Project title:	Dwarf green beans: Strategy for the control of pod rot by *Botrytis cinerea*
Project number:	FV 252
Project leader:	Dr Anthony Biddle Processors and Growers Research Organisation Great North Road Thornhaugh Peterborough PE8 6HJ
Report:	Final report, February 2006
Previous reports:	Annual reports 2004 and 2005
Location:	Commercial crops of green Beans in East Anglia, West Midlands and Peterborough
Project co-ordinator:	Mr. P. Langley Bomfords Manor Farm Luddington Warwicks.
Date commenced:	1 May 2003
Date completed:	March 2006
Key words:	Dwarf green beans, pod rot, varietal susceptibilty, fungicide evaluation, fungicide resistance, *Botrytis cinerea, Sclerotinia sclerotiorum*

CONTENTS

Headline

- Three products; Filan (boscalid), Frupica (mepanipyrim) and a coded product (A9219B), gave a 50% reduction in infected pods, which was equivalent to commercial standard treatment. These products are not currently approved for use, but approvals are now being investigated.
- Importantly, several isolates of *Botrytis cinerea* collected from commercial crops were found to exhibit resistance to Ronilan (vinclozolin), especially where the product had been applied twice during the season.
- Varietal screening highlighted differing levels of resistance / susceptibility to Botrytis pod rot. Cerdon and Albany gave good field resistance (see table).

Background and expected deliverables

Yield and quality loss of green beans for fresh market or freezing can be caused by Botrytis pod rot. Fungicide applications are costly and timing is precise. There is a limited range of approved products and repeated use increases the risk of resistance. There is little information on varietal tolerance to the disease.
New candidate fungicides will be screened during the life of the project. Checks on the resistance status of *Botrytis cinerea* will be examined and differences in varietal tolerance of a range of green bean types will be tested.

The expected deliverables from this work include:

Data on efficacy of fungicide screened in trials over three years for products suitable to obtain SOLAs
A survey of strains of Botrytis cinerea from commercial crops will be screened for resistance to the commonly used approved products.
The relative field resistance of new commercially available green beans varieties will be screened in trials in each of the three years.

Summary of the project and main conclusions

Fungicide screening
Two fungicide screening trials were carried out in commercial crops of green beans in each of the three years of the project. Disease level was generally low and differences in the level of control were not always statistically significant. Of the fungicides tested in each of the three years, Signum (boscalid and pyraclostrobin) and a coded material (A9219B) resulted in around 50% reduction of infected pods and this was as effective as the current standards, Amistar and Ronilan. In one year of tests, Filan (boscalid) and Frupica (mepanipyrim) also showed useful control of pod rot. Signum, Filan and Frupica are currently UK approved in vegetables or fruit and a SOLA could be generated. A9219 is currently approved in France and commercial development in the UK is being considered by the manufacturer.

Botrytis pod rot

Fungicide resistance

A number of isolates of *Botrytis cinerea* were collected from infected pods taken from commercial crops in Eastern England and the West Midlands in each of the three years. These were screened in laboratory bioassays for resistance to azoxystrobin (Amistar) and Ronilan (vinclozolin). In 2003 and 2005, several isolates were found to be resistant to vinclozolin. It was indicated that these were more frequently found in crops which had received two sprays of Ronilan in the season.

Varietal resistance to pod rot

Green bean varieties with a range of pod characteristics representing those used for freezing as sliced, cut or whole beans and for fresh market picking were evaluated for Botrytis pod rot in trials at Thornhaugh and in the West Midlands in each of the three years. Twenty one varieties were screened in each year and there were clear indications of varietal susceptibility to Botrytis pod rot. Moncayo, Ceres and Boston were the most susceptible and Cerdon, Albany and Masai were the most resistant.Varietal susceptibility to Botrytis pod rot 2003-2005

Susceptible	Moncayo Ceres Boston
Moderately susceptible	Artemis Baroma Cadillac SB 4251 Bravo Astun Lasso Green Arrow Nomad BB 2174
Slightly susceptible	BB 2175 R 9421 Laguna Scuba Jackpot
Good field resistance	Cerdon Albany

Financial benefits

Because of the risk of crop rejection as a result of a high proportion of pods being blemished by pod rot, the crop is usually sprayed with preventative fungicides on one or two occasions depending on the weather conditions at the time of flowering and pod development. The cost is estimated as:-

Standard treatment (Amistar or Ronilan)

2 applications at 1.0 l/ha £74 /ha (inc. application & chemical)

Where there is a choice of a good resistant variety, then this cost can be saved.

Where there is a requirement for more susceptible varieties to be grown for specific markets, then in some cases it is likely that the population of resistant Botrytis strains will increase where the standard fungicide products are in regular use. The risk of this occurring will be reduced if a choice of alternative products is available.

Action points for growers

- Avoid applying sequential sprays with the same fungicide product
- Alternate the fungicide product when choice becomes wider
- Consider the use of varieties with better resistance to pod rot

SCIENCE SECTION

Introduction

Pod rot caused by *Botrytis cinerea* can cause yield loss and reduce the value of the produce by blemishing. Disease development is influenced by weather conditions, but control relies on the use of a fungicide programme with a very limited range of products.

The project is aimed at producing a strategy for disease control by an evaluation of varietal susceptibility to the disease and the efficacy of both currently approved and candidate fungicides. In addition, an investigation will establish the status of fungicide resistant populations of *Botrytis cinerea* in dwarf green beans.

Materials and Methods

Varietal susceptibility

In each of the three years, varieties were drilled in disease observation plots at two sites. Thornhaugh, Cambs. in each year and in different sites in Worcestershire in commercial crops of green beans. At Thornhaugh the plot length was 10m and contained four rows of plants at a row spacing of 30cm. For the Worcs trials, each plot was 5m in length and contained two rows of each variety with 30cm row spacing. In all trials, each variety was replicated 3 times in a randomised block design.

The site details were as follows:

2003

Site 1 Thornhaugh, PGRO Trial ground, Peterborough, TF 078007
sowing date: 28th May 2003. Soil type: fine sand.

Site 2 Salford Priors, (Bomfords Ltd) New Inn Lane, Abbots Priors, Worcs, SP 060510
Sowing date; 25th June 2003. Soil type: sandy loam.

2004

Site 1 Thornhaugh, PGRO Trial ground, Peterborough, TF 078007
sowing date: 24th May 2004 Soil type: fine sandy loam.

Site 2 Rushford, Evesham Road, Salford Priors, Worcs, SP 055501
Sowing date; 1st July 2004. Soil type: sandy loam.

2005

Site 1. Thornhaugh, PGRO Trial Ground, Peterborough, TF 076011
Sowing date; 25th May 2005. Soil type sandy loam.

Site 2. Clifton, Worcs, SO 852463
Sowing date; 7th July 2005. Soil type silty loam

Each variety represented different pod types to reflect their usefulness for both processing and fresh market. The varieties and pod types and the years in which they were included in the trials are shown in table 1.

Table 1. Varieties screened for Botrytis pod rot infection

Variety	Pod type	Years tested		
Lasso	fine	2003	2004	2005
Albany	fine	2003	2004	2005
Excalibur	fine			2005
R 9421	fine		2004	2005
Cerdon	fine		2004	2005
Bravo	fine		2004	2005
Jackpot	fine		2004	2005
Koala	fine			2005
Canzone	fine			2005
Masai	fine	2003	2004	
Calgary	fine	2003		
PV 622	fine	2003		
Jersey	fine	2003		
Artemis	flat	2003	2004	2005
Ceres (BB 2160)	flat		2004	2005
Moncayo	flat	2003	2004	2005
Astun	flat	2003	2004	2005
Plazza	flat	2003		
Baroma	flat	2003	2004	2005
SB 4251	flat wax	2003	2004	2005
Green Arrow	large		2004	2005
BB 2174	medium		2004	2005
BB 2175	medium		2004	2005
Laguna	medium	2003	2004	2005
Nomad	medium		2004	2005
Scuba	medium		2004	2005
Boston	medium	2003	2004	2005
Opera	medium	2003		
Cadillac	medium	2003	2004	
Torpedo	medium	2003		
Parker	medium	2003		

Crop husbandry followed standard practice. At the freezing stage, 10 plants from each plot were selected at random and the pods examined. The number of pods infected with *Botrytis* was expressed as a % of the total and a mean value per plant calculated for each plot.

Fungicide evaluation

Two replicated field trials were carried out in commercial crops of beans in each of the two years. Plot size was 2m wide by 5m long and sprays were applied using an Azo plot sprayer with 02 F110 fan nozzles in a volume of 200l/ha at 2.0 bar provided by propane. Sprays were applied on one or two occasions according to commercial practice. The first timing was at the very early pod stage and the second timing was 7 days later.

The site details are as follows:-

2003
Site 1. Barningham Hall, Matlaske, Holt, Norfolk TG143357
Site 2. Jubilee Fram, Feltwell, Cambs TL 675917

2004
Site 1. Neaches Farm, Banningham, Norfolk TG238301
Site 2. Middle Farm, Feltwell Anchor, Southery, Cambs TL662891

2005
Site 1. Spa Farm, Aylsham, Norfolk TG193254
Site 2. Quanea House Farm, Ely, Cambs TL583815

Candidate fungicides were compared with the commercial standards Amistar and Ronilan, but new ones were added as they became available, whilst others were excluded in later years where efficacy was not considered to be satisfactory.

The treatment list for each year was as follows:-

2003 Trial sites

Trade name	Active ingredients	Application rate l/ha	Timing	Approval status
1. untreated				
2. Amistar	azoxystrobin	1.0	$T_1 + T_2$	SOLA
3. Ronilan	vinclozolin	1.0	T_1	approved
4. Ronilan	vinclozolin	1.0 followed by	T_1	approved
Rovral WP	iprodione	1.5 kg	T_2	SOLA
5. Signum	boscalid + pyroclostrobin	1.0	$T_1 + T_2$	UK registered
6. Elvaron Multi	tolyfluanid	3.4	$T_1 + T_2$	UK registered
7. Teldor	fenhaxamid	1.5	$T_1 + T_2$	UK registered
8. Talat	tolyfluanid + fenhaxamid	3.0	$T_1 + T_2$	UK registered

2004 Trial sites

Trade name	Active ingredients	Application rate l/ha	Timing	Approval status
1. untreated				
2. Amistar	azoxystrobin	1.0	$T_1 + T_2$	SOLA
3. Ronilan	vinclozolin	1.0	T_1	approved
4. Ronilan	vinclozolin	1.0 followed by	T_1	approved
Rovral WP	iprodione	1.0 kg	T_2	SOLA
5. Signum	boscalid + pyroclostrobin	1.0	$T_1 + T_2$	UK registered
6. A9219B (Switch)	cyprodonil + fludioxonil	3.4	$T_1 + T_2$	France registered
7. A14111B		1.5	$T_1 + T_2$	experimental
8. A14111B		2.5	$T_1 + T_2$	experimental
9. Amistar	azoxystrobin	1.0	T_1	SOLA
Rovral WP	iprodione	1.0	T_2	SOLA

2005 Trial sites

Trade name	Active ingredients	Application rate l/ha	Timing	Approval status
1. untreated				
2. Amistar	azoxystrobin	1.0	$T_1 + T_2$	SOLA
3. Ronilan	vinclozolin	1.0 followed by	T_1	approved
Rovral WP	iprodione	1.0 kg	T_2	SOLA
4. Signum	boscalid + pyroclostrobin	1.0	$T_1 + T_2$	UK registered
5. A9219B (Switch)	cyprodonil + fludioxonil	3.4	$T_1 + T_2$	France registered
6. A14111B		1.5	$T_1 + T_2$	experimental
7. Frupica	mepanipyrim	0.9	$T_1 + T_2$	UK registered
8. Filan	boscalid	0.5	$T_1 + T_2$	UK registered

Each treatment was replicated four times. At the practical freezing stage, 15 plants were selected at random from each plot and the numbers of healthy and infected pods recorded. Infection was expressed as % of infected pods per plant. All data were analysed by analysis of variance. (GENSTAT).

Fungicide resistance

In each of the three years samples of infected pods were taken from commercial green bean crops and *Botrytis cinerea* was isolated from each pod. Colonies were then inoculated onto potato dextrose agar containing dilutions of azoxystrobin and vinclozolin at 100 ppm a.i. Colony diameter was measured after 2, 5 and 8 days to indicate resistance. Samples were taken from the following locations.

2003 samples

Field	Number of isolates	Location	Crop spray regime
1.	1	Marshland 61, Suffolk	Ronilan fb. Amistar
2.	1	Sutton 119, Suffolk	Ronilan x 2
3.	4	Tunstall 10, Suffolk	Ronilan x 2
4.	1	Sutton 122, Suffolk	Amistar x 2
5.	2	Aldehouse 13, Suffolk	Ronilan fb Amistar
6.	11	Barningham, Norfolk	unsprayed
7.	10	Blickling, Norfolk	Ronilan x 1

2004 samples

Field	Number of isolates	Location	Crop spray regime
1.	4	Banningham, Norfolk	Ronilan x 2
2.	6	Rushford, Worcs	Amistar + Rovral WP x 2
3.	5	Southery, Cambs	Amistar fb Rovral WP

2005 samples

Field	Number of isolates	Location	Crop spray regime
1.	11	Scottow, Norfolk	Ronilan fb. Rovral WP
2.	9	Wood Farm, Aylsham	Ronilan fb. Rovral WP
3.	8	Clifton, Worcs	Amistar + Rovral WP x 3
4.	10	Quanea 8, Cambs	Amistar fb. Ronilan
5.	9	Sloley, Norfolk	Ronilan fb. Rovral WP
6.	9	Worstead, Norfolk	Ronilan x 2

Results

Varietal susceptibility

The very dry weather of 2003 during flowering and pod development was not conducive to disease development, although some *Botrytis* infection was present at the Thornhaugh site. At Salford Priors, no significant level of infection was recorded except on the flat podded varieties. The results of the Thornhaugh site are shown in Table 1 of the Appendix.

In 2004, *Botrytis* infection developed well at the Thornhaugh site, but at Rushford, no significant level of infection was recorded except on the flat podded varieties. The results of the Thornhaugh site are shown in Table 2 of the Appendix

In 2005, infection occurred at low levels at Thornhaugh and Clifton but differences between varieties were recorded. The results are shown in Tables 3 and 4 of the Appendix.

The results were then combined and where the varieties had been in trials for two or three years, the mean of the percentage of pods infected was calculated and the results are shown in Table 2 below.

Table 2. Summary of results: % pods infected by *Botrytis cinerea*

Variety	Pod type	2003	2004	2005	mean
Moncayo	flat	6.43	7.03	3.68	5.71
Ceres	flat		4.97	4.54	4.76
Boston	medium	2.33	3.67	3.69	3.23
Artemis	flat	1.37	4.43	2.31	2.70
Baroma	flat	2.77	1.6	3.66	2.68
Cadillac	medium	0.8	2.43		1.62
SB 4251	flat wax	3.9	0.7	0	1.53
Bravo	fine		2.07	0.88	1.48
Astun	flat	1.9	1.0	1.52	1.47
Lasso	fine	3.53	0	0.76	1.43
Green Arrow	large		0.57	2.16	1.37
Nomad	medium		0	2.68	1.34
BB 2174	medium		2.1	0.27	1.19
BB 2175	medium		1.27	0.41	0.84
R 9421	fine		0.37	1.22	0.80
Laguna	medium	1.43	0.3	0.65	0.79
Scuba	medium		0.1	1.25	0.68
Jackpot	fine		1.17	0	0.59
Cerdon	fine		0.7	0	0.35
Masai	fine	0.17	0.47		0.32
Albany	fine	0.67	0	0.17	0.28

Fungicide evaluation

Despite the hot dry conditions in 2003, the disease levels at the Holt site were sufficiently high enough to show differences in control between the treatments. However the variation in disease between plots was too high for the differences to be statistically significant even after transforming the data. Disease failed to develop at the Feltwell site, but the mean number of pods per plant from each were analysed to reflect any crop safety problems.

The data from the two trials are shown in tables 5 and 6 of the Appendix.

In 2004, Botrytis infection at the Banningham site was sufficiently high enough to show differences in control between the treatments. Disease levels were extremely low at the Southery site and the data are not presented. The data from Banningham are shown in table 7 of the Appendix.

In 2005, infection was again very low and differences in the level of infection at the Aylsham site failed to reach statistical significance. The data are shown in table 4. The trial at Ely became severely infected by *Sclerotinia sclerotiorum* and pod infection scores were also made on the trial, however none of the fungicides gave any obvious reduction of either Botrytis or Sclerotinia. The results are shown in table 8 of the Appendix.

A summary of the fungicide trial results for the three years is shown as the reduction in the percentage of infected pods in table 3.

Table 3. Summary of the level of control of Botrytis pod rot 2003-2005

	Treatment	rate l/ha	timing	% control of Botrytis 2003	% control of Botrytis 2004	% control of Botrytis 2005
1	untreated			0	0	0
2	Amistar	1.0	$T_1 + T_2$	39	51	66
3	Ronilan	1.0	T_1 f.b.			
	Rovral WP	1.0 kg	T_2	67	48	67
4	Signum	1.0	$T_1 + T_2$	64	28	68
5	A9219B (Switch)	3.4	$T_1 + T_2$	nt	49	64
6	A14111B	1.5	$T_1 + T_2$	nt	77	24
7	Elvaron Multi	3.4	$T_1 + T_2$	8	nt	nt
8	Teldor	1.5	$T_1 + T_2$	42	nt	nt
9	Talat	3.0	$T_1 + T_2$	0	nt	nt
10	Frupica	0.9	$T_1 + T_2$	nt	nt	57
11	Filan	0.5	$T_1 + T_2$	nt	nt	86

nt = not tested

Fungicide resistance

Isolates of *Botrytis cinerea* were collected from diseased pods taken from seven commercial crops of green beans in Norfolk and Suffolk during 2003. Six of the crops had been sprayed with fungicides on one or two occasions. Growth of each isolate was recorded at 5 and 8 days and the data from the 5 day count are shown in table 9 of the Appendix.

A summary of the results is shown in table 4. There was an indication that isolates from two of the seven fields were insensitive.

Table 4. Fungicide sensitivity of 2003 isolates

Field number	No. isolates *B. cinerea*	No. insensitive to Ronilan	No. insensitive to Amistar
1	10	0	0
2	11	0	0
3	2	0	0
4	1	0	0
5	2	2	0
6	1	1	0
7	1	0	0

In 2004, the isolates of *Botrytis cinerea* were again collected from diseased pods taken from three commercial crops of green beans in Norfolk, Cambs and Worcs. All of the crops had been sprayed with fungicides two occasions. Growth of each isolate was recorded at 2 and 5 days and the data from the 5 day count are shown in table 10 of the Appendix. There were no indications that any of the isolates were insensitive to vinclozolin. Similarly the growth of all isolates on the azoxystrobin amended medium was inhibited, albeit to a much lesser degree, and there were no obvious differences in sensitivity between isolates. A summary of the results is shown in table 5.

Table 5. Fungicide sensitivity of 2004 isolates.

Field number	No. isolates *B. cinerea*	No. insensitive to Ronilan	No. insensitive to Amistar
1	6	0	0
2	6	0	0
3	5	0	0

The work continued in 2005 with isolates from Norfolk, Cambs and Worcestershire. In this year, there were a number of isolates which were insensitive to Ronilan and one which was insensitive to Amistar. The results are shown in table 11 of the Appendix and summarised below in table 5.

Table 6. Fungicide sensitivity of 2005 isolates.

Field number	No. isolates *B. cinerea*	No. insensitive to Ronilan	No. insensitive to Amistar
1	11	7	0
2	9	4	0
3	8	0	0
4	10	1	0
5	9	4	0
6	8	1	1

Conclusions

There were significant differences in the number of infected pods between several of the varieties of green beans tested. These differences appeared to be consistent over two or three years of trials. As there were examples of most of the pod types within the low infection ratings, this should allow some choice of the least susceptible varieties for different markets.

Control of Botrytis pod rot by fungicides was not always satisfactory even with the newer products. Development of the disease is influenced by weather conditions and application timing is often limited by the stated harvest interval for the products. Disease level was generally low and differences in the level of control were not always statistically significant. It was also disappointing that Sclerotinia pod infection was not reduced by any of the treatments, but the disease appeared to have developed late in the season and it is likely that the fungicides would have lost their activity over that time. However, the screening trials did identify some products which have the potential to add to the limited list of approved products for Botrytis control in beans. Of the fungicides tested in each of the three years, Signum (boscalid and pyraclostrobin) and a coded material (A9219B) resulted in around 50% reduction of infected pods and this was as effective as the current standards, Amistar and Ronilan. In one year of tests, Filan (boscalid) and Frupica (mepanipyrim) also showed useful control of pod rot. Signum, Filan and Frupica are currently approved in the UK for vegetables or fruit and a SOLA could be generated, although further work would be required with Filan and Frupica to confirm these results. A9219 is currently approved in France and commercial development in the UK is being considered by the manufacturer.

A concerning aspect of the project was the finding of Ronilan insensitive strains of *Botrytis cinerea* in commercial crops. This indicated that resistance populations of *B. cinerea* were developing. There were very limited data but these indicated that repeated

use of Ronilan increases populations of insensitive strains within fields. This demonstrated the need to alternate products in a spray programme.

The main findings of the project were that several varieties are available which were much less susceptible to infection and may be at a lower risk of Botrytis pod rot than others. These include fine, medium and flat podded types which are examples of the types used for a range of market requirements. Where fungicides are required, then sequential use of the same product should be avoided to reduce the risk of resistant populations of Botrytis developing. Finally, the introduction of new products for Botrytis control will greatly improve the management of this disease.

Sclerotinia seems to be becoming more prevalent than Botrytis and the infection period does not seem to be so closely related to that of Botrytis. The persistency of the fungicides may not be enough to protect against late developing infection and there is a need to relate infection period with conditions so that adequate protection from sprays may be made more effective.

Acknowledgements

Trial sites for the fungicide screening work and access to commercial crops was kindly provided by Aylsham Growers, Farmspeed Ltd, and A S Lee and Son.
The variety evaluation sites were provided by Bomfords Ltd.

Appendix

Table 1. Varietal susceptibility to Botrytis pod rot. Thornhaugh 2003

Variety	pod type	% infected pods
Opera	medium	0.07
Masai	fine	0.17
Calgary	very fine	0.63
PV 622	fine	0.67
Cadillac	medium	0.80
Jersey	fine	1.10
Artemis	flat	1.37
Laguna	medium	1.43
Astun	flat	1.90
Boston	medium	2.33
Baroma	flat	2.77
Torpedo	medium	2.97
Parker	medium	3.37
Lasso	fine	3.53
SB 4251	flat, wax	3.90
BB2 160	flat	4.90
Moncayo	flat	6.43
Plazza	flat	6.77
LSD		3.45
Probability		0.005
Coefficient of variation %		83.0

Table 2. Varietal susceptibility to Botrytis pod rot. Thornhaugh 2004

Variety	pod type	% infected pods
Nomad	medium	0
Lasso	fine	0
Albany (PV 662)	fine	0
Scuba	medium	0.1
Laguna	medium	0.3
R 9241	fine	0.37
Masai	very fine	0.47
Green Arrow	large	0.57
Cerdon	fine	0.7
SB 4251	flat wax	0.7
Astun	flat	1.0
Jackpot	fine	1.17
BB 2175	medium	1.27
Baroma	flat	1.6
Bravo	fine	2.07
BB 2174	medium	2.1
Cadillac	medium	2.43
Boston	medium	3.67
Artemis	flat	4.43
BB 2160	flat	4.97
Moncayo	flat	7.03
LSD		2.67
Probability		<0.001
Coefficient of variation %		97.4

Table 3. Varietal susceptibility to Botrytis pod rot. Clifton 2005

Variety	pod type	% infected pods
Cerdon	fine	0
Jackpot	fine	0
Albany	fine	0.17
Canzone	fine	0.17
BB 2174	medium	0.27
BB 2175	medium	0.41
Laguna	medium	0.65
Koala	fine	0.72
Lasso	fine	0.76
Bravo	fine	0.88
Excalibur	fine	1.14
R 9421	fine	1.22
Scuba	medium	1.25
Astun	flat	1.52
Green Arrow	large	2.16
Artemis	flat	2.31
Nomad	medium	2.68
Baroma	flat	3.66
Moncayo	flat	3.68
Boston	medium	3.69
Ceres	flat	4.54
LSD		2.39
Probability		0.002
Coefficient of variation %		100.1

Table 4. Control of Botrytis by fungicides - Holt 2003

Treatment	rate l/ha	timing	% infection by *Botrytis cinerea*	% control
1. untreated			4.32	0
2. Amistar	1.0	$T_1 + T_2$	2.64	39
3. Ronilan	1.0	T_1	1.38	68
4. Ronilan	1.0	T_1 followed by		
Rovral WP	1.5	T_2	1.42	67
5. Signum	1.0	$T_1 + T_2$	2.01	64
6. Elvaron Multi	3.4	$T_1 + T_2$	3.96	8
7. Teldor	1.5	$T_1 + T_2$	2.49	42
8. Talat	3.0	$T_1 + T_2$	4.48	0
LSD			2.68	5.51
Probability			0.12	0.10
Coefficient of variation %			64.2	42.3

Table 5. Pods per plant following fungicide application - Feltwell 2003

Treatment	rate l/ha	timing	pods/plant
1. untreated		$T_1 + T_2$	7.65
2. Amistar	1.0	$T_1 + T_2$	7.87
3. Ronilan	1.0	T_1	7.95
4. Ronilan	1.0	T_1 followed by	
Rovral WP	1.5	T_2	8.07
5. Signum	1.0	$T_1 + T_2$	9.15
6. Elvaron Multi	3.4	$T_1 + T_2$	8.62
7. Teldor	1.5	$T_1 + T_2$	9.10
8. Talat	3.0	$T_1 + T_2$	8.45
LSD			1.78
Probability			0.54
Coefficient of variation %			14.4

Table 6. Control of Botrytis by fungicides - Banningham 2004

Treatment	rate l/ha	timing	% infection by *Botrytis cinerea*	% control
1. untreated			7.43	0
2. Amistar	1.0	$T_1 + T_2$	3.61	51
3. Ronilan	1.0	T_1	2.98	60
4. Ronilan	1.0	T_1 followed by		
Rovral WP	1.0 kg	T_2	3.87	48
5. Signum	1.0	$T_1 + T_2$	5.36	28
6. A9219B (Switch)	3.4	$T_1 + T_2$	3.77	49
7. A14111B	1.5	$T_1 + T_2$	1.70	77
8. A14111B	2.5	$T_1 + T_2$	4.37	41
9. Amistar	1.0	T1		
Rovral WP	1.0	T2	4.04	46
LSD			2.53	
probability			0.01	
Coefficient of variation %			41.9	

Table 7. Control of Botrytis by fungicides - Aylsham 2005

Treatment	rate l/ha	timing	% infection by *Botrytis cinerea*	% control
1. untreated			0.92	0
2. Amistar	1.0	$T_1 + T_2$	0.31	66
3. Ronilan	1.0	T_1 followed by		
Rovral WP	1.0 kg	T_2	0.30	67
4. Signum	1.0	$T_1 + T_2$	0.29	68
5. A9219B (Switch)	3.4	$T_1 + T_2$	0.33	64
6. A14111B	1.5	$T_1 + T_2$	0.70	24
7. Frupica	0.9	$T_1 + T_2$	0.39	57
8. Filan	0.5	$T_1 + T_2$	0.13	86
LSD			0.76	
Probability			0.46	
Coefficient of variation %			122.9	

Table 8. Control of Botrytis and Sclerotinia by fungicides - Ely 2005

Treatment	rate l/ha	timing	% infection by *Botrytis cinerea*	% infection by Sclerotinia
1. untreated			1.4	3.59
2. Amistar	1.0	$T_1 + T_2$	1.7	4.66
3. Ronilan	1.0	T_1 followed by		
Rovral WP	1.0 kg	T_2	1.7	2.53
4. Signum	1.0	$T_1 + T_2$	0.7	5.53
5. A9219B (Switch)	3.4	$T_1 + T_2$	1.05	4.51
6. A14111B	1.5	$T_1 + T_2$	0.89	3.78
7. Frupica	0.9	$T_1 + T_2$	1.65	4.22
8. Filan	0.5	$T_1 + T_2$	0.94	3.59
LSD			1.31	3.25
Probability			0.57	0.71
Coefficient of variation %			71.1	54.5

Table 9. *Botrytis cinerea* colony growth on fungicide amended medium. 2003 samples.

Spray programme	Field	Isolate no	Colony diameter after 5 days (mm) (max growth 85)		
			PDA + Amistar	PDA + Ronilan	PDA
Ronilan x 1	1. Blicking	1	2.4	2.4	37.6
		2	20.0	0	85
		3	34.0	0	85
		4	36.0	0	85
		5	34.8	0	85
		6	40.4	0	85
		7	36.0	0	85
		8	25.0	2	85
		9	38.0	0	85
		10	34.0	0	85
unsprayed	2. Barningham	1	34.0	0	85
		2	35.6	0	85
		3	21.2	0	85
		4	40.0	0	85
		5	31.6	0	85
		6	27.6	0	85
		7	28.0	0	85
		8	33.6	0	85
		9	34.0	0	85
		10	28.8	0	85
		11	25.0	0	85
Ronilan x 1	3. Aldehouse 13	1	23.2	0	85
Amistar x 1		2	12.4	0	85
Amistar x1	4. Sutton 122	1	24.8	0	85
Ronilan x 2	5. Tunstel 10	1	36.0	0	85
		2	26.0	1.6	85
		3	25.6	16.4	85
		4	26.0	0	85
Ronilan x 2	6. Sutton 119	1	28.4	4.8	85
Ronilan x 1	7. Marshland 61	1	30.0	0	85
Amistar x 1					

Table 10. *Botrytis cinerea* colony growth on fungicide amended medium. 2004 samples

Spray programme	Field	Isolate no	Colony diameter after 5 days (mm) (max growth 85)		
			PDA + Amistar	PDA + Ronilan	PDA
Ronilan x 2	1. Banningham	1	44.8	0	85
		2	37.0	2.0	85
		3	33.1	0	85
		4	31.0	0	85
Ronilan + Amistar x 2	2. Rushford	1	42.6	0	85
		2	39.8	2.2	85
		3	38.0	1.5	85
		4	36.1	0.7	85
		5	34.6	0	85
		6	38.4	0	85
Ronilan x 1 Amistar x 1	3. Southery	1	34.0	0.1	85
		2	34.2	0	85
		3	49.8	0	85
		4	38.5	0	78.2
		5	36.2	0	85

Table 11. *Botrytis cinerea* colony growth on fungicide amended medium. 2005 samples

Spray programme	Field	Isolate no	Colony diameter after 5 days (mm) (max growth 85)		
			PDA + Amistar	PDA + Ronilan	PDA
Ronilan x 1 Rovral WP x 1	1. Scottow	1	24.4	10.6	85
		2	58.0	18.0	85
		3	51.4	12.0	85
		4	54.0	11.4	85
		5	47.0	8.0	85
		6	53.8	2.0	85
		7	41.0	0	85
		8	51.2	0	85
		9	48.4	0	85
		10	49.4	0	85
		11	31.0	16.0	85
Ronilan x 1 Rovral WP x 1	2. Wood Farm	1	50.0	47.0	85
		2	34.5	0	85
		3	41.0	9.0	85
		4	40.0	0	85
		5	45.4	0	85
		6	47.0	5.0	85
		7	35.4	0	85
		8	23.0	10.0	85
		9	69.2	0	85

Table 11…. (continued)

Spray programme	Field	Isolate no	Colony diameter after 5 days (mm) (max growth 85)		
			PDA + Amistar	PDA + Ronilan	PDA
Amistar + Rovral WP x 2	3. Clifton	1	74.8	0	85
		2	66.0	0	85
		3	48.8	0	85
		4	65.8	0	85
		5	45.0	0	85
		6	46.5	0	85
		7	72.6	0	85
		8	49.8	0	85
Amistar x 1 Ronilan x 1	4. Quanea 8	1	52.0	0	85
		2	55.0	0	85
		3	52.4	0	85
		4	46.6	0	85
		5	45.2	0	85
		6	48.2	0	85
		7	52.0	0	85
		8	49.0	0	85
		9	42.0	2.4	85
		10	45.8	0	85
Ronilan x 1 Rovral WP x 1	5. Sloley	1	27.4	0	85
		2	33.8	0	85
		3	44.6	0	85
		4	28.0	8.4	85
		5	44.6	16.0	85
		6	39.0	0	85
		7	41.6	10.6	85
		8	32.0	0	85
		9	54.4	12.8	85
Ronilan x 2	6. Worstead	1	67.6	0	85
		2	85.0	0	85
		3	53.0	0	85
		4	45.0	0	85
		5	31.4	63.0	85
		6	49.0	0	85
		7	43.5	0	85
		8	43.0	0	85