Project Title:	Dwarf green beans: Strategy for the control of pod rot by *Botrytis cinerea*
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GROWER SUMMARY

Headline

- In a limited study in the first year of the project, there was an indication that repeated use of a single product increased the risk of fungicide resistant *Botrytis cinerea* in green beans.

- Early indications from fungicide screening trials suggested the possibility of a wider choice of products for green beans in the near future.

- There appeared to be some differences in varietal tolerance to *Botrytis* pod rot, and this will be further evaluated.

Summary

In the first year of this three year project, a fungicide screening trial indicated that useful control of *Botrytis* pod rot in green beans could be obtained from one new fungicide product. However disease pressure was low and further evaluations are necessary before firm conclusions can be made.

There was an indication that some isolates of *Botrytis cinerea* collected from commercial crops which had been sprayed with fungicides, were showing some resistance to vinclozolin where this had been applied in a two spray programme.

Several varieties exhibited good tolerance to *Botrytis* pod rot in a variety screen.

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 tolerance 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 tolerance

Varieties were drilled in disease observation plots at Thornhaugh, Cambs and Salford Priors, Worcs, in 2003. At Thornhaugh the plot length was 10m and contained four rows of plants at a row spacing of 30cm. At Salford Prior each plot was 5m in length and contained two rows of each variety with 30cm row spacing. Each variety was replicated 3 times in a randomised block design.

The site details were as follows:

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.

Eighteen varieties were sown at each site. They represented different pod types to reflect their usefulness for both processing and fresh market. The varieties and pod types were as follows:

Very fine	fine	medium	flat	flat, wax
Calgary	Jersey	Boston	Artemis	SB 4251
	Lasso	Cadillac	Astun	
	PV 622	Laguna	Baroma	
	Masai	Opera	BB 2160	
		Parker	Moncayo	
		Torpedo	Plazza	

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 and randomised field trials were carried out in commercial crops of beans at Holt, Norfolk and Feltwell, Cambs. 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 treatments were as follows:

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	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

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

Samples of infected pods were taken from crops in East Anglia 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. In 2003, samples were taken from the following locations.

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

Results

Varietal tolerance

The very dry weather 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.

Table 1. Varietal differences in pod rot infection by *Botrytis cinerea.* Thornhaugh 2003

Variety	pod type	% infected pods	transformed data
Opera	medium	0.07	0.85
Masai	fine	0.17	1.35
Calgary	very fine	0.63	4.54
PV 622	fine	0.67	3.70
Cadillac	medium	0.80	3.99
Jersey	fine	1.10	5.93
Artemis	flat	1.37	5.36
Laguna	medium	1.43	6.74
Astun	flat	1.90	6.37
Boston	medium	2.33	8.75
Baroma	flat	2.77	7.76
Torpedo	medium	2.97	9.81
Parker	medium	3.37	10.57
Lasso	fine	3.53	10.6
SB 4251	flat, wax	3.90	10.57
BB2 160	flat	4.90	12.66
Moncayo	flat	6.43	13.75
Plazza	flat	6.77	10.68
LSD		3.45	6.36
Probability		0.005	0.001
Coefficient of variation %		83.0	50.0

Most of the varieties at the Salford Priors site failed to show any infection and the data are not presented.

Fungicide evaluation

Despite the hot dry summer, 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 is shown in tables 2 and 3.

Table 2. Control of pod rot by fungicides - Holt 2003

Treatment	rate l/ha	timing	% infection by *Botrytis cinerea*	ang transformed data	% control
1. untreated			4.32	11.8	0
2. Amistar	1.0	$T_1 + T_2$	2.64	9.24	39
3. Ronilan	1.0	T_1	1.38	5.52	68
4. Ronilan	1.0	T_1 followed by			
Rovral WP	1.5	T_2	1.42	5.66	67
5. Signum	1.0	$T_1 + T_2$	2.01	6.73	64
6. Elvaron Multi	3.4	$T_1 + T_2$	3.96	11.31	8
7. Teldor	1.5	$T_1 + T_2$	2.49	8.91	42
8. Talat	3.0	$T_1 + T_2$	4.48	11.78	0
LSD			2.68	5.51	5.51
Probability			0.12	0.10	0.10
Coefficient of variation %			64.2	42.3	42.3

Table 3. Pods per plant following fungicide application - Feltwell 2003

Treatment	rate l/ha	timing	pods/plant	log transformed
1. untreated		$T_1 + T_2$	7.65	0.936
2. Amistar	1.0	$T_1 + T_2$	7.87	0.947
3. Ronilan	1.0	T_1	7.95	0.948
4. Ronilan	1.0	T_1 followed by		
Rovral WP	1.5	T_2	8.07	0.956
5. Signum	1.0	$T_1 + T_2$	9.15	1.00
6. Elvaron Multi	3.4	$T_1 + T_2$	8.62	0.980
7. Teldor	1.5	$T_1 + T_2$	9.10	0.998
8. Talat	3.0	$T_1 + T_2$	8.45	0.974
LSD			1.78	0.083
Probability			0.54	0.60
Coefficient of variation %			14.4	5.8

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 2, 5 7 and 9 days and the data from the 5 day count are shown in table 4.

Table 4. *Botrytis cinerea* colony growth on fungicide amended media.

Spray programme	Field	Isolate no	Colony diameter after 5 days (mm)		
			PDA + Amistar	PDA + Ronilan	PDA
Ronilan applied once	Blicking (variety Scuba sampled 27/8/03)	1	2.4	2.4	37.6
		2	20	0	90
		3	34	0	90
		4	36.0	0	90
		5	34.8	0	90
		6	40.4	0	90
		7	36	0	90
		8	25	2	90
		9	38	0	90
		10	34	0	90
unsprayed	Barningham (variety Magnum sprayed 26/8/03)	1	34	0	90
		2	35.6	0	90
		3	21.2	0	90
		4	40	0	90
		5	31.6	0	90
		6	27.6	0	90
		7	28	0	90
		8	33.6	0	90
		9	34	0	90
		10	28.8	0	90
		11	25	0	90
Ronilan x 1 followed by Amistar x 1	Aldehouse 13 (variety Laguna sampled 2/9/03	1	23.2	0	90
		2	12.4	0	90
Amistar x1	Sutton 122 (variety Laguna sampled 2/9/3	1	24.8	0	90
Ronilan x 2	Tunstel 10 (variety Laguna sampled 2/9/03)	1	36.0	0	90
		2	26.0	1.6	90
		3	25.6	16.4	90
		4	26.0	0	90
Ronilan x 2	Sutton 119 (variety Laguna sampled 2/9/03	1	28.4	4.8	90
Ronilan x 1 Amistar x 1	Marshland 61 (variety Laguna sampled 2/9/03)	1	30	0	90

Conclusions

The very dry summer weather was not conducive to *Botrytis* infection and results from the investigations should be interpreted with care. However, the fungicide screening trial indicated some useful new products and further candidates will be screened in years 2 and 3. All products appeared to be crop safe. Differences were also apparent in varietal tolerance and as data accumulates, this will provide a robust guide for variety choice in the future. The fungicide resistance study indicated that some variable sensitivity to Ronilan was present where crops which had received a two spray Ronilan programme produced some less sensitive isolates. Where disease pressure becomes greater, this may be more significant, further demonstrating that alternative fungicides are urgently required. Although the Amistar appeared to suppress *Botrytis cinerea* growth for only a short period, there was no indication that resistance was occurring.