wheat, but at the other two sites the wheat was clearly higher yielding. Generally the strobilurin fungicide programme gave higher triticale yields, though these differences were not always statistically significant.

Lodging was recorded in triticale at the Hatton site, and whilst there are no obvious trends with respect to treatments, the lodging scores do relate to some extent to the yields, and may therefore be a contributory factor to the latter:

	Seed treatment	% area lodged	Yield (t/ha)
Triticale (triaz.)	Sibutol	3	9.04
	Sib.+Latitude	48	8.19
	Jockey	10	8.95
Triticale (strob.)	Sibutol	25	8.96
	Sib.+Latitude	25	8.65
	Jockey	17	8.90

4. Gross margins

The gross margins achieved at each site, averaged across the seed treatments, were as follows:

Gross margin (£/ha)

	Cirencester	Caythorpe	Hatton
Winter wheat	230	404	383
Triticale (+ strobilurins)	230	344	332
Triticale (+ triazoles)	228	332	349
Winter barley	253	391	334

At Cirencester, barley was the most profitable crop overall, with wheat and triticale giving similar returns. At Caythorpe and Hatton, the higher yields seen from the wheat crop are carried through to the margins, this being the most profitable at both sites, though at Caythorpe the barley margin was not far behind. In the Hatton trial, wheat was clearly the best option, but there was a total absence of take-all at this site, which would have helped this crop more than the others.

2001

The Hatton trial was not established in 2000/01

1. Take-all infection

Take-all index (root infection) GS75

Crop	Seed trt	Cirencester	Caythorpe
Triticale	Sibutol	11	0
	Sib+Latitude	12	0
	Jockey	10	0
Wheat	Sibutol	8	0
	Sib+Latitude	4	0
	Jockey	n/a	0
Barley	Raxil S	24	0
	Raxil S+Latitude	12	0

Levels of take-all were again low, as in 2000, with none recorded at Caythorpe and only moderate infection at Cirencester, though here levels on wheat were the lowest in trial. Latitude seed treatment gave a noticeable reduction in take-all in the barley crop at Cirencester, but neither Latitude nor Jockey reduced the already-low levels on the triticale.

2. Foliar disease on triticale

% *Septoria tritici* (whole plant)

Cirencester:

	Sibutol	Sibutol +Latitude	Jockey
Triazole programme	8	6	6
Strobilurin programme	7	7	6

As in 2001 disease levels were very low in this crop, and there are no differences in levels between the fungicide programmes. Again disease was at trace levels or below in the Caythorpe trial.

3. Yields

Yield (t/ha)

Crop	Seed treatment	Cirencester	Caythorpe	Mean
Triticale (triaz.)	Sibutol	6.11	7.89	7.00
	Sib.+Latitude	6.70	7.78	7.24
	Jockey	5.64	7.70	6.67
Triticale (strob.)	Sibutol	5.81	7.83	6.82
	Sib.+Latitude	6.38	7.93	7.20
	Jockey	6.59	7.79	7.19
Wheat	Sibutol	5.28	7.62	6.45
	Sib.+Latitude	5.78	7.78	6.78
	Jockey	5.07	7.61	6.34
Barley	Raxil S	4.03	7.04	5.53
	Raxil+Latitude	4.69	6.65	5.67
LSD (t/ha) triticale		0.67	0.33	
wheat		0.78	0.26	
barley		0.55	0.85	

In the Cirencester trial Latitude seed treatment gave large yield increases on all three crops, though only on barley was the difference statistically significant. However Jockey produced a significant yield benefit in the strobilurin-treated triticale at this site. At Caythorpe the differences in yield between seed treatments were much smaller with no seed treatment giving a clear benefit. Strobilurin fungicides gave a significant benefit over the non-strobilurin programme at Cirencester where Jockey seed treatment was used, but not with Latitude or Sibutol.

Generally the triticale at Cirencester outyielded the wheat, with some of the comparative figures being statistically significant. Both out-performed the barley, the yield of which was exceptionally low. At Caythorpe, again there are few differences in yields, the wheat and triticale giving very similar values.

4. Gross margins

The gross margins achieved at each site, averaged across the seed treatments, were as follows:

Gross margin (£/ha)

Crop	Cirencester	Caythorpe
Winter wheat	274	395
Triticale (+ strobilurins)	313	334
Triticale (+ triazoles)	354	331
Winter barley	162	295

Triticale was clearly the most profitable crop at Cirencester, though using a strobilurin fungicide programme was not. Barley was least profitable, reflecting its low yields. At the Caythorpe site, wheat was again the most cost-effective crop choice (as in 2000), and as at Cirencester, there was no clear advantage in using strobilurin fungicides on triticale.

5. Grain protein levels

Following the 2001 harvest, grain samples from the triticale and wheat were analysed for grain protein levels.

Crop	Seed treatment	Cirencester	Caythorpe
Triticale (triaz.)	Sibutol	11.05	10.30
	Sib.+Latitude	11.05	10.49
	Jockey	10.87	10.64
Triticale (strob.)	Sibutol	11.12	10.14
	Sib.+Latitude	11.18	10.32
	Jockey	10.70	11.03
Wheat	Sibutol	10.76	10.52
	Sib.+Latitude	11.06	10.61
	Jockey	10.93	10.88

In the Cirencester analyses, triticale compares most favourably with wheat where Sibutol seed treatment was used, with differences up to 0.36%. With the other seed treatments the figures for protein are closer together. At Caythorpe, there is less evidence of a difference between wheat and triticale, but where the latter was treated with strobilurins, there was a marked improvement in protein level where Jockey seed treatment was used. (However this is the reverse of comparable Cirencester data).

Generally there was little difference between the two crops in terms of grain protein content.

2002

1. Take-all infection

Take-all index (root infection) GS75

Crop	Seed trt	Cirencester	Caythorpe	Hatton
Triticale	Sibutol	2	0	33
	Sib+Latitude	4	0	28
	Jockey	2	0	24
Wheat	Sibutol	8	0	67
	Sib+Latitude	7	0	59
	Jockey	7	0	59
Barley	Raxil S	25	0	42
	Raxil S+Latitude	14	0	19

Take-all levels were fairly low at Cirencester, with the exception of the barley, and totally absent in all crops at Caythorpe. However, the levels in the Hatton trial were the highest seen at any site during the course of this project. The wheat plots showed the highest levels, around twice as much as on triticale, but with both of these crops the seed treatments had little effect in reducing infection levels. Control was, however, more apparent with the winter barley.

2. Foliar disease on triticale

All three sites recorded no assessable disease in any of the triticale plots.

3. Yields

Yield (t/ha)

Crop	Seed treatment	Cirencester	Caythorpe	Hatton	Mean
Triticale (triaz.)	Sibutol	8.12	8.67	7.40	8.06
	Sib.+Latitude	7.87	8.57	8.11	8.18
	Jockey	7.73	8.71	7.93	8.12
Triticale (strob.)	Sibutol	8.01	8.65	8.07	8.24
	Sib.+Latitude	8.12	9.07	8.37	8.52
	Jockey	8.22	8.86	8.36	8.48
Wheat	Sibutol	7.57	10.08	5.31	7.65
	Sib.+Latitude	7.84	10.14	6.09	8.02
	Jockey	7.47	10.06	6.33	7.95
Barley	Raxil S	6.02	9.20	3.86	6.36
	Raxil+Latitude	6.27	8.84	4.68	6.60
LSD (t/ha)					
triticale		0.52	0.45	0.48	
wheat		0.49	0.51	0.39	
barley		1.76	0.66	0.90	

With the low levels of take-all at Cirencester and Caythorpe, there were no significant yield benefits from Latitude or Jockey on any of the three crops. Triticale was marginally the higher yielding crop at Cirencester, with barley the lowest. In the Caythorpe trial, as in previous years winter wheat gave the highest yields, with winter barley slightly higher yielding than triticale.

At Hatton the yields reflect the take-all levels reasonably well, with triticale higher yielding than wheat. This has also carried through to the three-site mean values. Despite the low level of take-all control from Latitude and Jockey in the Hatton trial, both seed treatments have given higher yields than Sibutol for wheat and triticale. These responses were statistically significant in the wheat and triazole-treated triticale.

4. Gross margins

The gross margins achieved at each site, averaged across the seed treatments, were as follows:

Gross margin (£/ha)

Crop	Cirencester	Caythorpe	Hatton
Winter wheat	178	417	118
Triticale (+ strobilurins)	201	309	237
Triticale (+ triazoles)	215	316	236
Winter barley	120	291	48

Triticale was again, as in 2001 the most profitable crop at Cirencester, though again using a strobilurin fungicide programme was not. Barley was least profitable, reflecting its low yields. At the Caythorpe site, wheat was, for the third year in succession, the most cost-effective crop choice, and as at Cirencester, there was no margin advantage in using strobilurin fungicides on triticale.

With the high take-all levels at the Hatton site, the wheat crop appeared to be compromised the most, and as a result triticale was the most profitable crop, though again there was no clear advantage to the use of strobilurin fungicides. As at the other sites, barley was least profitable, and carried the largest financial penalty at this site.

Lodging

Apart from the lodging figures recorded at the Hatton site in 2000 (qv), no other trial recorded any lodging in any of the three crops.

Gross margins: three-year summaries

Cirencester

Gross margin (£/ha)

Crop	2000	2001	2002	Mean
Winter wheat	230	274	178	227
Triticale (+ strobilurins)	230	313	201	248
Triticale (+ triazoles)	228	354	215	266
Winter barley	253	162	120	178

Triticale has performed well at this site, giving the highest margins in two of the three years. The three-year mean shows it to be more profitable than wheat or barley with either fungicide programme, though the non-strobilurin (triazole) programme was more cost-effective.

Caythorpe

Gross margin (£/ha)

Crop	2000	2001	2002	Mean
Winter wheat	404	395	417	405
Triticale (+ strobilurins)	344	334	309	329
Triticale (+ triazoles)	332	331	316	326
Winter barley	391	295	291	326

Wheat has consistently been the most successful crop at this site (despite the similar soil type to Cirencester), with triticale and barley giving similar returns over the three years. As at Cirencester, there has been no financial benefit from strobilurins on triticale.

Hatton

Gross margin (£/ha)

Crop	2000	2002	Mean
Winter wheat	383	118	251
Triticale (+ strobilurins)	332	237	285
Triticale (+ triazoles)	349	236	293
Winter barley	334	48	191

With only two years' data the figures should be treated with reserve. There is a contrast in results over the two years, with wheat being the most successful second cereal in 2000, when take-all was absent from the trial, but in 2002 with high take-all levels triticale became the best option. This latter result was the more influential in that the two-year mean still shows triticale to be the most profitable crop.

Discussion

Although the best evidence only comes from one trial (Hatton 2002), the results generated in this project suggest that triticale would be a potential alternative to wheat in second/third cereal fields where yield potential is low, perhaps due to high take-all pressure. Unfortunately many of the trials in this project experienced low levels of take-all, and perhaps as a consequence of this triticale did not always appear a cost-effective alternative. Particularly at the Lincolnshire site, take-all levels have consistently been low and wheat has consistently been the best option for a second cereal crop. (It should be remembered, however, that the first cereal in the Lincolnshire trials was spring barley, so the trials may be considered to have been run in untypical second cereal positions). At the Cirencester site, take-all has regularly developed on the three crops, and though not at severe levels, wheat was not the best crop option at this site in any of the three years (barley in 2000, triticale in 2001 and 2002).

Of the three crops, barley has been least consistent. Along with its good performance at Cirencester and Caythorpe in 2000, it was frequently the least profitable crop in the latter years. Yields of barley on farm have been disappointing generally in recent years, leading to a significant reduction in the area grown, and the results here reflect this. However it has shown significant levels of take-all in some trials, on occasion more than was seen on wheat, and an appreciation of its susceptibility to this disease may explain its disappointing performances, given that on farm it is usually grown in a second or third cereal position.

A further reflection of this is seen in the responses in barley to the take-all seed treatments. At Cirencester in 2001 and Hatton in 2002, the barley gave some of the largest responses to Latitude. This corresponded in both cases with very low yields, reflecting fairly high take-all levels. However the link between take-all levels and barley yield is not consistent, since in the Cirencester trial in 2000 levels of take-all were fairly high, as high as on wheat, but there was no yield response to Latitude in this case.

Take-all developed to reasonable levels in the triticale at Caythorpe in 2000 and at Hatton in 2002, indicating that this crop can suffer from this disease. Where it did reach significant levels, take-all seed treatments increased yield, though the responses were not always statistically significant. The value of these treatments on this crop cannot be ruled out, even though the crop is less susceptible to take-all than wheat.

Another effect seen in some of these trials is the yield response to Latitude and Jockey, despite only minimal take-all control (e.g. Hatton 2002). However, these responses still correspond to high take-all pressure, and where levels of the disease were low, then so were responses to the seed treatments even where they appeared to reduce these levels.

In terms of crop management for triticale, there were frequent responses to strobilurin fungicides over non-strobilurin, triazole-based programmes. However these responses were only statistically significant in a few cases, and with the low levels of foliar disease seen in this crop, the case for strobilurin use is not strong based on the data generated here.

There is strong evidence in this project to suggest that triticale can compete with winter wheat as an option for a second or third cereal crop, where the yield potential is low, and/or take-all pressure is expected to be high. In the absence of significant take-all, wheat yields have been relatively high (9 t/ha and above) and this crop has been seen to be the most cost-effective. However, with moderate or high levels of take-all, and corresponding lower yields, triticale has competed well on gross margin with wheat. The use of take-all seed treatments improved the wheat yield in these cases, but since similar responses were also seen in triticale, this did not necessarily reduce the difference in overall performance between these two crops.

It was also shown that in terms of disease control, triticale should be cheaper to grow than wheat. It was always difficult to find significant levels of disease in the triticale plots. However the one aspect of the triticale crop which needs addressing is the market. In the gross margin comparisons presented here, triticale was priced the same as wheat. In some cases it is actually marketed at a discount to wheat, whilst some would argue its different grain quality attributes should attract a premium. No differences in grain protein levels between wheat and triticale were recorded, though there may be other quality parameters that would be relevant to the triticale crop.

Until there is a definite, recognised market for the crop, the economic viability can only be inferred, but if an end market can be assured, then triticale would have a place in low yielding second cereal situations.

Appendix

Supplementary data

1. Specific weights (kg/hl)

2000

Crop	Seed treatment	Cirencester	Caythorpe	Hatton
Triticale (triaz.)	Sibutol	70.8	69.9	68.0
	Sib.+Latitude	72.6	71.0	66.5
	Jockey	71.9	69.9	66.7
Triticale (strob.)	Sibutol	72.3	70.8	66.5
	Sib.+Latitude	72.5	70.2	66.1
	Jockey	72.7	70.0	66.4
Wheat	Sibutol	71.7	75.2	75.9
	Sib.+Latitude	71.9	74.6	76.6
	Jockey	66.4	74.8	75.0
Barley	Raxil S	62.6	64.8	65.0
	Raxil+Latitude	63.0	62.8	65.5

2001

Crop	Seed treatment	Cirencester	Caythorpe
Triticale (triaz.)	Sibutol	70.9	70.0
	Sib.+Latitude	71.3	69.9
	Jockey	70.2	69.7
Triticale (strob.)	Sibutol	70.9	69.8
	Sib.+Latitude	71.4	69.8
	Jockey	71.3	69.7
Wheat	Sibutol	69.1	75.9
	Sib.+Latitude	71.2	75.7
	Jockey	69.2	75.4
Barley	Raxil S	56.5	67.3
	Raxil+Latitude	60.5	67.6

2002

Crop	Seed treatment	Cirencester	Caythorpe	Hatton
Triticale (triaz.)	Sibutol	73.2	74.0	69.8
	Sib.+Latitude	n/a	72.8	70.4
	Jockey	73.9	72.2	70.3
Triticale (strob.)	Sibutol	73.6	72.8	71.3
	Sib.+Latitude	73.0	74.0	71.2
	Jockey	73.8	73.6	70.9
Wheat	Sibutol	75.6	74.0	72.4
	Sib.+Latitude	74.7	74.2	72.0
	Jockey	74.4	74.8	73.5
Barley	Raxil S	66.2	68.8	68.1
	Raxil+Latitude	67.3	68.8	69.3

2. Grain prices

The following grain prices were used for gross margin calculations (£/tonne)

	2000	2001	2002
Wheat and triticale	58	74	53
Barley	60	63	51

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