Project Title: Runner beans: control of rust (*Uromyces appendiculatus*)

Report:	Final Report (April 1997)
Project Number:	FV 174
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Date Project Commenced:	July 1995
Date Project Completed:	December 1996
Key Words:	Runner beans, Rust (*Uromyces appendiculatus*), Fungicides

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PRACTICAL SECTION FOR GROWERS

Objectives

The objective of the project was to evaluate a range of fungicides for the control of rust in runner beans in screening trials carried out in outdoor crops and to examine the persistency and optimum timing of application of the most successful products.

Summary of results

Runner bean rust was effectively controlled in outdoor crops by several fungicides applied as foliar sprays at the start of the main infection period. Formulations of tebuconazole, propiconazole, cyproconazole and fenpropimorph, either alone, or in mixtures with chlorothalonil or carbendazim, were applied in 200 l of water per hectare. Chlorothalonil plus carbendazim was ineffective. In a second series of trials, tebuconazole (Folicur), fenpropimorph plus chlorothalonil (Corbel CL) and propiconazole plus chlorothalonil (Alto Elite) applied at normal and half normal dose rates, one week before first pick resulted in satisfactory control of rust. Disease was effectively suppressed throughout the picking period following the single spray.

Relevance to growers

1. Several commercial fungicide products were effective in controlling rust. However, as yet, none are Approved for use in runner beans.

2. Three of the products showed a good persistency of protection which lasted throughout the picking period.

3. The project indicated that a single application made 7 days before the first pick, will provide an adequate level of protection from bean rust.

4. Residue work is required before a submission for off-label approval can be made.

EXPERIMENTAL SECTION

A. GENERAL INTRODUCTION

Problems with continuity of production of blemish-free runner beans frequently occur at the end of the picking season when weather conditions become favourable for infection. This coincides with higher prices for beans as the season ends and yields generally decline.

Rust (*Uromyces appendiculatus*) is very troublesome in most years. Infection can begin at any time but, is more often apparent in outdoor crops in August, when relative humidity increases at the end of the day and temperatures remain high. Leaf infection can develop rapidly, resulting in defoliation, reduction of flower production and a rapid truncation of the picking period.

There are no fungicides currently approved for rust control in runner beans and although several products are used in other crops, the approach to control may need to be modified to maintain an acceptable harvest interval if any of these products are to be of value in runner beans.

In the first year of this project, screening trials were carried out to evaluate the efficacy of a range of fungicides for the control of rust. In the second year, the persistency and optimum timing of application of the most successful products was examined.

B. PART I - SCREENING TRIALS WITH FUNGICIDES

Materials and methods

Sites

Trials were carried out at two sites in commercial crops of runner beans cv. Enorma. Site 1, D. Revell, Sandford Farm, Seven Stoke, Worcester and Site 2, D. Lloyd, Temple Laughern, Oldbury Road, Worcester. In 1996, two trials in runner beans at Temple Laughern were carried out in early and late planted beans. At each site the beans were supported on wigwams of bamboo in rows approximately 1.5 m apart.

Trial details

Sprays were applied using an Azo plot sprayer with 4 Lurmark 02-F110 fan nozzles 0.5 m apart on a 2 m boom held vertically to allow the beans to be sprayed their whole length. All fungicides were applied in 200 l water/ha at a pressure of 2.5 bar pressured by propane gas.

The products were chosen based on their efficacy in controlling rust in other crops. Additionally, several of the products have activity on other fungal diseases such as *Botrytis cinerea*, which may be useful in reducing pod spoilage in wet seasons.

The sprays and their timings are shown in Table 1.

Product	Chemical name	rate of product per ha	time of application (see below)
1. untreated	-	-	-
2. Folicur	tebuconazole	0.5	1 spray, T_1
3. Folicur	tebuconazole	0.5	2 sprays, T_1 & T_2
4. Bravocarb	chlorothalonil + carbendazim	2.0	T_1
5. Bravocarb	chlorothalonil + carbendazim	2.0	T_1 & T_2
6. Corbel CL	fenpropimorph + chlorothalonil	3.0	T_1
7. Corbel CL	fenpropimorph + chlorothalonil	3.0	T_1 & T_2
8. Alto Elite	cyproconazole + chlorothalonil	2.0	T_1
9. Alto Elite	cyproconazole + chlorothalonil	2.0	T_1 & T_2
10. Hispor 45	propiconazole + carbendazim	0.5	T_1
11. Hispor 45	propiconazole + carbendazim	0.5	T_1 & T_2

T_1: when rust pustules first found on foliage
T_2: 14 days after T_1

(see table 1 of Appendix I)

Each treatment was replicated three times in a randomised block design, each block represented by a row of beans. Sprays were applied to one side of the row only, each plot being 5 m in length and containing 4 wigwams (site 1) or 3 wigwams (site 2).

Disease assessments

Assessments of rust infection was based on a visual inspection of the foliage at the bottom, middle and top thirds of each wigwam. Two assessments were made per third of the wigwam and each wigwam was assessed in this way for every plot. Each assessment was based on an estimation of the percentage leaf area covered by rust. The spraying and assessment dates are shown in Appendix I.

The mean percentage leaf area infected for the bottom, middle and top thirds of each wigwam was then calculated. In 1995, each plot was assessed 14 days after T_1 and 14 days after T_2. The results were analysed by GENSTAT for leaf infection.

Results

At site 1, rust infection was present on most of the plants in the trial at about 1-5% leaf area infection. The crop was being harvested and flowering and pod development was active. Disease progressed well and the results are shown together with the full statistical analysis in tables 2 and 3 of Appendix I.

At site 2, rust was less severe at the time of the first application and harvesting had just commenced. The crop was about a week later in maturity than site 1 and because the daily temperatures in the second half of August had fallen, the infection continued to be less severe than at site 2. The results are shown in tables 4 and 5 of Appendix I.

All fungicide products with the exception of Bravocarb, significantly controlled rust development at both sites. This level of control had become more obvious four weeks after the first spray application.

There was an apparent decrease in the infection on treated plots from the time of the first application, but this was probably due to the production of new leaves which remained healthy and masked the original infected foliage. However, disease continued to develop on the untreated plots at both sites.

There was no significant difference in control between the single earlier spray and the two spray programme and this indicated a long persistency of activity. However, the disease pressure may not have been high due to the cooler temperatures at the end of August.

There was little difference in the efficacy of the different products although Folicur appeared to produce the most consistent level of control with Hispor 45 being slightly less effective. Bravocarb produced no significant level of control at either site.

B. PART II - TIMING TRIALS

Materials and Methods

Sites

Trials were carried out in two plantings of commercial crops of runner beans cv. Enorma at Temple Laughern, Oldbury Road, Worcester. Site 1 was planted week beginning 20th March 1996 and site 2, week beginning 1 April 1996. At each site, the beans were supported on wigwams of bamboo in rows approximately 1.5 m apart. The crop received the normal level of husbandry including fertiliser, weed control and irrigation, the latter being applied by an overhead spray system.

Trial details

Sprays were applied using an Azo plot sprayer with 4 Lurmark 02-F110 fan nozzles, 0.5 m apart on a 2 m boom held vertically to allow the beans to be sprayed their whole length. All fungicides were applied in 200 l water/ha at 2.5 bar pressured by propane gas.

The treatments are shown in Table 2.

Table 2. Fungicides and time of application

	Product	Chemical name	Rate of product/ha	* Time of application
1	untreated			
2	Folicur	tebuconazole	0.5	T_1
3	Folicur	tebuconazole	0.5	T_2
4	Folicur	tebuconazole	0.25	T_1
5	Folicur	tebuconazole	0.25	T_2
6	Corbel CL	fenpropimorph + chlorothalonil	3.0	T_1
7	Corbel CL	fenpropimorph + chlorothalonil	3.0	T_2
8	Corbel CL	fenpropimorph + chlorothalonil	1.5	T_1
9	Corbel CL	fenpropimorph + chlorothalonil	1.5	T_2
10	Alto Elite	cyproconazole + chlorothalonil	2.0	T_1
11	Alto Elite	cyproconazole + chlorothalonil	2.0	T_2
12	Alto Elite	cyproconazole + chlorothalonil	1.0	T_1
13	Alto Elite	cyproconazole + chlorothalonil	1.0	T_2

* Timing - T_1 at 1st pod - 3 weeks before first pick
T_2 14 days later (1 week before first pick)
(see Table 1, Appendix II)

Each treatment was replicated three times in a randomised block design, each block represented by a row of beans. Sprays were applied to one side of the row only, each plot containing 3 wigwams.

Disease assessments

An assessment of rust infection was based on a visual inspection of the foliage at the bottom, middle and top thirds of the sprayed sides of each wigwam. Assessments were made on four occasion, two weeks after each application timing. Each assessment was based on an estimation of the percentage leaf area covered by rust. Spraying and assessment dates are shown in table 1 of Appendix II.

The mean percentage leaf area infected for the bottom, middle and top thirds of the plants in each plot was then calculated and the results analysed by GENSTAT.

Results

At site 1, the earlier planted beans, only a low level of rust was present on the lower parts of the plants at the time of the second spray and disease was not assessed on this occasion. The full results are shown in tables 2, 3 and 4 of Appendix II.

At the later planted site, rust developed more slowly as the weather became cooler and was less conducive to infection. The fourth disease assessment was not made as the crop was senescing by that time. (Tables 5, 6 and 7 of Appendix II).

Folicur, Corbel CL and Alto Elite continued to provide rust control by the end of the picking season, however, the best results were obtained from the later of the two application timings. This was probably due to less foliage being present at the time of the earlier application and the chemicals may have lost activity by the end of the picking period. The second spray timing, made two weeks later when the foliage was more profuse, thereby offered more of a surface for the chemicals to provide protectant activity. The low rates of fungicides were not as effective as the higher rates at the earlier spray timing, but at the later timing, there was no difference in efficacy between the higher and lower rates of the three products.

The results again demonstrated the persistency of control of rust and indicated that a lower dose rate of any of the three products applied a week before the first pick, may be satisfactory for long term protection.

C. OVERALL CONCLUSIONS

Fungicides specifically used for control of rust diseases in cereals were very effective in runner beans, providing a degree of persistent protection from later infection which often occurs during the harvesting period.

The results of these trials in outdoor runner beans clearly demonstrated the efficacy of three of the products selected and indicated that a lower dose rate, applied one week before the first pick, may be satisfactory for long term protection, although the normal dose rate could ensure protection during conditions which are favourable for severe disease development.

The application timing will be useful in providing a more acceptable interval between application and harvesting, but further work to establish acceptable residue levels is necessary before a specific off-label approval can be sought.

D. ACKNOWLEDGEMENTS

Trial sites were made available by D. Lloyd and D. Revell of Worcester Bean Growers Association.

APPENDIX I

Table 1. Spray timing and assessment details

	Site 1	Site 2
First spray T_1	4.8.95	10.8.95
First disease assessment	16.8.95	24.8.95
Second spray T_2	16.8.95	24.8.95
Second disease assessment	30.8.95	8.9.95

Table 2. Rust infection following first application in Site 1

Treatment	Application	% rust infection			ang. transf.			% rust reduction
		Bottom	Middle	Top	Bottom	Middle	Top	(mean)
1. untreated		14.0	9.7	5.5	21.8	17.8	13.6	0
2. Folicur	T_1	9.6	4.6	3.2	17.7	12.1	10.1	40
3. Folicur	T_1 & T_2	14.0	7.3	3.3	21.8	15.5	10.3	15
4. Bravocarb	T_1	18.3	10.7	7.2	24.7	18.8	15.3	0
5. Bravocarb	T_1 & T_2	21.3	13.8	11.0	27.3	21.7	19.2	0
6. Corbel CL	T_1	11.1	4.8	3.3	18.4	12.4	10.3	33
7. Corbel CL	T_1 & T_2	9.5	4.9	2.1	17.5	12.2	8.0	43
8. Alto Elite	T_1	9.8	4.0	2.1	18.2	11.6	8.1	45
9. Alto Elite	T_1 & T_2	15.8	7.5	3.0	23.0	15.2	9.7	9
10. Hispor 45	T_1	9.5	5.5	3.4	17.7	13.3	10.4	37
11. Hispor 45	T_1 & T_2	12.7	7.8	3.0	20.6	15.7	9.4	20
SED @ p = 0.05		5.2	2.9	1.7	4.5	3.3	2.4	
		NSD	NSD	SIG	NSD	NSD	SIG	
cv%		48.5	48.2	47.8	26.4	26.8	26.1	

Table 3 Rust infection following second application - Site 1

Treatment	Application	% rust infection			ang. transf.			% rust reduction (mean)
		Bottom	Middle	Top	Bottom	Middle	Top	
1. untreated		25.4	16.3	12.3	30.2	23.8	20.4	0
2. Folicur	T_1	8.4	4.7	3.9	16.6	12.4	11.4	69
3. Folicur	T_1 & T_2	7.8	5.6	3.0	16.1	13.6	9.9	70
4. Bravocarb	T_1	22.7	14.8	10.8	28.1	22.4	19.0	11
5. Bravocarb	T_1 & T_2	23.8	15.2	11.9	29.0	22.8	20.2	6
6. Corbel CL	T_1	9.0	5.1	4.1	16.9	13.0	11.4	66
7. Corbel CL	T_1 & T_2	9.3	5.4	3.1	17.6	13.3	9.9	67
8. Alto Elite	T_1	7.1	4.4	2.0	15.4	12.1	8.1	75
9. Alto Elite	T_1 & T_2	9.4	6.2	3.5	17.6	14.1	10.3	65
10. Hispor 45	T_1	9.7	6.3	6.1	17.9	14.6	14.2	59
11. Hispor 45	T_1 & T_2	10.4	6.5	4.6	18.5	14.7	11.7	60
SED @ p = 0.05		4.0	2.0	1.6	3.4	2.0	2.2	
		SIG	SIG	SIG	SIG	SIG	SIG	
cv%		37.7	29.6	33.7	20.3	15.2	20.5	

Table 4 Rust infection following first application - Site 2

Treatment	Application	% rust infection			ang. transf.			% rust reduction (mean)
		Bottom	Middle	Top	Bottom	Middle	Top	
1. untreated		12.8	9.4	5.2	20.3	16.7	12.1	0
2. Folicur	T_1	7.3	5.6	3.3	15.4	12.8	10.0	41
3. Folicur	T_1 & T_2	5.8	3.3	1.5	13.9	10.0	6.8	61
4. Bravocarb	T_1	10.5	8.0	4.1	18.1	15.8	10.5	17
5. Bravocarb	T_1 & T_2	9.2	5.6	3.0	17.3	13.1	9.4	35
6. Corbel CL	T_1	9.2	5.1	2.4	17.5	12.5	8.2	39
7. Corbel CL	T_1 & T_2	8.7	6.9	3.8	16.9	14.4	10.9	29
8. Alto Elite	T_1	8.3	5.8	2.7	16.7	13.6	9.3	29
9. Alto Elite	T_1 & T_2	10.6	6.3	3.1	18.4	14.0	9.3	27
10. Hispor 45	T_1	12.5	5.0	4.2	20.0	11.7	11.3	21
11. Hispor 45	T_1 & T_2	7.8	5.7	2.6	16.1	13.6	9.1	41
SED @ p = 0.05		2.9	2.6	1.4	2.6	3.0	1.9	
		NSD	NSD	NSD	NSD	NSD	NSD	
cv%		38.3	52.3	53.4	18.3	27.3	24.5	

Table 5. Rust infection following second application - Site 2

Treatment	Application	% rust infection			ang. transf.			% rust reduction (mean)
		Bottom	Middle	Top	Bottom	Middle	Top	
1. untreated		19.8	16.1	15.0	26.1	23.2	22.3	0
2. Folicur	T_1	1.3	0.3	0.4	5.9	3.2	3.8	96
3. Folicur	T_1 & T_2	1.2	0.8	1.2	5.5	5.0	5.4	94
4. Bravocarb	T_1	11.3	9.9	9.8	18.3	17.6	16.8	39
5. Bravocarb	T_1 & T_2	15.8	10.1	9.2	23.0	18.0	17.3	31
6. Corbel CL	T_1	1.4	0.8	1.3	6.5	5.2	6.5	93
7. Corbel CL	T_1 & T_2	0.7	0.6	0.4	4.6	4.1	3.8	97
8. Alto Elite	T_1	2.0	1.1	1.1	7.7	5.6	5.0	92
9. Alto Elite	T_1 & T_2	1.3	0.2	1.2	5.1	1.4	6.2	95
10. Hispor 45	T_1	4.7	4.2	7.7	10.9	10.6	14.3	67
11. Hispor 45	T_1 & T_2	2.3	2.8	4.1	8.2	8.7	10.9	82
SED @ p = 0.05		4.0	3.2	4.0	4.3	3.3	4.0	
		SIG	SIG	SIG	SIG	SIG	SIG	
cv%		86.7	90.7	105.247.4	43.5	47.9		

APPENDIX II

Table 1. Spray timing and disease assessments

	Site 1	Site 2
First spray timing T_1	24.7.96	9.8.96
Second spray timing T_2	9.8.96	21.8.96
First disease assessment	21.8.96	5.9.96
Second disease assessment	5.9.96	19.9.96
Third disease assessment	19.9.96	3.10.96
Fourth disease assessment	3.10.96	-

Table 2. Site 1 - Rust infection at assessment date 2

	Treatment	Timing	% rust infection			% reduction
			Bottom	Middle	Top	(mean)
1	untreated		4.39	4.95	3.78	0
2	Folicur	T_1	4.17	3.61	3.17	16.5
3	Folicur	T_2	0.70	0.75	0.28	87.0
4	Folicur	T_1	4.35	2.44	1.89	44.0
5	Folicur	T_2	0.72	0.94	0.33	85.0
6	Corbel CL	T_1	0.67	1.04	1.00	79.4
7	Corbel CL	T_2	0.78	0.72	0.28	86.4
8	Corbel CL	T_1	1.61	1.50	1.11	67.8
9	Corbel CL	T_2	1.28	1.0	1.00	75.0
10	Alto Elite	T_1	0.56	1.06	0.61	83.0
11	Alto Elite	T_2	0.44	0.61	0.50	92.4
12	Alto Elite	T_1	4.61	4.0	3.67	6.4
13	Alto Elite	T_2	0.33	0.39	0.39	91.5
SED @ p = 0.05			1.37	1.12	1.06	
			SIG	SIG	SIG	
cv%			88.7	77.9	93.8	

Table 3. Site 1 - Disease assessment date 3

	Treatment	Timing	% rust infection			% reduction
			Bottom	Middle	Top	(mean)
1	untreated		7.67	13.32	16.22	0
2	Folicur	T_1	2.78	6.06	7.39	64.4
3	Folicur	T_2	0.80	3.17	7.11	71.2
4	Folicur	T_1	2.33	5.22	11.11	50.0
5	Folicur	T_2	1.55	3.39	5.83	71.0
6	Corbel CL	T_1	2.06	5.28	6.06	64.0
7	Corbel CL	T_2	0.50	1.72	3.61	84.3
8	Corbel CL	T_1	1.0	3.05	5.78	73.6
9	Corbel CL	T_2	0.89	1.28	3.28	85.4
10	Alto Elite	T_1	1.06	3.72	5.28	73.0
11	Alto Elite	T_2	0.11	0.66	2.39	91.5
12	Alto Elite	T_1	1.72	6.06	10.0	52.2
13	Alto Elite	T_2	0.44	0.67	1.0	94.3
SED @ p = 0.05			NSD	3.24	3.6	
			NSD	SIG	SIG	
cv%			155.3	96.1	67.4	

Table 4. Site 1 - Disease assessment date 4

	Treatment	Timing	% rust infection			% reduction
			Bottom	Middle	Top	(mean)
1	untreated		18.06	21.93	23.04	0
2	Folicur	T_1	9.72	13.61	17.22	35.7
3	Folicur	T_2	3.78	5.25	5.53	76.9
4	Folicur	T_1	7.78	15.0	18.61	34.3
5	Folicur	T_2	5.94	6.22	8.33	67.5
6	Corbel CL	T_1	2.95	5.11	8.94	73.0
7	Corbel CL	T_2	1.61	1.78	3.67	88.8
8	Corbel CL	T_1	3.44	6.11	8.61	71.2
9	Corbel CL	T_2	1.56	2.22	3.0	89.2
10	Alto Elite	T_1	4.89	7.22	9.44	65.8
11	Alto Elite	T_2	1.22	1.78	3.22	90.1
12	Alto Elite	T_1	8.17	11.72	16.67	42.0
13	Alto Elite	T_2	1.05	3.28	3.50	87.6
SED @ p = 0.05			1.93	2.03	2.38	
			SIG	SIG	SIG	
cv%			43.8	31.9	29.2	

Table 5. Site 2 - Disease assessment date 1

	Treatment	Timing	% rust infection			% reduction
			Bottom	Middle	Top	(mean)
1	untreated		2.44	1.45	0.95	0
2	Folicur	T_1	0.67	0.28	0.17	77.0
3	Folicur	T_2	1.22	0.33	0	68.0
4	Folicur	T_1	1.89	0.67	0.33	42.1
5	Folicur	T_2	0.39	0.33	0.39	77.1
6	Corbel CL	T_1	0.44	0.22	0.17	82.9
7	Corbel CL	T_2	0.89	0.39	0.11	71.3
8	Corbel CL	T_1	0.45	0.17	0.22	82.6
9	Corbel CL	T_2	0.61	0.67	0.67	58.7
10	Alto Elite	T_1	0.72	0.39	0.34	70.0
11	Alto Elite	T_2	1.0	0.11	0	77.1
12	Alto Elite	T_1	0.22	0.23	0.28	84.9
13	Alto Elite	T_2	0.11	0.28	0.33	85.1
SED @ p = 0.05			NSD	0.32	0.21	
			NSD	SIG	SIG	
cv%			105.7	93.3	85.7	

Table 6. Site 2 - Disease assessment date 2

	Treatment	Timing	% rust infection			% reduction
			Bottom	Middle	Top	(mean)
1	untreated		1.94	4.11	2.83	0
2	Folicur	T_1	0.28	0.89	1.22	73.1
3	Folicur	T_2	0	0.11	0.28	95.6
4	Folicur	T_1	0.61	1.11	1.55	63.2
5	Folicur	T_2	0	0.17	0.50	92.5
6	Corbel CL	T_1	0.06	0.5	0.67	86.1
7	Corbel CL	T_1	0.06	0.11	0.17	96.2
8	Corbel CL	T_1	0.22	0.57	1.11	78.6
9	Corbel CL	T_2	0.28	0.39	0.17	90.5
10	Alto Elite	T_1	0.22	0.61	1.11	78.2
11	Alto Elite	T_2	0	0.06	0.11	98.1
12	Alto Elite	T_1	0.22	1.0	1.39	70.6
13	Alto Elite	T_2	0	0	0.17	98.1
SED @ p = 0.05			0.42	0.40	0.46	
			SIG	SIG	SIG	
cv%			172.4	65.3	64.6	

Table 7. Site 2 - Disease assessment date 3

	Treatment	Timing	% rust infection			% reduction
			Bottom	Middle	Top	(mean)
1	untreated		6.5	7.49	7.28	0
2	Folicur	T_1	2.22	3.56	4.78	50.4
3	Folicur	T_2	0.89	1.56	1.78	80.1
4	Folicur	T_1	3.89	4.61	5.39	44.7
5	Folicur	T_2	0.50	1.11	2.17	82.3
6	Corbel CL	T_1	1.11	1.17	1.39	82.7
7	Corbel CL	T_2	0.28	0.33	0.50	94.8
8	Corbel CL	T_1	3.17	2.61	3.33	67.2
9	Corbel CL	T_2	1.06	1.05	0.83	86.2
10	Alto Elite	T_1	3.0	3.22	4.33	50.4
11	Alto Elite	T_2	0.55	0.33	0.83	92.0
12	Alto Elite	T_1	2.70	3.62	3.45	54.1
13	Alto Elite	T_2	0.28	0.58	1.31	89.8
SED @ p = 0.05			0.89	0.92	1.16	
			SIG	SIG	SIG	
cv%			54.1	46.7	49.5	