Project Report

Effect of cultivar resistance rating and fungicide spray interval on the control of potato blight with newly approved and established fungicide products in 2006

Ref: R242

Final Report : May 2007

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2007

Project Report 2007/5

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1. Summary

In 2006, the control of foliar and tuber blight was investigated using combinations of cultivar resistance, fungicide product and spray interval in two trials at ADAS Rosemaund, near Hereford and at SAC, Auchincruive Estate, Ayrshire. At each site, two cultivars were treated with four fungicides at two fixed intervals. The cultivars used at Rosemaund were King Edward (foliar and tuber blight resistance ratings of 3 and 4, respectively) and Maris Piper (ratings of 4 and 5, respectively) and at Auchincruive, King Edward and Saturna (ratings of 4 and 5, respectively). The fungicides evaluated were two new products, Infinito and Valbon, and two fungicides widely used in GB, Curzate M and Shirlan each applied at intervals of 7 or 10 days. These fungicides were evaluated as components of season-long spray programmes and were applied from canopy stable stage through to haulm desiccation. The primary objectives were to independently evaluate these new fungicides and investigate the interactions between cultivar resistance, the frequency of fungicide application and fungicide product so that better use can be made of resistance traits in fungicide spray programmes in the future. In addition to the above core treatments funded by the BPC, comparisons were also made between different manufacturer-sponsored spray programmes. These treatments were applied to King Edward only.

The trial in Ayrshire confirmed that cultivar resistance can be substituted for fungicide input. However, whether blight control was significantly better on the more resistant cultivar using 10-day intervals compared with the more susceptible cultivar treated at shorter intervals depended on the fungicide used. Cultivar, spray interval and the fungicide used all had highly significant effects on foliar blight severity. Foliar blight was consistently less severe on Saturna than King Edward for each combination of fungicide and spray interval. There were many highly significant interactions between treatment factors. Differences between fungicide treatments and intervals were much smaller on the more resistant cultivar indicating that a foliar blight rating of 4 compared with 3 substantially reduced the importance of spray timing and also fungicide product. Foliar blight was consistently more severe where the fungicides had been applied at the longer interval for each combination of cultivar and fungicide but the difference between the spray intervals depended on fungicide product, cultivar resistance and date of assessment. The tuber blight results were confounded by the large differences in foliar blight severities between some treatments and therefore interpretation of the tuber blight results is complicated. The incidence of tuber blight for the different fungicide treatments was generally less for the more resistant Saturna than King Edward.

At Rosemaund, despite inoculation and overhead misting, the blight epidemic was extremely slow to develop and there was insufficient of a disease challenge to show differences between the various treatments. However, the low levels of foliar infection produced enough inoculum to infect the tubers. In the untreated Maris Piper plots tuber infection was higher than in the King Edward plots and this may be a reflection of the cultivars' ability to support different levels of sporulation. The fungicides Shirlan and Infinito gave the best control of tuber infection and there was also a significant interaction between cultivar and fungicide. Despite a slow, late epidemic at Rosemaund, fungicides significantly increased yield of ware.

There were differences between some of the manufacturer sponsored spray programmes in the control of both foliar and tuber blight at the Ayrshire site but not at Rosemaund.
N.B: The data were generated in a single season and therefore these results should be treated with caution.

2. Experimental Section

2.1 Project objectives

- To compare the control of foliar and tuber blight using combinations of cultivar resistance, fungicide product and fungicide application interval.
- To provide an independent evaluation of two new fungicides, Infinito and Valbon, with two established products, Curzate M and Shirlan.
- To compare a range of spray programmes for the control of foliar and tuber blight sponsored by fungicide manufacturers

2.2 Introduction

GB growers are under increasing pressure to reduce the cost of production and to produce blight-free crops at a time when there is a demand from retailers and consumers for the environmental impact of crop protection of potatoes to be reduced. At the same time there is increasing evidence to suggest that the population of *P. infestans* in GB has become more variable and possibly is more aggressive. In combination these factors may contribute to a greater reliance on cultivar resistance to achieve satisfactory levels of blight control in future years. There is a significant body of research evidence from Europe and the US to show that fungicide inputs can be reduced on potato cultivars with good resistance to foliar blight. For example, researchers in the United States have attempted to match the dose of Shirlan (0, 33, 50, 66 or 100% of label dose) and spray interval (5, 7, 10 or 14 days) to cultivar resistance (Kirk *et al.*, 2005). In Norway three doses of fluazinam (100%, 50% and 33% of the label dose) were applied at three intervals (7, 14 and 21 days) to six cultivars with different levels of foliar and tuber blight resistance (Naerstad *et al.*, 2007). Also, as part of the Dutch Umbrella Plan the appropriate dose of Shirlan, i.e. 20, 40, 60, 80 or 100% of 0.4 l/ha, for the 30 most commonly grown cultivars was determined (Kessel *et al.*, 2006). In these trials the first three fungicide applications were at fixed 7-day intervals but subsequently Plant Plus was used to determine spray dates. In Denmark researchers have worked on a weekly spraying model to determine the most appropriate doses (25, 50, 75 or 100% of label dose) of seven fungicides, depending on cultivar resistance, blight risk and the presence of blight in the area (Neilsen, 2004). The work carried out in these other countries clearly shows that there is potential for adjusting fungicide input depending on cultivar resistance. However, these results are not transferable between most countries primarily because there are too few cultivars in common between countries. The practical value of much of the research for GB growers is also limited because the vast majority of the cultivars tested are not grown in GB.

The aim of this work was to study the interactions between cultivar resistance, fungicide and application intervals for three GB cultivars and determine the scope for utilising existing cultivar resistance to improve the targeting of fungicide spray programmes. The work compared the effect of fixed fungicide interval (7 or 10 days) and cultivar resistance level using two new fungicides, Infinito and Valbon, that were introduced into the UK in 2006, and two older and widely used fungicides, Curzate M and Shirlan. These fungicides were applied during the canopy stable phase through to desiccation to two potato varieties. At Rosemaund the cultivars were King Edward (foliar and tuber resistance ratings of 3 and 4, respectively) and Maris Piper (ratings of 4 and 5, respectively) and at Auchincruive King Edward and Saturna (ratings of 4 and 5, respectively).

In addition to these core treatments funded by the BPC, the following agrochemical manufacturers included products in spray programmes:

BASF plc
Belchim Crop Protection Ltd.
Certis (Rosemaund only)
Dow AgroSciences Ltd.
Syngenta Crop Protection UK Ltd.

2.3 Materials and methods

2.3.1 Experimental design and fungicide application

Design

The core fungicide treatments were applied to plots of the varieties King Edward and Maris Piper at Rosemaund and King Edward and Saturna at Auchincruive. The experiment was a split plot design with the cultivars as whole plots and the fungicide programmes as subplots. There were four replicate blocks. The varieties were randomised in each block and the fungicide programmes were randomised within each variety plot.

The evaluation of manufacturer sponsored spray programmes was restricted to King Edward at both sites and the programmes were randomised in each block. The plots at both sites were four rows wide, measuring 3.56 m at Rosemaund and 3.4 m at Auchincruive. Plot lengths were 8.0 m at Rosemaund and 7.4 m at Auchincruive.

At Rosemaund, the experimental plots were surrounded either by 2 rows or a 2.0 m wide headland. Unsprayed infector rows were planted down the length of each block. The headlands were sprayed with a range of different fungicides at 10-day intervals. At Auchincruive, plots were separated along their length by 2.6 m of bare ground. Unsprayed infector areas (measuring 3.4 m wide and 1.8 m long) were located at the top and bottom of each fungicide-treated plot.

Fungicide application

At Rosemaund, the spray treatments were applied using an Oxford Precision Sprayer in 250 litres of water per hectare operating at 250 kPa through 110° flat fan nozzles. The spray booms were mounted at a boom height 30 cm above the crop on a Growmobile mechanised sprayer which allowed up to eight different treatments to be applied in one pass and maintained a constant forward speed (Turley *et. al,* 1995).

At Auchincruive fungicides were applied in 200 litres of water per ha using a tractor-mounted, modified AZO compressed air sprayer, operating at 3 bar to give a medium/fine spray quality. The nozzles were Lurmark F03-110.

The details of spray timings for the BPC funded core treatments and sponsored treatments at Rosemaund and Auchincruive are given in Appendix 1.

2.3.2 Spray programmes, active ingredients and rates of use

TABLE 1. COMPARISON OF FUNGICIDE SPRAY PROGRAMMES – CORE TREATMENTS AT ADAS ROSEMAUND (KING EDWARD & MARIS PIPER) AND SAC AUCHINCRUIVE (KING EDWARD & SATURNA)

Treatment Number	Core treatments
T1	Untreated control. No fungicide.
T2	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Shirlan (@ 0.3 L/ha) applied at 7-day intervals throughout until desiccation
T3	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Shirlan (@ 0.3 L/ha) applied at 10-day intervals throughout until desiccation
T4	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Curzate M (@ 2.0 kg/ha) applied at 7-day intervals throughout until desiccation
T5	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Curzate M (@ 2.0 kg/ha) applied at 10-day intervals throughout until desiccation
T6	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Infinito (@ 1.6 kg/ha) applied at 7-day intervals throughout until desiccation
T7	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Infinito (@ 1.6 kg/ha) applied at 10-day intervals throughout until desiccation
T8	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Valbon (@ 1.6kg /ha) + ZinZan (@150 ml/ha) applied at 7-day intervals throughout until desiccation
T9	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Valbon (@ 1.6kg /ha) + ZinZan (@150 ml/ha) applied at 10-day intervals throughout until desiccation

* The first spray was applied when the foliage was meeting along the rows.

The 1.6 kg/ha rate of Infinito was selected because the 1.2 kg rate is not recommended at both 7 and 10-day spray intervals by the manufacturer.

Table 1 (Cont'd). Manufacturer sponsored spray programmes at ADAS Rosemaund (King Edward) and SAC Auchincruive (King Edward)

Treatment Number	Manufacturer sponsored spray programmes
T10 Syngenta 1	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Shirlan (@ 0.4 L/ha) applied at 7-day intervals throughout until desiccation
T11 Syngenta 2	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Shirlan (@ 0.4 L/ha) applied at 10-day intervals throughout until desiccation
T12 BASF	Invader (@ 2.0kg/ha) applied at 7-day intervals throughout until desiccation
T13 Certis **(Rosemaund only)**	Epok * (@ 0.375L/ha)(x 1 spray), Valbon (@ 1.6 kg/ha)+ZinZan (@150 ml/ha) (x 3 sprays), Curzate M (@ 2.0 kg/ha) (x 1 spray), Valbon (@ 1.6 kg/ha)+ZinZan (@150 ml/ha) (x 3 sprays), Shirlan (@ 0.4 L/ha)(x2 sprays) prior to desiccation. Sprays to be applied at 7-day intervals throughout to be confirmed
T14 Belchim 1	Tattoo* (@ 4.0L/ha) (x3 sprays) followed by Ranman A+B (@ 0.2/0.15L/ha) applied at 7-day intervals until desiccation.
T15 Belchim 2	Tattoo* (@ 4.0L/ha) (x3 sprays) followed by Ranman A+B (@ 0.2/0.15L/ha) applied at 10- day intervals until desiccation
T16 Belchim 3	Tattoo* (@ 4.0L/ha) (x 3 sprays) followed by Ranman A+B (@ 0.2/0.15L/ha) + Option (@ 0.15kg/ha) applied at 10 day intervals until desiccation
T17 Dow 1**	Dithane DF (@ 2.0 kg/ha)(x1 spray @ rosette stage) followed by Epok (@ 0.375l/ha)(x2 sprays),Curzate M WG (@ 2 kg/ha)(x1 spray), then from stable canopy/tuber initiation stage, Electis (@1.8kg/ha) (x1 spray) Curzate M WG (@ 2 kg/ha)(x1 spray) Electis (@ 1.8kg/ha) (x1 spray), Ranman A+B (0.2L + Adj 0.15L) (x1 spray), Electis (@1.8kg/ha) (x1), Shirlan (@ 0.4L/ha) (X2 sprays) prior to desiccation. Sprays to be applied at 7 day intervals throughout but see ** below
T18*** Dow 2**	Dithane DF (@ 2.0 kg/ha) (x1 spray @ rosette stage) followed by Epok (@ 0.375l/ha) (x2 sprays), Curzate M WG (@ 2 kg/ha) (x1 spray), then from stable canopy/tuber initiation stage, Electis (@ 1.8kg/ha) (x 2 sprays), Ranman A+B (@ 0.2L + Adj 0.15L) (x 2 sprays), Electis (@ 1.8kg/ha) (x 1 spray), Infinito (@ 1.2l/ha) (x2 sprays) prior to desiccation. Sprays to be applied at 7 day intervals throughout but see ** below

*Spray programmes to start at the first blight warning or when haulm meets along the rows, whichever is the soonest. Unless specified otherwise, the first three spray treatments are to be applied at **10- day intervals** unless weather conditions are unsuitable and there is a risk of inaccurate spraying. Subsequent treatments to be applied at **7 or 10-day intervals** according to the treatment list again unless weather conditions are unsuitable and there is a risk of inaccurate spraying. The decision to delay spray application will be made according to blight risk by the Principle Investigator for each site.

** If blight risk is very high when Infinito is applied, the Study Director is to determine whether the rate needs to be increased from 1.2L to 1.6L/ha. Apply treatments at 7-day intervals, throughout. If Electis or Ranman intervals are stretched to 9 days, add C50 at 0.2 kg/ha and if Infinito stretched apply at 1.6l/ha.

*** At Auchincruive this treatment was labelled T13.

TABLE 2. FUNGICIDES AND RATE OF USE

Fungicide	**Active Ingredients (a.i.)**			**Rate (kg or L/ha)**	
	Common name	g/kg (L) product		active ingredient	product
Curzate M WG*	cymoxanil + mancozeb	45+ 680		0.09+ 1.36	2.0
Epok*	fluazinam + metalaxyl m	400 + 200		0.15 + 0.075	0.375 (L)
Infinito*	fluopicolide + propamocarb hcl	62.5 + 625		100 + 1000	1.6
Invader WG*	dimethomorph + mancozeb	75 + 667		0.15 + 1.334	2.0
Option	cymoxanil	600		90	0.15
Ranman A + Ranman B	cyazofamid + adjuvant	400 + 1000		0.08 + 150	0.20(L) + 0.15 (L)
Shirlan 500SC	fluazinam	500/L		0.15 –0.20	0.3 –0.4(L)
Tattoo*	propamocarb hcl + mancozeb	248+ 301.6		0.992+ 1.20	4.0 (L)
Valbon*	benthiavalicarb-isopropyl+ mancozeb	17.5 + 700		28 + 1120	1.6
ZinZan	adjuvant	-		-	0.15 (L)

*Formulated mixture

2.3.3 Assessments

Assessments of foliar blight

Foliage blight was assessed regularly during the epidemic as a percentage of leaf area destroyed by blight using a modified MAFF key 2.1.1 – Potato Blight on the Haulm (Anon., 1947 & 1976; Large, 1952). A similar key, modified slightly, was used at Auchincruive.

Blight %		Description			
0		Not seen			
0.1	1+	Lesion per plot		)	
0.2	25	Lesions per plot		)	
0.3	50	Lesions per plot		)	
0.4	75	Lesions per plot		)	
0.5	100	Lesions per plot	or	1 lesion per plant)	Assuming
0.6				2 lesions per plant)	100 plants
0.7				4 lesions per plant)	per plot
0.8				6 lesions per plant)	
0.9				8 lesions per plant)	
1.0				10 lesions per plant)	
5.0	1	Lesion per compound leaf	or	50 lesions per plant)	
10.0	2	Lesions per compound leaf	or	100 lesions per plant)	
25.0		Nearly every leaflet with blight lesions – plants still retaining their normal form – 75% plot leaf area remaining green			
50.0		About half of the leaf area destroyed by blight			
75.0		About three-quarters of the leaf area destroyed by blight			
95.0		Stems green, only a few leaves remaining			
100.0		All leaves dead, stems dead or dying			

Assessment of tuber blight

At Rosemaund, sub-samples of 100 tubers (>35 mm) were taken from each plot at harvest. The samples were stored in Hessian sacks in ambient conditions for approximately 6 weeks before washing and assessing for tuber blight.

At Auchincruive the same number of tubers were sampled from each plot of the trial. Tubers were assessed for blight within a few weeks of harvest. The remaining healthy tubers were stored in a frost-free store until mid-February and assessed for any blight that had developed during storage.

Assessment of yield

At Rosemaund, yields were taken from the centre two rows of each plot (the plots were harvested using a two row mechanical lifter). At Auchincruive, one of the centre rows per plot was hand lifted. All tubers >35 mm were included in the yield totals excluding splits, greens and rotted tubers. Harvested row lengths were 7.0 m at Rosemaund and 7.4 m at Auchincruive.

Assessment of growth stage

Crop growth stage was recorded at Rosemaund at each assessment date (Jeffries & Lawson, 1991). Ground cover was recorded at Auchincruive until it reached 100%.

2.3.4 Statistical Analysis

Differences between foliar blight means at each assessment date, tuber blight levels and ware yield were subjected to Analysis of Variance appropriate for a split plot design for the core treatments. The manufacturer-sponsored treatments were analysed together with the core treatments on King Edward also using an Analysis of Variance. The data were transformed before analysis where appropriate.

To aid interpretation of the data, the statistical significance of differences between treatment means has been determined using the Least Significant Difference test at $P<0.05$ (5%).

N.B. The foliar blight data for the Rosemaund site has not been statistically analysed because of the low levels of foliar blight in the treatments. An Analysis of Variance to include the untreated control data would not be appropriate because of the skewed distribution of the data.

2.4 Results

Important note: It should be noted that because the data were generated in a single season the results should be treated with caution. Also, for some fungicide treatments the maximum number of treatments and/or total dose, as specified on the product label, were exceeded so that scientifically valid comparisons could be made.

2.4.1 Blight epidemic at ADAS Rosemaund, Herefordshire

The crop at Rosemaund was planted on 11 May and reached 100% emergence by approximately 9 June. The daily rainfall recorded at the site together with foliar blight progress in the untreated King Edward plots is given in Fig. 1. Blight favourable conditions as defined by Smith Periods together with 'Near Misses' are also given in Fig. 1. These are taken from the BlightWatch website (blightwatch.co.uk) and the data presented for the Rosemaund site used the HR1 postcode cell.

Unsprayed areas within and surrounding the site were inoculated on four occasions. Within the trial, infector rows were inoculated at the mid point adjacent to each plot and similarly on unsprayed areas surrounding the trial. Inoculations were made on 5 July, 31 July, 11 August and 23 August. Infection and subsequent epidemic development was encouraged by misting/irrigation. Despite this, blight development was extremely slow because weather conditions in England and Wales generally were unfavourable for blight activity as a result of hot dry conditions in late June and much of July. Whilst Smith criteria & Near misses were recorded sporadically, Full Smith Periods were only recorded on 29/30 June, 24/25 July & 9/10/11 September. The 2006 season at Rosemaund should therefore be regarded as a low disease year.

The epidemic was stimulated to develop eventually by using overhead misting which allowed infection to become established in the untreated plots in mid/late August and which developed to almost complete haulm destruction by mid September. Blight was recorded in the treated plots in early September but failed to develop above 1 % infection and as a result, treatment differences were not recorded. The 'slow blight epidemic' did provide conditions suitable for tuber infection and treatment differences were recorded for this phase of the epidemic.

2.4.2 Blight epidemic at Auchincruive, Ayrshire

The trial was planted later than planned, on 1 and 2 June. The percentage ground cover was assessed in plots of King Edward from early July until the cover was c. 100%. The development of foliar blight in untreated plots of King Edward, together with Smith Period information and daily rainfall are given in Fig. 2. Blight risk information was calculated using meteorological data obtained from the Met. Office station at Auchincruive. Smith Periods were recorded on 18-19 August, 20-21 August, 5-6 September and 25-26 September.

Untreated infector plots at each end of the fungicide-treated plots were inoculated with *P. infestans* on 24 July with a mixture of isolates, i.e. 15904, 3333, 14203, 13933, 4512, 4711 (See Appendix 1, Table A10 for further information on the iolsates). The inoculation was successful. The trial plots were irrigated using seephose in late July and early August to maintain a suitable soil moisture content. Foliar blight was first observed in the untreated plots on 18 August. The epidemic on plots without fungicide developed quickly during the second half of August and early September. By 10 September the untreated plots of King Edward were dead and those of untreated Saturna were almost completely dead.

The first applications of the different fungicide treatments, after the initial three applications of Tattoo, were made on 15 and 16 August. Therefore most blight development in the fungicide treated plots took place after several applications of the different fungicides and intervals.

Conditions were favourable for tuber infection. Most tuber blight was recorded at the pre-storage assessment of tuber blight but for most treatments some symptoms developed on stored tubers that had been healthy at the first assessment.

Figure 1. Daily Rainfall recorded at ADAS Rosemaund and Smith Periods recorded on BlightWatch, and Blight Progress in untreated plots of King Edward 2006.

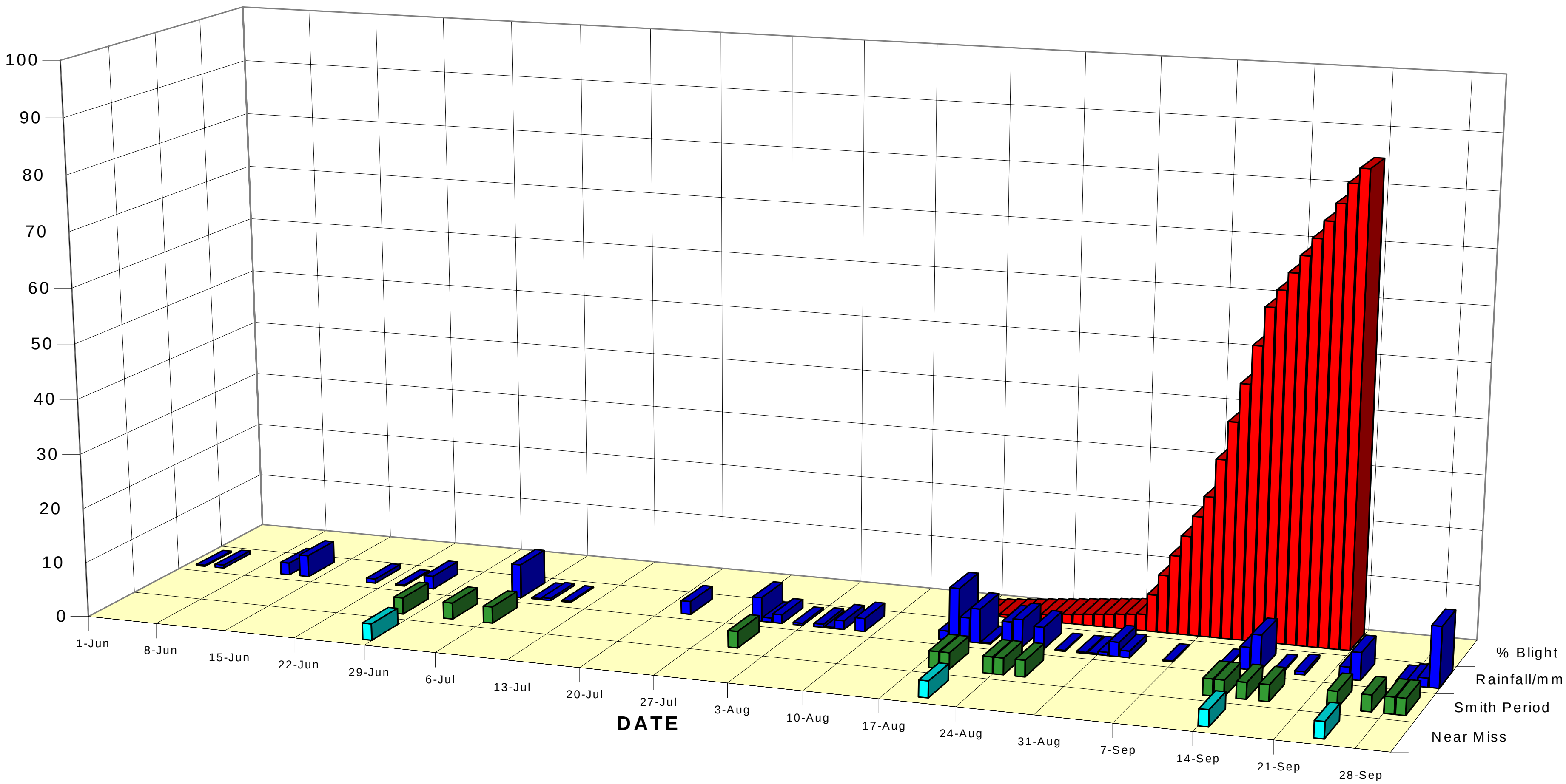
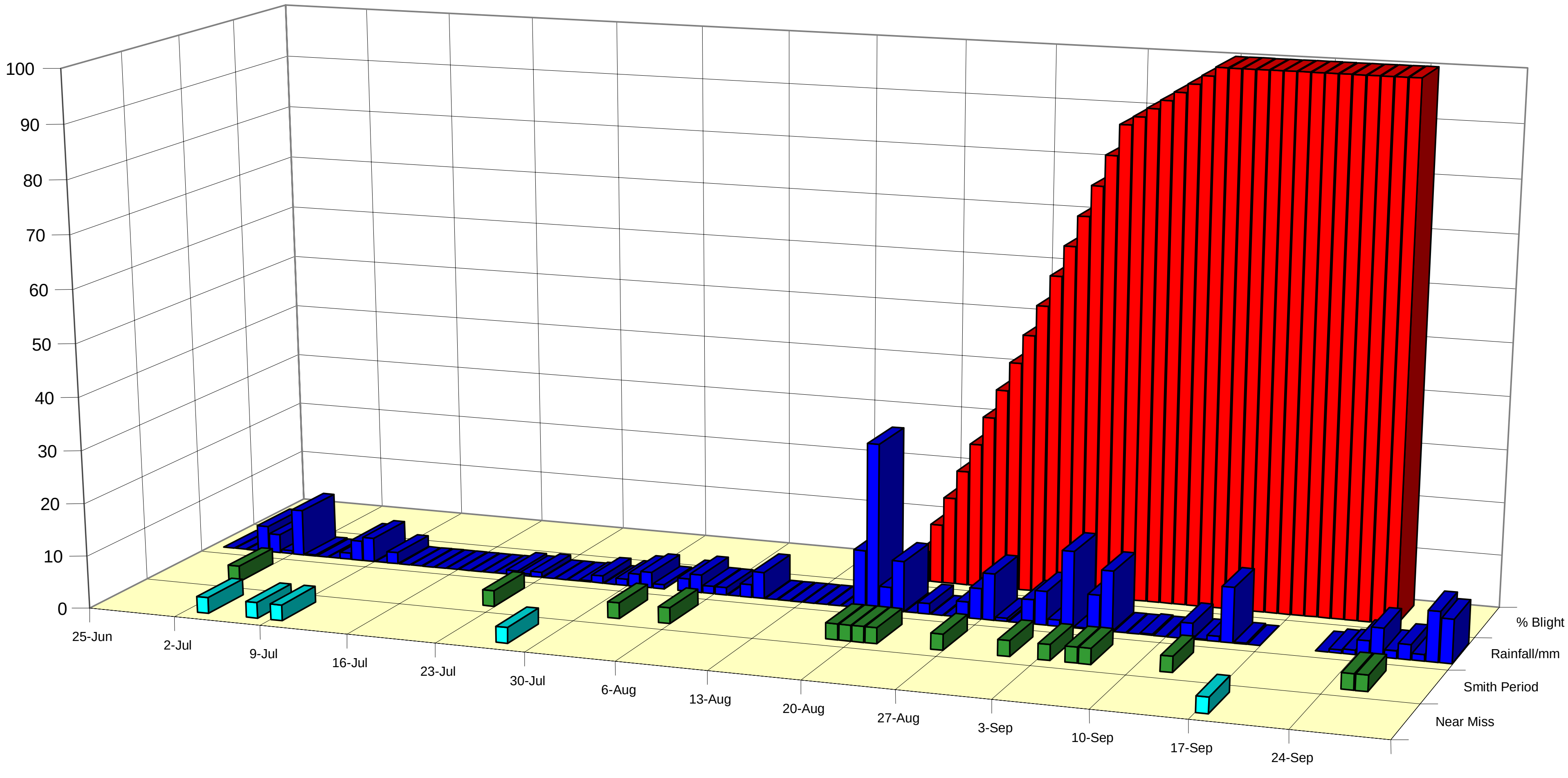


Figure 2. Smith Periods and daily rainfall recorded at SAC, Auchincruive and foliar blight progress in untreated plots of King Edward in 2006



2.4.3 Evaluation of fungicide treatments – ADAS Rosemaund.

The application dates for the fungicide treatments at Rosemaund are given in Appendix 1. Comparisons between the BPC core treatments on King Edward and Maris Piper followed three applications of Tattoo applied during the rapid growth phase starting when the haulm was meeting along the rows.

Foliar Blight
Foliar blight developed late at Rosemaund in 2006 despite a number of attempts at artificial inoculation and overhead misting. The crop at Rosemaund was also grown as an irrigated crop following Irriguide recommendations. Despite this and abundant nutrient availability the epidemic developed late and was first seen in the untreated plots on 17 August. Infection levels were 3% infection in the untreated King Edward plots and 0.1% infection in the untreated Maris Piper plots by 1 September. The disease failed to reach complete haulm destruction in either the King Edward or Maris Piper plots even by the third week in September. The disease challenge was therefore not strong enough to draw out any treatment effects either in the core treatments or in the manufacturer sponsored spray programmes.

Details of the foliar blight progress for the core treatments and the manufacturer-sponsored treatments are given in Tables 3 and 4, respectively.

TABLE 3. EVALUATION OF FUNGICIDES PROGRAMMES – CORE TREATMENTS: EFFECT ON FOLIAR BLIGHT SEVERITY (%) AT ADAS ROSEMAUND, 2006

Mean Percentage Leaf Area Destroyed by Blight – MAFF Key 2.1.1				
	King Edward		**Maris Piper**	
Spray Programme	**% foliar blight 12 September**	**% foliar blight 20 September**	**% foliar blight 12 September**	**% foliar blight 20 September**
Untreated control.	60	85	13.5	61.25
Core treatments				
Tattoo (x 3), Shirlan at 7-day intervals	0.1	0.125	0.1	0.15
Tattoo (x 3), Shirlan at 10-day intervals	0.1	0.125	0.075	0.45
Tattoo (x 3), Curzate M at 7-day intervals	0.1	0.15	0.1	0.125
Tattoo (x 3), Curzate M at 10-day intervals	0.1	0.125	0.075	0.275
Tattoo (x 3), Infinito at 7-day intervals	0.1	0.1	0.075	0.1
Tattoo (x 3), Infinito at 10-day intervals	0.1	0.125	0.075	0.15
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	0.1	0.1	0.075	0.1
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	0.1	0.2	0.1	0.35

N.B. The foliar blight data have not been statistically analysed because of the low levels of foliar blight in the treatments. An Analysis of Variance to include the untreated control data would not be appropriate because of the skewed distribution of the data.

TABLE 4. EVALUATION OF FUNGICIDES PROGRAMMES – MANUFACTURER SPONSORED TREATMENTS: EFFECT ON FOLIAR BLIGHT SEVERITY (%) AT ADAS ROSEMAUND, 2006

	King Edward	
Spray programme	**% foliar blight 12 September**	**% foliar blight 20 September**
Untreated control	60	85
Core treatments		
Tattoo (x 3), Shirlan at 7-day intervals	0.1	0.125
Tattoo (x 3), Shirlan at 10-day intervals	0.1	0.125
Tattoo (x 3), Curzate M at 7-day intervals	0.1	0.15
Tattoo (x 3), Curzate M at 10-day intervals	0.1	0.125
Tattoo (x 3), Infinito at 7-day intervals	0.1	0.1
Tattoo (x 3), Infinito at 10-day intervals	0.1	0.125
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	0.1	0.1
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	0.1	0.2
Sponsored treatments		
Syngenta 1: (Tattoo (x 3) fb Shirlan at 7-day intervals	0.1	0.1
Syngenta 2: (Tattoo (x 3) fb Shirlan at 10-day intervals	0.1	0.1
BASF: (Invader) at 7-day intervals	0.1	0.1
Certis: (Epok (x 1), Valbon +ZinZan (x 3), Curzate M (x 1), Valbon +ZinZan (x 3), Shirlan (x2)at 7-day intervals	0.1	0.1
Belchim 1: (Tattoo (x 3) fb Ranman at 7-day intervals	0.1	0.1
Belchim 2: (Tattoo (x 3) fb Ranman at 10- day intervals	0.1	0.1
Belchim 3: (Tattoo (x 3) fb Ranman + Option at 10 day intervals	0.1	0.1
Dow 1: (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 1), Curzate M WG (x 1), Electis (x 1), Ranman (x 1), Electis (x1), Shirlan (x 2) at 7 day intervals	0.1	0.1
Dow 2: (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 2), Ranman (x 2), Electis (x 1), Infinito (x 2) at 7 day intervals	0.1	0.1

N.B. The foliar blight data have not been statistically analysed because of the low levels of foliar blight in the treatments. An Analysis of Variance to include the untreated control data would not be appropriate because of the skewed distribution of the data.

Tuber blight- Core treatments

Despite low levels of foliar infection there were substantial levels of tuber blight particularly in some of the Maris Piper treatments and there was a significant cultivar x fungicide treatment interaction ($P<0.001$). There were no significant differences either in the percentage by number or percentage by weight of infected tubers between any of the core treatments in the King Edward plots. In the Maris Piper plots the highest level of tuber infection was in the untreated controls and at 14.25% of tubers infected, this was significantly higher than all the other treatments except where Curzate M had been applied at 10-day intervals ($P<0.001$). Both of the Curzate M treatments had significantly more tuber infection than any of the others including both of the Valbon spray programmes ($P<0.001$). Shirlan and Infinito spray programmes had the lowest incidence of tuber infection and were significantly lower than the Valbon treatments ($P<0.001$). With the exception of Shirlan at 10-day intervals and Valbon at 7-day intervals that were not significantly different on Maris Piper ($P>0.05$), these effects were consistent whether measuring tuber blight as the percentage by number or weight of infected tubers. This clearly indicates that both Shirlan and Infinito were having an effect on the tuber infection process i.e. on direct infection.

There was no significant effect of spray interval on the incidence of tuber infection and no significant interactions between variety and spray intervals or fungicide and spray intervals ($P>0.05$). There was significantly more tuber blight on Maris Piper (tuber rating 5) compared with King Edward (tuber rating 4) for five out of the nine core treatments. This unexpected result was probably because published disease resistance ratings are predominantly based on tests in which tubers are challenged directly and the quantity of inoculum is uniform within the test. In the field trial at Rosemaund the incidence of tuber blight will have been influenced by factors such as the amount of inoculum produced on the haulm of the two cultivars and the depth of progeny tubers in the ridge.

TABLE 5. EVALUATION OF FUNGICIDES PROGRAMMES – CORE TREATMENTS: EFFECT ON TUBER BLIGHT INCIDENCE (%) POST STORAGE AT ADAS ROSEMAUND, 2006

Spray Programme*	**% affected tubers by number**		**% affected tubers by weight**	
	King Edward	**Maris Piper**	**King Edward**	**Maris Piper**
Untreated control.	2.75	14.25	3.02	15.18
Core treatments				
Tattoo (x 3), Shirlan at 7-day intervals	0.25	0.75	0.42	1.05
Tattoo (x 3), Shirlan at 10-day intervals	0.50	1.75	0.49	2.03
Tattoo (x 3), Curzate M at 7-day intervals	3.25	10.00	3.57	11.58
Tattoo (x 3), Curzate M at 10-day intervals	2.75	12.00	3.36	13.00
Tattoo (x 3), Infinito at 7-day intervals	0.25	0.75	1.81	1.50
Tattoo (x 3), Infinito at 10-day intervals	0.25	0.00	0.18	0.00
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	0.75	5.75	0.69	6.12
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	0.75	6.25	0.72	7.68
F pr (48 df)	See below		See below	
LSD (5%)	3.595		4.410	

Factor	**F pr. tuber blight by number**	**F pr. tuber blight by Weight**
Cultivar	<0.001	<0.001
Interval	NS	NS
Fungicide	<0.001	<0.001
Cultivar x interval	NS	NS
Cultivar x fungicide	<0.001	<0.001
Interval x fungicide	NS	NS
Cultivar x interval x fungicide	NS	NS

Tuber blight – Manufacturer sponsored treatments

The manufacturer-sponsored treatments were only applied to King Edward and the incidence of tuber blight was analysed together with the core treatments also applied to King Edward. There were no significant differences in incidence of tuber infection measured either as percentage by number or weight of tubers infected between the majority of the manufacturer-sponsored spray programmes and core treatments (P>0.05). All spray programmes significantly reduced the incidence of tuber infection compared with the untreated control and both Curzate M treatments (P<0.001). Similar differences were recorded when tuber blight was measured as the percentage by weight of infected tubers. However, the weight of infected tubers in the Infinito 7-day programme was not significantly different from the Curzate treatments and the unsprayed control (P>0.05). This is probably an artefact and a reflection of the size of tubers infected.

TABLE 6. EVALUATION OF FUNGICIDES PROGRAMMES – MANUFACTURER SPONSORED TREATMENTS: EFFECT ON TUBER BLIGHT INCIDENCE (%) POST STORAGE AT ADAS ROSEMAUND, 2006

	King Edward	
Spray programmes	**% infected tubers by number**	**% infected tubers by weight**
Untreated control	2.75	3.02
Core treatments		
Tattoo (x 3), Shirlan at 7-day intervals	0.25	0.42
Tattoo (x 3), Shirlan at 10-day intervals	0.50	0.49
Tattoo (x 3), Curzate M at 7-day intervals	3.25	3.57
Tattoo (x 3), Curzate M at 10-day intervals	2.75	3.36
Tattoo (x 3), Infinito at 7-day intervals	0.25	1.81
Tattoo (x 3), Infinito at 10-day intervals	0.25	0.18
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	0.75	0.69
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	0.75	0.72
Sponsored treatments		
Syngenta 1: (Tattoo (x 3) fb Shirlan at 7-day intervals	0.25	0.23
Syngenta 2: (Tattoo (x 3) fb Shirlan at 10-day intervals	0.00	0.00
BASF: (Invader at 7-day intervals	1.00	0.12
Certis: (Epok (x 1), Valbon +ZinZan (x 3), Curzate M (x 1), Valbon +ZinZan (x 3), Shirlan (x2)at 7-day intervals	0.00	0.00
Belchim 1: (Tattoo (x 3) fb Ranman at 7-day intervals	0.00	0.00
Belchim 2: (Tattoo (x 3) fb Ranman at 10- day intervals	0.50	0.32
Belchim 3: (Tattoo (x 3) fb Ranman + Option at 10 day intervals	0.25	0.33
Dow 1: (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 1), Curzate M WG (x 1), Electis (x 1), Ranman (x 1), Electis (x1), Shirlan (x 2) at 7 day intervals	0.00	0.00
Dow 2: (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 2), Ranman (x 2), Electis (x 1), Infinito (x 2) at 7 day intervals	0.00	0.00
F pr (54 df)	<0.001	<0.001
LSD (5%)	1.278	1.767

Yield – Core treatments

There were no significant interactions between cultivar, fungicide or spray interval and combinations thereof (P>0.05; Table 7). There were no significant differences between yields of King Edward and Maris Piper or an effect of spray interval (P>0.05). All of the treatments applied to both cultivars increased yield compared with the unsprayed control. There were no significant differences between the fungicide treatments on King Edward (P>0.05). However on Maris Piper, both of the Shirlan treatments (7 & 10 day intervals) and the Curzate M 10 day schedule significantly out-yielded the other core programmes (P=0.035).

TABLE 7. COMPARISON OF FUNGICIDES PROGRAMMES – CORE TREATMENTS: YIELD (T/HA >35 MM) AT ADAS ROSEMAUND, 2006

	Total marketable yield	
Spray Programme*	**King Edward**	**Maris Piper**
Untreated control.	38.32	48.08
Core treatments		
Tattoo (x 3), Shirlan at 7-day intervals	51.25	56.71
Tattoo (x 3), Shirlan at 10-day intervals	55.07	58.12
Tattoo (x 3), Curzate M at 7-day intervals	50.21	53.71
Tattoo (x 3), Curzate M at 10-day intervals	54.31	57.60
Tattoo (x 3), Infinito at 7-day intervals	53.35	54.47
Tattoo (x 3), Infinito at 10-day intervals	53.02	51.26
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	49.04	48.87
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	50.44	51.71
F pr (47 df)	See below	
LSD (5%)	7.134	

*Untreated control excluded from the statistical analysis

Factor	**F pr. 17 September**
Cultivar	NS
Interval	NS
Fungicide	0.035
Cultivar x interval	NS
Cultivar x fungicide	NS
Interval x fungicide	NS
Cultivar x interval x fungicide	NS

Yield – Manufacturer sponsored treatments

The total yield from the Manufacturer sponsored treatments on King Edward have been analysed together with the core treatments applied to King Edward. A contrast was taken out comparing the untreated control with the mean of the other treatments. This showed that the significant effect was due to the difference between the control and the rest of the treatments. Inspection of the data showed a cluster of negative residual values in a number of plots in replicate four. This indicates that yields were lower and may reflect an area of the field with lower fertility. The yield data has been analysed for four replicates and also omitting replicate four (Table 8). Comments have been restricted to the analysis of the yield data from three replicates.

Although the majority of treatments significantly increased yield compared with the untreated control ($P<0.001$). there were no significant differences between treatments ($P=0.081$). This would be expected in a situation such as this where the foliar blight epidemic developed late as the crop had reached almost full maturity.

TABLE 8. COMPARISON OF FUNGICIDE PROGRAMMES – MANUFACTURER SPONSORED TREATMENTS: YIELD (T/HA >35 MM) AT ADAS ROSEMAUND, 2006.

	King Edward	
Spray programmes*	**3 Replicates**	**4 Replicates**
Untreated control	38.82	38.82
Core treatments		
Tattoo (x 3), Shirlan at 7-day intervals	51.88	51.25
Tattoo (x 3), Shirlan at 10-day intervals	51.79	55.07
Tattoo (x 3), Curzate M at 7-day intervals	49.36	50.21
Tattoo (x 3), Curzate M at 10-day intervals	53.70	54.31
Tattoo (x 3), Infinito at 7-day intervals	50.75	53.35
Tattoo (x 3), Infinito at 10-day intervals	52.04	53.68
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	47.23	49.04
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	49.52	50.44
Sponsored treatments		
Syngenta 1: (Tattoo (x 3) fb Shirlan at 7-day intervals	46.05	45.04
Syngenta 2: (Tattoo (x 3) fb Shirlan at 10-day intervals	49.33	48.75
BASF: (Invader at 7-day intervals	45.27	45.52
Certis: (Epok (x 1), Valbon +ZinZan (x 3), Curzate M (x 1), Valbon +ZinZan (x 3), Shirlan (x2)at 7-day intervals	47.75	46.75
Belchim 1: (Tattoo (x 3) fb Ranman at 7-day intervals	45.79	44.18
Belchim 2: (Tattoo (x 3) fb Ranman at 10- day intervals	50.39	48.54
Belchim 3: (Tattoo (x 3) fb Ranman + Option at 10 day intervals	45.03	44.02
Dow 1: (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 1), Curzate M WG (x 1), Electis (x 1), Ranman (x 1), Electis (x1), Shirlan (x 2) at 7 day intervals	47.22	45.45
Dow 2: (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 2), Ranman (x 2), Electis (x 1), Infinito (x 2) at 7 day intervals	45.20	44.75
F pr (35 df)	0.001	
LSD (5%)	7.757	
F pr (35 df) treatment comparisons	NS	
F pr (53 df)		<0.001
LSD (5%)		6.807

*Untreated control excluded from the statistical analysis

2.4.4 Evaluation of fungicide programmes – SAC Auchincruive.

Fungicide application dates are listed in Appendix 1. In the BPC-funded core treatments, and some of the manufacturers' treatments, the different fungicides were applied after three applications of Tattoo to cover the period from foliage meeting along the rows to the end of rapid haulm growth. The core treatments were applied to both King Edward and Saturna. The manufacturer-sponsored treatments were only applied to King Edward and the foliar blight, tuber blight and yield results were analysed together with the King Edward core treatments.

Foliar blight –Core treatments

At the final three assessments, cultivar, spray interval and fungicide had highly significant effects on the severity of foliar blight (Table 9). At these assessment times the interactions cultivar x interval, cultivar x fungicide and interval x fungicide were generally significant. Foliar blight was consistently less severe on Saturna than King Edward. A foliar blight rating of 4 compared with 3 substantially reduced the importance of spray interval and also fungicide product. Differences between fungicide treatments and intervals were much smaller on the more resistant cultivar.

The foliar blight results confirm that cultivar resistance can be substituted for fungicide input. However, the extent to which the more resistant variety allowed the use of longer intervals depended on fungicide. It was found that blight control on the more resistant cultivar Saturna using 10-day spray intervals resulted in significantly better control (Shirlan), similar control (Infinito and Curzate M) or significantly worse control (Valbon) than on King Edward with the same fungicides at 7-day intervals (Table 9). In addition, the same level of foliar blight protection was achieved using a less effective fungicide on Saturna compared with a stronger fungicide on King Edward, i.e. Valbon at 7 days on Saturna compared with Infinito at 10 days on K Edward.

Foliar blight was consistently more severe where the fungicides had been applied at the longer interval. The difference in foliar blight control for 7-day compared with 10-day intervals depended on fungicide product, cultivar resistance and date of assessment. For the final three assessments of foliar blight more of the differences between the two spray intervals were significant for Valbon + ZinZan than Shirlan or Curzate M. For Infinito foliar blight was never significantly worse for the longer spray interval. The relative efficacies of the four fungicides were generally different at the two application intervals. For example on 17 September, at 7 days on King Edward, Infinito and Valbon were not significantly different and neither were Curzate M and Shirlan. However, at 10-day intervals all four products resulted in significantly different levels of foliar blight control. On 24 September Infinito applied at either interval gave significantly better control of foliar blight than the three other fungicides applied at the same interval. Interval differences were generally greater on King Edward than Saturna.

TABLE 9. EVALUATION OF FUNGICIDE PROGRAMMES – CORE TREATMENTS: EFFECT ON FOLIAR BLIGHT SEVERITY (%) AT SAC AUCHINCRUIVE, 2006

	% foliar blight 27 August		**% foliar blight 3 September**		**% foliar blight 10 September**		**% foliar blight 17 September**		**% foliar blight 24 September**	
Spray Programme	**King Edward**	**Saturna**	**King Edward**	**Saturna**	**King Edward**	**Saturna**	**King Edward**	**Saturna**	**King Edward**	**Saturna**
Untreated control	48.8	5.9	88.8	37.5	100.0	97.5	100.0	100.0	100.0	100.0
Core treatments										
Tattoo (x 3), Shirlan at 7-day intervals	0.20	0.05	0.50	0.35	1.4	0.7	36.3	2.8	70.0	34.2
Tattoo (x 3), Shirlan at 10-day intervals	0.22	0.08	0.39	0.33	3.5	1.7	81.1	14.8	80.4	43.8
Tattoo (x 3), Curzate M at 7-day intervals	0.28	0.10	0.53	0.30	0.8	0.6	38.8	5.8	58.7	35.0
Tattoo (x 3), Curzate M at 10-day intervals	0.28	0.13	0.45	0.38	2.3	0.9	61.3	16.3	73.8	61.2
Tattoo (x 3), Infinito at 7-day intervals	0.30	0.05	0.30	0.10	0.5	0.4	1.7	0.8	5.1	1.7
Tattoo (x 3), Infinito at 10-day intervals	0.35	0.10	0.48	0.28	0.8	0.6	5.2	1.8	13.2	3.5
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	0.30	0.08	0.35	0.20	0.6	0.5	7.5	1.9	30.0	11.1
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	0.23	0.13	0.43	0.35	1.4	0.9	41.3	17.5	63.8	55.0

F pr.	See below	See below	See below	See below	See below
LSD (*P*=0.05)	0.161	0.199	0.53	9.67	18.81

Factor	**F pr. 27 August**	**F pr. 3 September**	**F pr. 10 September**	**F pr. 17 September**	**F pr. 24 September**
Cultivar	<0.001	<0.001	< 0.001	< 0.001	< 0.001
Interval	0.538	0.123	< 0.001	< 0.001	< 0.001
Fungicide	0.366	0.060	< 0.001	< 0.001	< 0.001
Cultivar x interval	0.482	0.271	< 0.001	< 0.001	NS
Cultivar x fungicide	0.554	0.769	< 0.001	< 0.001	0.02
Interval x fungicide	0.890	0.076	< 0.001	< 0.001	0.004
Cultivar x interval x fungicide	0.854	0.900	0.090	0.024	NS

On 18 August only the untreated plots were blighted. The severity of foliar blight for King Edward and Saturna was 0.40 and 0.28 respectively. Untreated excluded from analyses.

Foliar blight –Manufacturer sponsored treatments

At all assessments, treatment had a significant effect on the severity of foliar blight (Table 10). For straight Ranman, control was better at 7 compared with 10-day intervals but the difference was only significant on 17 September. Similarly for the 0.4 l/ha rate of Shirlan, foliar blight was generally less at the shorter interval but the difference was significant on 10 and 17 September only. The higher rate of Shirlan did not result in significantly less foliar blight than the 0.3 l/ha rate at either spray interval, except on 17 September at the shorter interval. Foliar blight control with the two Dow programmes was good, sometimes significantly better than with the higher rate of Shirlan, Invader or Ranman at the same intervals.

TABLE 10. EVALUATION OF FUNGICIDE PROGRAMMES – MANUFACTURER SPONSORED TREATMENTS: EFFECT ON FOLIAR BLIGHT SEVERITY (%) AT SAC, AUCHINCRUIVE, 2006 (KING EDWARD)

Spray programme	% foliar blight 27 August	% foliar blight 3 Sept	% foliar blight 10 Sept	% foliar blight 17 Sept	% foliar blight 24 Sept
Untreated control	48.8	88.8	100.0	100.0	100.0
Core treatments					
Tattoo (x 3), Shirlan at 7-day intervals	0.20	0.50	1.4	36.2	70.0
Tattoo (x 3), Shirlan at 10-day intervals	0.21	0.40	3.5	81.1	80.4
Tattoo (x 3), Curzate M at 7-day intervals	0.28	0.52	0.8	38.8	58.7
Tattoo (x 3), Curzate M at 10-day intervals	0.28	0.45	2.3	61.2	73.8
Tattoo (x 3), Infinito at 7-day intervals	0.30	0.30	0.5	1.7	5.1
Tattoo (x 3), Infinito at 10-day intervals	0.35	0.47	0.8	5.2	13.2
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	0.30	0.35	0.6	7.5	30.0
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	0.23	0.42	1.4	41.2	63.7
Sponsored treatments					
Syngenta 1: Tattoo (x 3) fb Shirlan (0.4 l/ha) at 7-day intervals	0.30	0.60	1.0	23.8	66.2
Syngenta 2: Tattoo (x 3) fb Shirlan (0.4 l/ha) at 10-day intervals	0.35	0.52	4.0	76.2	73.8
BASF: Invader at 7-day intervals	0.15	0.37	0.9	38.8	66.2
Belchim 1: Tattoo (x 3) fb Ranman at 7-day intervals	0.23	0.35	0.7	1.8	38.8
Belchim 2: Tattoo (x 3) fb Ranman at 10-day intervals	0.33	0.37	1.2	21.2	51.2
Belchim 3: Tattoo (x 3) fb Ranman + Option at 10-day intervals	0.40	0.45	1.1	11.2	37.5
Dow (T17): (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 1), Curzate M WG (x 1), Electis (x 1), Ranman (x 1), Electis (x1), Shirlan (x 1) at 7 day intervals	0.03	0.15	0.6	6.7	25.0
Dow (T13): (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 1), Electis + Option (x1), Ranman (x 2), Electis (x 1), Infinito (x 1) at 7 day intervals	0.10	0.27	0.8	4.4	22.6
F pr.	<0.001	0.005	<0.001	<0.001	<0.001
LSD (*P*=0.05)	0.153	0.193	0.54	11.84	13.73

On 18 August only the untreated plots were blighted. The severity of foliar blight for King Edward was 0.40. Untreated excluded from analyses.

Tuber blight – Core treatments

Comments refer to the total incidence (pre- plus post-storage) of tuber blight by weight. Cultivar spray interval, fungicide and the interaction interval x fungicide significantly affected the total incidence of tuber blight (Table 11). The incidences of tuber blight were moderate.

In general, spray interval had no significant effect on tuber blight (Table 11). For some treatments tuber blight incidence was higher for the 7-day compared with the 10-day interval applications. The tuber blight results were confounded by the large differences in foliar blight severities between some treatments. This is an artefact of blight trials and care is required when interpreting the results. It is difficult to relate tuber blight control by the different combinations of fungicide and spray interval in this trial to their efficacy in commercial crops. The confounding effect is the most obvious explanation for the incidence of tuber blight being significantly lower for Valbon + ZinZan at the longer spray interval on both cultivars. It is most likely that at the time when conditions favoured tuber infection, haulm treated at the shorter interval had a greater capacity to support sporulation because of more green leaf tissue.

The incidence of tuber blight for the different fungicide treatments was generally less for the more resistant Saturna (tuber blight rating of 5) than King Edward (tuber blight rating of 4). On King Edward, only Infinito at 7 days resulted in significantly less tuber blight than the untreated. For both cultivars tuber blight incidence was significantly higher for Valbon + ZinZan at 7 days compared with the untreated.

TABLE 11. EVALUATION OF FUNGICIDE PROGRAMMES – CORE TREATMENTS: EFFECT ON TOTAL TUBER BLIGHT INCIDENCE (%) (PRE-STORAGE PLUS POST-STORAGE) AT SAC AUCHINCRUIVE, 2006

	% infected tubers by number		**% infected tubers by weight**	
Spray Programme	**King Edward**	**Saturna**	**King Edward**	**Saturna**
Untreated control	6.5	1.5	5.8	1.5
Core treatments				
Tattoo (x 3), Shirlan at 7-day intervals	8.5	3.8	7.5	3.8
Tattoo (x 3), Shirlan at 10-day intervals	5.5	4.0	4.3	3.8
Tattoo (x 3), Curzate M at 7-day intervals	5.4	5.5	4.2	5.5
Tattoo (x 3), Curzate M at 10-day intervals	4.8	2.5	4.3	2.5
Tattoo (x 3), Infinito at 7-day intervals	0.5	0.7	1.0	0.9
Tattoo (x 3), Infinito at 10-day intervals	1.8	1.0	1.6	1.2
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	13.2	8.2	12.4	8.4
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	7.0	2.2	7.1	2.6
F pr.	See below		See below	
LSD (*P*=0.05)	4.34		4.33	

Factor	**F pr. tuber blight by number**	**F pr. tuber blight by weight**
Cultivar	0.003	0.027
Interval	0.007	0.010
Fungicide	<0.001	<0.001
Cultivar x interval	0.998	0.904
Cultivar x fungicide	0.156	0.215
Interval x fungicide	0.020	0.049
Cultivar x interval x fungicide	0.634	0.565

Tuber blight – Manufacturer sponsored treatments

The effect of fungicide treatment on the total incidence of tuber blight was highly significant (Table 12). Good control of tuber blight was achieved using the two Dow programmes and the three Ranman treatments. Both straight Ranman treatments, i.e. Ranman at either 7 or 10-day intervals, gave significantly better control than the untreated, Shirlan at 0.3 l/ha at 7 days, Valbon + ZinZan at both spray intervals and the Invader treatment. For both Shirlan at 0.4 l/ha and Ranman there was no significant difference between the 7 and 10-day spray intervals.

TABLE 12. EVALUATION OF FUNGICIDE PROGRAMMES – MANUFACTURER SPONSORED TREATMENTS: EFFECT ON TOTAL TUBER BLIGHT INCIDENCE (%) (PRE-STORAGE PLUS POST-STORAGE) AT SAC, AUCHINCRUIVE 2006

	King Edward	
Spray programme	**% infected tubers by number**	**% infected tubers by weight**
Untreated control	6.5	5.8
Core treatments		
Tattoo (x 3), Shirlan at 7-day intervals	8.5	7.5
Tattoo (x 3), Shirlan at 10-day intervals	5.5	4.3
Tattoo (x 3), Curzate M at 7-day intervals	5.4	4.2
Tattoo (x 3), Curzate M at 10-day intervals	4.8	4.3
Tattoo (x 3), Infinito at 7-day intervals	0.5	1.0
Tattoo (x 3), Infinito at 10-day intervals	1.8	1.6
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	13.2	12.4
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	7.0	7.1
Sponsored treatments		
Syngenta : Tattoo (x 3) fb Shirlan (0.4 l/ha) at 7-day intervals	4.5	4.4
Syngenta : Tattoo (x 3) fb Shirlan (0.4 l/ha) at 10-day intervals	3.0	3.4
BASF : Invader at 7-day intervals	7.0	6.2
Dow (T13): (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 1), Electis + Option (x1), Ranman (x 2), Electis (x 1), Infinito (x 1) at 7 day intervals	1.0	0.9
Belchim : Tattoo (x 3) fb Ranman TP at 7-day Intervals	1.3	1.0
Belchim : Tattoo (x 3) fb Ranman TP at 10-day Intervals	0.5	0.3
Belchim : Tattoo (x 3) fb Ranman TP + Option at 10-day intervals	1.8	1.8
Dow (T17): (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 1), Curzate M WG (x 1), Electis (x 1), Ranman (x 1), Electis (x1), Shirlan (x 1) at 7 day intervals	1.5	1.4
F pr.	<0.001	<0.001
LSD (*P*=0.05)	4.75	4.57

Yield - Core treatments

Comments refer to blight-free yields. For the different combinations of fungicide and spray interval, the blight-free yields for Saturna were consistently significantly greater than for King Edward (Table 13). For the individual fungicides, spray interval had no significant effect on blight-free yield. Infinito applied at either 7- or 10-day intervals gave the highest blight-free yields. On King Edward the yields for Infinito were significantly greater than Shirlan at 0.3 l/ha or Valbon + ZinZan at both intervals and also Curzate M at the longer interval. There were no significant differences between treatments (combinations of interval and fungicide) on the more resistant Saturna.

For all four fungicides, with Saturna it was possible to use 10-day intervals and still obtain a significantly higher yield of blight-free tubers than for King Edward treated every 7 days.

TABLE 13. EVALUATION OF FUNGICIDE PROGRAMMES – HARVESTED YIELD AND BLIGHT-FREE YIELD (T/HA >35 MM) AT SAC, AUCHINCRUIVE 2006

	Harvested yield		**Blight-free yield**	
Spray Programme	**King Edward**	**Saturna**	**King Edward**	**Saturna**
Untreated control	14.13	29.91	13.40	29.61
Core treatments				
Tattoo (x 3), Shirlan at 7-day intervals	33.88	51.69	31.66	49.62
Tattoo (x 3), Shirlan at 10-day intervals	27.37	52.02	26.22	51.21
Tattoo (x 3), Curzate M at 7-day intervals	36.09	51.07	35.09	47.61
Tattoo (x 3), Curzate M at 10-day intervals	35.04	50.73	32.86	49.81
Tattoo (x 3), Infinito at 7-day intervals	40.96	55.68	40.37	54.71
Tattoo (x 3), Infinito at 10-day intervals	42.04	54.76	42.04	54.76
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	35.70	56.19	32.32	51.40
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	31.67	50.23	29.85	48.82
F pr.	See below		See below	
LSD (*P*=0.05)	7.712		7.398	

Untreated excluded from statistical analyses

Factor	**F pr. Harvested yield**	**F pr. Blight-free yield**
Variety	< 0.001	< 0.001
Fungicide	0.004	< 0.001

Yield – Manufacturer sponsored treatments

The Dow programme (T13) gave the largest yield of blight-free tubers, significantly greater than Shirlan at 0.4 l/ha at both intervals, Invader and Ranman alone at 10-day intervals (Table 14). Ranman applied at 7-day intervals also gave a high yield. For the higher rate of Shirlan and Ranman alone spray interval did not significantly influence blight-free yield.

TABLE 14. EVALUATION OF FUNGICIDE PROGRAMMES – HARVESTED AND BLIGHT-FREE YIELD (T/HA) AT SAC, AUCHINCRUIVE 2006

	King Edward	
	Harvested yield	**Blight-free yield**
Spray programmes*		
Untreated control	14.13	13.40
Core treatments		
Tattoo (x 3), Shirlan at 7-day intervals	33.88	31.66
Tattoo (x 3), Shirlan at 10-day intervals	27.37	26.22
Tattoo (x 3), Curzate M at 7-day intervals	36.09	35.09
Tattoo (x 3), Curzate M at 10-day intervals	35.04	32.86
Tattoo (x 3), Infinito at 7-day intervals	40.96	40.37
Tattoo (x 3), Infinito at 10-day intervals	42.04	42.04
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	35.70	32.32
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	31.67	29.85
Sponsored treatments		
Syngenta 1: (Tattoo (x 3) fb Shirlan at 7-day intervals	33.95	33.36
Syngenta 2: (Tattoo (x 3) fb Shirlan at 10-day intervals	27.58	27.38
BASF: (Invader at 7-day intervals	33.69	31.98
Belchim 1: (Tattoo (x 3) fb Ranman at 7-day intervals	41.14	40.94
Belchim 2: (Tattoo (x 3) fb Ranman at 10- day intervals	32.81	32.81
Belchim 3: (Tattoo (x 3) fb Ranman + Option at 10 day intervals	36.60	36.60
Dow (T17): (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 1), Curzate M WG (x 1), Electis (x 1), Ranman (x 1), Electis (x1), Shirlan (x 1) at 7 day intervals	38.48	37.76
Dow (T13): (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 1), Electis + Option (x1), Ranman (x 2), Electis (x 1), Infinito (x 1) at 7 day intervals	42.32	42.32
F pr.	0.028	0.003
LSD (*P*=0.05)	9.085	8.452

*Untreated excluded from statistical analyses

2.5 Discussion

In the Introduction details of research in The Netherlands, Denmark, Norway and the US, to investigate the effectiveness of reduced fungicide inputs on more resistant varieties was outlined. This research demonstrated that cultivar resistance could be substituted for part of the fungicide input required to control blight. The results of the trial in Scotland in 2006 confirm that there is potential for adjusting fungicide input depending on cultivar resistance to control foliar blight. However, in the trial tuber blight results were confounded by differences in foliar blight control therefore no conclusions can be made regarding the effectiveness of the combination of less fungicide applied to a more resistant cultivar to control tuber blight.

The agrochemical industry has developed and introduced new, more effective blight fungicides in recent years. However, the increase in efficacy is unlikely to be enough by itself to maintain effective blight control if concerns regarding global warming and changes in the pathogen population are realised. Greater use may need to be made of cultivar resistance in future not least because of pressure from EU legislation on pesticide use. This will encourage the GB potato industry to adopt an Integrated Pest Management (IPM) approach. Greater use of cultivar resistance will be an essential part of a successful IPM strategy.

There is a wide range of foliar blight resistance ratings among the most widely grown cultivars in GB. In spite of this fungicide programmes are generally similar for both resistant and susceptible cultivars. This is a reflection of growers' concerns about the potential effects of blight on both yield and quality and the demands of the marketplace and also management practices. Better use of cultivar resistance not only has the potential to improve control of potato blight but could also reduce the costs and the perceived (or real) impact of blight fungicides on the environment, as well as minimising further any possible fungicide residues on tubers.

This preliminary work has shown that substituting a cultivar with a blight resistance rating one point higher can make a substantial contribution to blight control. The data are limited, and should therefore be treated with caution, but they do confirm earlier GB trials in the mid-1990s in which fungicide product efficacy was matched to cultivar resistance and gave promising results (Bain, unpublished). The interactions between cultivar resistance, fungicide and application intervals are complex but these results clearly show that there is scope for utilising existing and future cultivar resistance to improve the targeting of fungicide spray programmes on GB cultivars.

2.6 Conclusions

It is not possible to draw firm conclusions from such a limited dataset as is produced here but together with the significant body of research evidence from continental Europe and the US it shows that fungicide inputs can be reduced on potato cultivars with good resistance to foliar blight. However, the practical value of much of the overseas research is limited because it has usually concentrated on reducing dose rates of a specific fungicide on a wide range of cultivars. In addition, the vast majority of the cultivars tested are not grown in GB and therefore the results are of limited value to GB growers. Robust data using GB cultivars are necessary to give GB agronomists confidence in the system.

One approach for further GB research would be to evaluate fungicides with difference ratings for efficacy against foliar blight (taken from the EU.NET.ICP ratings table (Bradshaw, 2006)) on different cultivars representing classes of foliar blight resistance. In this way, the results would be ‘future proofed’ as new fungicides and cultivars are brought onto the GB market. Fungicides could be evaluated in spray programmes at 7 & 10-day intervals on three or four representative cultivars at either i) the rapid haulm growth phase and/or ii) during the canopy complete stage though to desiccation. Also, where appropriate, different rates of fungicides could be matched to cultivar resistance.

At a BPC decision support system (DSS) stakeholder meeting in September 2006 it was concluded that the industry required a basic (Tier 1) DSS to be widely available now. However, it was recognised that a more sophisticated system, i.e. one taking account of cultivar resistance, was likely to be required in the future. For the GB potato industry to benefit from existing and future cultivar resistance to blight, agronomists will need robust information demonstrating how effective blight control can be achieved using less fungicide input on more resistant cultivars without compromising market requirements.

The objectives of any further work should aim to investigate the following and a database of at least six sites/years is considered appropriate:

1. To show to what extent fungicide inputs (product, rate and spray interval) can be reduced on more blight resistant cultivars whilst maintaining acceptable control of foliar and tuber blight.
2. To provide a dataset for the GB industry demonstrating blight control for different levels of fungicide input on cultivars representing classes of foliar blight resistance.
3. To determine whether fungicide costs can be further optimised through the use of a forecasting system to dictate spray timings, compared with fixed spray intervals.
4. To provide a cost/benefit analysis for the different combinations of cultivar resistance, fungicide product and spray interval.
5. To identify at which level of cultivar resistance, blight control is not influenced by fungicide choice or spray interval (7 or 10 days).

2.7 References

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3. Project deliverables

As the data were generated in a single season the results should be treated with caution. The authors do not consider it appropriate to formulate specific recommendations based on these preliminary results that rely mainly on a blight epidemic at one site. As the characteristics of blight epidemics are influenced by weather and the onset of disease development in relation to crop growth stage conclusions should be drawn from several experiments over a number of years.

- Together with previous UK data and reports from Europe and the USA, these preliminary results have shown that even a slight increase in cultivar resistance to foliar blight can make a useful contribution to disease control.
- The results suggest that where a more resistant cultivar, rather than a very susceptible one, is grown the choice of fungicide product or spray interval is less important.
- The data generated in this preliminary project can be used to establish a database of blight control for different combinations of cultivar resistance and fungicide input which would be of benefit to GB potato agronomists when making fungicide recommendations.
- The research provides a basis for the development of an IPM strategy for blight control in GB.
- The core treatment data provide independent information on the relative performance of two new fungicides compared with two established products.
- The manufacturer-sponsored spray programmes provided important efficacy data for additional products and doses, and also the efficacy of some commercial programmes.
- Effective control of foliar and tuber blight was demonstrated in the presence of known and recently characterised blight genotypes.

The use of cultivar resistance characteristics will not be immediately quantifiable as cultivar choice is often dependent on higher priority traits required by the market. Nevertheless, continued research to develop a robust data set and further promotion of the results may encourage the GB industry to consider the benefits of blight resistance. This will in time influence the area of crop grown with resistant cultivars but will inevitably this will be confounded by other factors affecting cultivar choice.

4. Knowledge transfer activities

1. Auchincruive site demonstrated to BPC staff, agronomists, distributors and fungicide manufacturers on 19 September 2006.
2. Interim results published on the BPC website and sent to the company sponsors (Nov 2006).
3. Presentation at the UK Blight Forum (7 Feb 2007).

6. Appendix 1

Table A1. Plot & treatment layout at ADAS Rosemaund, 2006

2	**18**	**3**	**18**	**5**	**12**	**5**	**19**		
7	**11**	**6**	**12**	**7**	**16**	**9**	**10**		
5	**10**	**8**	**11**	**4**	**11**	**4**	**15**		
3	**12**	**5**	**16**	**2**	**14**	**8**	**14**		
4	**15**	**1**	**14**	**8**	**10**	**1**	**11**		
8	**Blank**	**7**	**Blank**	**6**	**Blank**	**6**	**Blank**		
9	**5**	**9**	**4**	**3**	**4**	**7**	**1**		
1	**4**	**2**	**1**	**1**	**7**	**3**	**8**		
6	**9**	**4**	**5**	**9**	**2**	**2**	**4**		
Blank	**7**	**Blank**	**3**	**Blank**	**8**	**Blank**	**5**		
17	**2**	**13**	**6**	**17**	**9**	**12**	**9**		
13	**6**	**10**	**9**	**13**	**5**	**13**	**2**		
14	**8**	**15**	**7**	**19**	**6**	**17**	**6**		
19	**1**	**17**	**2**	**18**	**3**	**18**	**7**		
16	**3**	**19**	**8**	**15**	**1**	**16**	**3**		

Maris Piper

King Edward

Table A2. Plot layout at SAC, Auchincruive, 2006

17	5	1	9	2	11	6	9
3	6	4	10	8	13	15	3
15	4	6	5	1	16	12	4
4	8	2	17	6	10	3	1
7	3	7	2	5	14	2	7
2	1	5	7	3	12	5	5
9	2	3	4	4	7	14	2
16	9	8	13	7	6	4	8
8	7	9	1	9	8	9	6
GAP	GAP	GAP	GAP	GAP	GAP	GAP	GAP
11	13	6	12	17	2	7	11
12	14	8	16	5	15	1	13
6	5	3	11	1	4	16	17
1	10	15	14	9	3	8	10

King Edward **Saturna**

Table A3. Details of soil type, nutrient status, cultivations and agronomy at each site.

	ADAS Rosemaund	SAC Auchincruive
Soil Series:	Bromyard Series	-
Soil Texture:	Silty Clay Loam	Silty Sandy Loam
Soil Analysis:		
P index	3	Mod
K index	3	High
Mg index	3	High
PH	7.1	6.0
Previous Cropping:		
2005	Spring Oats	Grass
2004	Winter Wheat	Grass
2003	Oilseed Rape	Grass
Cultivations:	Ploughed	Plough
	Flatlift	Disc
	Rotospike	Rotovate
	Rotovate	Rotovate
Cultivars & seed health status:	King Edward – SE1	King Edward - SE1
	Maris Piper – SE1	Saturna - SE 1
Planting date:	11 May	1 & 2 June
Harvesting date:	16/17 Oct 2006	2 November 2006
Fertiliser (kg/ha):		
N	286.5	190
P	54.0	176
K	231	176
FYM (t/ha)	30 (3 Feb 2006)	-
Herbicides:	Sencorex @ 1.0 kg/ha Gramoxone @ 3.0 l/ha	Linuron @ 2.9 L/ha + PDQ @ 1.0 L/ha
	(All applied pre-em on 2 June)	applied on 24 June
Insecticides:	Dovetail @ 1.5 L/ha	Plenum @ 0.3 kg/ha
	on 29 June	on 11 September
	Hardy Slug Pellets @ 16 kg/ha on 29 June & 15 July	-
Desiccant:	Reglone @ 4.0 L/ha on 21 Sept	Reglone @ 4.0 L/ha on 29 Sept
Trace elements	None	None

Table A4. Misting & irrigation regime applied at ADAS Rosemaund, 2006

Date	Amount of water applied (mm)	Duration (min)
19 July	20mm applied with boom irrigator	n/a
20 July	25mm applied with boom irrigator	n/a
1 Aug	2.7	30 mm
2 Aug	5.4	60 mm
3 Aug	5.4	60 mm
8 Aug	20mm applied with boom irrigator	n/a
11 Aug	1.8	20 mm
14 Aug	1.8	20 mm
29 Aug	5.4	60 mm
5 Sept	4.1	45 mm
12 Sept	20mm applied with boom irrigator	n/a

Table A5. Irrigation regime applied at SAC Auchincruive, 2006. Water applied through seephose.

Date	Duration (hours)
31 Jul - 2 Aug	12.0
8-11 Aug	10.5

Table A6. Spray treatment dates and fungicide used at ADAS Rosemaund, 2006.

Treatment No	23 June	30 June	3 July	7 Jul	13 July	15 July	22 July	23 July
Interval-7 days	-	**8**		**7**		**8**	**7**	
-10 days	-		**11**		**10**			**10**
Ground cover (%)	75	90	90	90	90	90	95	95
Growth stage	313	316/410	322/410	323-324/420-430	322-332/410-430	322-332/410-430	322-332/420-430	322-332/420-430
1	**Untreated**							
Core treatments								
2	Tattoo	Tattoo		Tattoo		Shirlan	Shirlan	
3	Tattoo		Tattoo		Tattoo			Shirlan
4	Tattoo	Tattoo		Tattoo		Curzate	Curzate	
5	Tattoo		Tattoo		Tattoo			Curzate
6	Tattoo	Tattoo		Tattoo		Infinito	Infinito	
7	Tattoo		Tattoo		Tattoo			Infinito
8	Tattoo	Tattoo		Tattoo		Valbon	Valbon	
9	Tattoo		Tattoo		Tattoo			Valbon
Manufacturer programmes								
10	Tattoo	Tattoo		Tattoo		Shirlan (0.4)	Shirlan (0.4)	
11	Tattoo		Tattoo		Tattoo			Shirlan (0.4)
12	Invader	Invader		Invader		Invader	Invader	
13	Epok	Valbon		Valbon		Valbon	Curzate	
14	Tattoo	Tattoo		Tattoo		Ranman	Ranman	
15	Tattoo		Tattoo		Tattoo			Ranman
16	Tattoo		Tattoo		Tattoo			Ranman +Option
17	Dithane	Epok		Epok		Curzate	Electis	
18	Dithane	Epok		Epok		Curzate	Electis	

Table A6. Spray treatment dates and fungicide used at ADAS Rosemaund, 2006 (Cont'd)

Treatment No	**28 July**	**4 Aug**	**14 Aug**	**22 Aug**	**24 Aug**	**1 Sept**	**4 Sept**	**11 Sept**	**18 Sept**
Interval-7 days	**6**	**7**	**10**	**8**		**10**		**10**	
-10 days		**12**	**10**		**10**		**11**		**14**
Ground cover (%)	95	95	95	98	99	100	100	100	100
Growth stage	324-334/420-430	331-335/440-450	324-335/430-440	324-334/430-440	322-334/420-430	322-334/420-440	322-334/420-430	322-334/440-450	322-334/440-450
1	**Untreated**								
Core treatments									
2	Shirlan	Shirlan	Shirlan	Shirlan		Shirlan		Shirlan	
3		Shirlan	Shirlan		Shirlan		Shirlan		Shirlan
4	Curzate	Curzate	Curzate	Curzate		Curzate		Curzate	
5		Curzate	Curzate		Curzate		Curzate		Curzate
6	Infinito	Infinito	Infinito	Infinito		Infinito		Infinito	
7		Infinito	Infinito		Infinito		Infinito		Infinito
8	Valbon	Valbon	Valbon	Valbon		Valbon		Valbon	
9		Valbon	Valbon		Valbon		Valbon		Valbon
Manufacturer Programmes									
10	Shirlan (0.4)	Shirlan (0.4)	Shirlan (0.4)	Shirlan (0.4)		Shirlan (0.4)		Shirlan (0.4)	
11		Shirlan (0.4)	Shirlan (0.4)		Shirlan (0.4)		Shirlan (0.4)		Shirlan (0.4)
12	Invader	Invader	Invader	Invader		Invader		Invader	
13	Valbon	Valbon	Valbon	Shirlan		Shirlan		Shirlan	
14	Ranman	Ranman	Ranman	Ranman		Ranman		Ranman	
15		Ranman	Ranman		Ranman		Ranman		Ranman
16		Ranman +Option	Ranman +Option		Ranman +Option		Ranman +Option		Ranman +Option
17	Curzate	Electis	Ranman	Electis		Shirlan		Shirlan	
18	Electis	Ranman	Ranman	Electis		Infinito		Infinito	

Table A7. Spray treatment dates and fungicide used at SAC Auchincruive, 2006

Ground cover (%)	22.5 (6 July)		60.0 (13 July)			85.8 (20 July)	98.1 (27 July)
Treatment No.	**04-Jul**	**11-Jul**	**11-Jul**	**19-Jul**	**21-Jul**	**21-Jul**	**27-Jul**
Interval (days)			**7**	**8**	**10**	**10**	**8**
1	**Untreated**						
Core treatments							
2		Tattoo				Tattoo	
3		Tattoo				Tattoo	
4		Tattoo				Tattoo	
5		Tattoo				Tattoo	
6		Tattoo				Tattoo	
7		Tattoo				Tattoo	
8		Tattoo				Tattoo	
9		Tattoo				Tattoo	
Manufacturer programmes							
10		Tattoo				Tattoo	
11		Tattoo				Tattoo	
12		Invader		Invader			Invader
13	Dithane		Epok		Epok		
14		Tattoo				Tattoo	
15		Tattoo				Tattoo	
16		Tattoo				Tattoo	
17	Dithane		Epok		Epok		

Table A7. Comparison of fungicide programmes – spray treatment dates and fungicide used at SAC Auchincruive, 2006 (Cont'd).

Treatment No.	03-Aug	04-Aug	04-Aug	11-Aug	11-Aug	15-Aug	16-Aug	21-Aug
Interval (days)	**13**	**14**	**8**	**8**	**7**	**11**	**12**	**10**
1	**Untreated**							
Core treatments								
2		Tattoo					Shirlan	
3		Tattoo				Shirlan		
4		Tattoo					Curzate M	
5		Tattoo				Curzate M		
6		Tattoo					Infinito	
7		Tattoo				Infinito		
8		Tattoo					Valbon+	
							ZinZan	
9		Tattoo				Valbon+		
Manufacturer programmes						ZinZan		
10		Tattoo					Shirlan	
11		Tattoo				Shirlan		
12			Invader		Invader			Invader
13	Curzate M			Electis				Electis+
								Option
14		Tattoo					Ranman	
15		Tattoo				Ranman		
16		Tattoo				Ranman+		
						Option		
17	Curzate M			Electis				Curzate M

Table A7. Comparison of fungicide programmes – spray treatment dates and fungicide used at SAC Auchincruive, 2006 (Cont'd).

Treatment No. **Interval (days)**	**24-Aug** **8**	**25-Aug** **10**	**29-Aug** **8**	**31-Aug** **7**	**04-Sep** **10**	**06-Sep** **8**	**08-Sep** **8**	**13-Sep** **9**
1	**Untreated**							
Core treatments								
2	Shirlan			Shirlan			Shirlan	
3		Shirlan			Shirlan			Shirlan
4	Curzate M			Curzate M			Curzate M	
5		Curzate M			Curzate M			Curzate M
6	Infinito			Infinito			Infinito	
7		Infinito			Infinito			Infinito
8	Valbon+			Valbon+			Valbon+	
	ZinZan			ZinZan			ZinZan	
9		Valbon+			Valbon+			Valbon+
Manufacturer programmes		ZinZan			ZinZan			ZinZan
10	Shirlan			Shirlan			Shirlan	
11		Shirlan			Shirlan			Shirlan
12			Invader			Invader		
13			Ranman			Ranman		
14	Ranman			Ranman			Ranman	
15		Ranman			Ranman			Ranman
16		Ranman+			Ranman+			Ranman+
		Option			Option			Option
17			Electis			Ranman		

Table A7. Comparison of fungicide programmes – spray treatment dates and fungicide used at SAC Auchincruive, 2006 (Cont'd).

Treatment No.	13-Sep	15-Sep	22-Sep	22-Sep	23-Sep
Interval (days)	7	7	9	7	10
1	**Untreated**				
Core treatments					
2		Shirlan		Shirlan	
3					Shirlan
4		Curzate M		Curzate M	
5					Curzate M
6		Infinito		Infinito	
7					Infinito
8		Valbon+		Valbon+	
		ZinZan		ZinZan	
9					Valbon+
Manufacturer programmes					ZinZan
10		Shirlan		Shirlan	
11					Shirlan
12	Invader		Invader		
13	Electis		Infinito		
			(1.6 kg)		
14		Ranman		Ranman	
15					Ranman
16					Ranman+
					Option
17	Electis		Shirlan		

At SAC the actual spray intervals for the target 10-day treatments were 10, 10, 9 and 10 days and for the target 7-day applications were 8, 7, 8, 7, and 7.

Table A8. Evaluation of fungicides programmes – Core treatments: effect on tuber blight incidence (%) pre-storage at SAC Auchincruive, 2006

	% infected tubers by number		**% infected tubers by weight**	
Spray Programme	**King Edward**	**Saturna**	**King Edward**	**Saturna**
Untreated control	6.5	1.0	5.8	1.0
Core treatments				
Tattoo (x 3), Shirlan at 7-day intervals	4.8	3.8	3.9	3.8
Tattoo (x 3), Shirlan at 10-day intervals	5.0	2.3	3.8	2.0
Tattoo (x 3), Curzate M at 7-day intervals	3.9	5.5	2.7	5.5
Tattoo (x 3), Curzate M at 10-day intervals	4.3	2.2	3.8	2.3
Tattoo (x 3), Infinito at 7-day intervals	0.3	0.7	0.8	0.9
Tattoo (x 3), Infinito at 10-day intervals	1.5	0.5	1.3	0.7
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	8.8	7.7	8.2	7.9
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	4.7	2.0	4.6	2.4
F pr. LSD (P=0.05)	See below 2.991		See below 2.916	

Factor	**F pr. tuber blight by number**	**F pr. tuber blight by weight**
Cultivar	0.048	NS
Interval	0.003	0.003
Fungicide	< 0.001	< 0.001
Cultivar x interval	0.048	0.038
Cultivar x fungicide	NS	NS
Interval x fungicide	0.004	0.012
Cultivar x interval x fungicide	NS	NS

Table A9. Evaluation of fungicide programmes – Manufacturer sponsored treatments: effect on tuber blight incidence (%) pre-storage at SAC, Auchincruive 2006

Spray programme	King Edward	
	% infected tubers by number	**% infected tubers by weight**
Untreated control	6.5	5.8
Core treatments		
Tattoo (x 3), Shirlan at 7-day intervals	4.8	3.9
Tattoo (x 3), Shirlan at 10-day intervals	5.0	3.8
Tattoo (x 3), Curzate M at 7-day intervals	3.9	2.7
Tattoo (x 3), Curzate M at 10-day intervals	4.3	3.8
Tattoo (x 3), Infinito at 7-day intervals	0.3	0.8
Tattoo (x 3), Infinito at 10-day intervals	1.5	1.3
Tattoo (x 3), Valbon + ZinZan at 7-day intervals	8.8	8.2
Tattoo (x 3), Valbon + ZinZan at 10-day intervals	4.7	4.6
Sponsored treatments		
Syngenta: Tattoo (x 3) fb Shirlan (0.4 l/ha) at 7-day intervals	4.0	3.8
Syngenta: Tattoo (x 3) fb Shirlan (0.4 l/ha) at 10-day intervals	2.5	2.9
BASF: Invader at 7-day intervals	6.0	5.3
Dow (T13): (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 1), Electis + Option (x1), Ranman (x 2), Electis (x 1), Infinito (x 1) at 7 day intervals	0.5	0.4
Belchim: Tattoo (x 3) fb Ranman TP at 7-day Intervals	0.5	0.4
Belchim: Tattoo (x 3) fb Ranman TP at 10-day Intervals	0.5	0.3
Belchim: Tattoo (x 3) fb Ranman TP + Option at 10-day intervals	0.8	0.8
Dow (T17): (Dithane DF (x 1), Epok (x 2), Curzate M WG (x 1), Electis (x 1), Curzate M WG (x 1), Electis (x 1), Ranman (x 1), Electis (x1), Shirlan (x 1) at 7 day intervals	1.5	1.4
F pr. LSD (*P*=0.05)	<0.001 3.00	<0.001 2.91

Table A10. Details of isolates used as inoculum in trial at SAC

Isolate	**Year isolated**	**Variety**	**Location isolated**	**Mating type**	**Metalaxyl sensitivity**	**Genotype**	**SSR type**	**% of 2006 population**
15904	2005	Saxon	KY10	A1	S [1]	Not determined	Not determined	
14203	2005	Desiree	DD2	A1	S [1]	Not determined	Not determined	
13933	2005	Not known	DD10	A1	Not tested	Not determined	Not determined	
04.05.1.2	2003	Saturna	Angus	A1	S [1]	RF6	8_A1	11.5
03.03.3.3	2003	P Javelin	Kelso	A1	R	RF39	2_A1	6.5
04.07.1.1	2003	Ranger Russet	Aberdeen	A1	S [1]	Not determined	Misc.[2]	

[1] determined at SAC
[2] only found at one site and did not match anything else