Project Report

Comparative efficacy of available and new active ingredients in Great Britain

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PROJECT SUMMARY 2003-2005

Project aims

- To provide an independent evaluation of fungicides for the control of foliar & tuber blight
- To determine whether there is any benefit in the control of foliar blight by applying fungicides at an early stage of crop development and to monitor subsequent disease progress
- To compare the effectiveness of commercially available fungicides applied early in spray programmes for the control of foliar blight
- To compare a range of commercially available fungicides applied from the end of rapid haulm growth through the canopy stable stage until crop desiccation for the control of foliar blight
- To identify suitable replacements for the 'fentin based fungicides' and to validate commercial claims of specific activity in the control of tuber blight
- To compare a range of fungicide manufacturer sponsored spray programmes for the control of both foliar and tuber blight

Work undertaken

In each of the three years from 2003 to 2005, a range of fungicide spray programmes were evaluated in field experiments at two sites for the control of foliar and tuber blight. The sites were located at ADAS Rosemaund, near Hereford and at SAC, Auchincruive, Ayrshire. The same treatment protocols were followed at each site where comparisons were made between

(i) fungicides applied early in the development of the crop from 100% crop emergence (Protocol 1) and

(ii) an evaluation of established and recently-introduced fungicides as main season (canopy stable stage to crop desiccation) fungicide treatments together with commercial spray programmes from agrochemical manufacturers (Protocol 2).

The fungicides were applied to the blight susceptible variety King Edward. Unsprayed guard areas surrounding the trials at both sites were inoculated with isolates of the late blight pathogen (*Phytophthora infestans*) to stimulate the establishment of an early epidemic. At Rosemaund, overhead misting was applied to the trial plots when weather conditions were not conducive for disease development. Misting encouraged the disease to sporulate in the unsprayed guard areas and to progress naturally into the trial plots. At Auchincruive, small

infector plots at the top and bottom of each treatment plot were mist irrigated when necessary.

Progress of the foliar blight epidemic was visually assessed at 5-7 day intervals throughout the season (Protocols 1&2) and the effect of the treatments on the incidence of tuber blight and total ware yield was measured (Protocol 2 only).

For 2003 & 2004, details of crop husbandry at both sites, the experimental treatments applied and their effect on disease development are given in previous reports. The same details for the 2005 experiments are given later in this report.

Key findings and conclusions

Evaluation of early season fungicide applications (Protocol 1)

- As the trial sites were artificially inoculated, the disease risk was clearly exaggerated compared with commercial practice.

- There was a clear benefit in terms of foliar blight control from early season fungicide use under both high and low disease pressure conditions.

- The benefit remained evident for several weeks after the early treatments had stopped suggesting that fungicides were suppressing blight inoculum before visible symptoms were evident. This could indicate that fungicides are most effective when inoculum levels are low.

- There were statistically significant differences in the relative efficacy of some of the fungicides tested although this tended to vary in different seasons reflecting the weather conditions and the severity of the foliar epidemic.

- Some fungicide sprays when used early significantly reduced tuber blight. The effect was substantial for fluazinam in 2003 but not consistent over the years. At one trial site in 2005 two applications of a phenylamide-based product significantly and consistently reduced tuber blight incidence.

These results do not change the current advice to GB growers, which is to use systemic fungicides early in the life of a crop to take full advantage of their mobility within the plant during the rapid growth phase. In addition, the first fungicide application in a spray programme should be made when plants are at the rosette stage or when the haulm is meeting along the rows and not as early as 100 % emergence unless local risk is judged to be extremely high. Defining this level of risk remains very much a local decision.

Evaluation of fungicides and commercial fungicide programmes (Protocol 2)

- There was a significant disease challenge (foliar and/or tuber blight) at the two sites in all three years of the project although this varied in intensity depending on prevailing weather conditions.

- In all of the experiments, the fungicides tested gave good control of foliar blight compared with the untreated controls.

- Fungicides were less effective when disease pressure was extreme and fungicide applications were delayed due to adverse weather conditions. It was clear that the intrinsic curative properties (or kick-back activity) of certain fungicides could only be expressed when they were used shortly after high risk periods.

- Resistance to fungicide weathering is an important attribute of fungicides. In 2004, the effectiveness of the core treatments in terms of foliar blight control reflected the relative rainfastness of the fungicides.

- There were differences between fungicides in their relative performance for the control of foliar blight. However, this was not always the case. Where the severity of foliar blight was low in an experiment the results should be treated with caution.

- In 2005, the curative property of certain fungicides was evaluated. However at both sites, there was limited opportunity to test the benefit of using a fungicide with curative properties because very few Smith Periods occurred.

- During the period of this investigation high levels of tuber blight were recorded. In 2004, at Auchincruive, the epidemic was particularly severe and control of tuber blight was associated with the control of foliar infection (indirect control). In 2004 at Rosemaund, the severity of foliar blight was low and differences between fungicide performance were considered to be an effect on the tuber infection process (direct control). There was a good correlation between the effects on direct and indirect tuber infection for some of the products tested (r^2=0.81, *P*=0.019).

- Both sites in 2005 showed that high incidences of tuber blight can occur where there is little obvious foliar blight This is almost certainly a function of the pace and duration of the foliar blight epidemic. A relatively slow blighting epidemic extends the period of exposure of tubers to inoculum. As in 2004, this provides a strong Knowledge Transfer message demonstrating the importance of maintaining fungicide protection until the crop has completely senesced or has died following desiccation.

- The project clearly demonstrated that there are effective fentin replacements. Good control of tuber blight was consistently given by several core treatments. The effectiveness of the different fungicides in controlling tuber blight was generally consistent across sites and years. Using the average incidence of tuber blight across five trials, the ranking order of the six fungicides (with the most effective first) was Ranman, Shirlan, Electis, Sonata, Invader and Curzate M.

- At Auchincruive in 2004, there was a close relationship between the severity of foliar blight in September and the total incidence of tuber blight. There was also a close agreement between the tuber blight results for the fungicide treatments at both Rosemaund and Auchincruive.

- In all three years, the manufacturer sponsored programmes were very robust for the level of risk. It was difficult to interpret which fungicides were contributing to the observed efficacy of individual programmes because some were very complex.

EXPERIMENTAL SECTION

Introduction

Fungicides will continue to be used routinely for blight control in conventional potato production at least for the foreseeable future because of the lack of robustness, perceived or real, in existing blight forecasting systems. Intervals between sprays are usually no longer than 14 days reducing to 7 days, sometimes 5 days, depending on blight risk. Maintaining short spray intervals in high-risk conditions is essential and in these situations the interval between fungicide applications is often as important as product choice.

In the UK in 2005, there were 14 different fungicide actives registered and approved for the control of potato blight, down from 20 in 2002 (Whitehead, 2005). These were available in 20 formulations or co-formulations and were sold as approximately 55 proprietary blight fungicides. These fungicides cost from £5 to £25/ha /application and because of the nil tolerance for tuber blight set by retailers in the UK, fungicide use to control blight is a significant production cost. Official surveys have shown that on average, between six and 15 fungicide applications (mean 11) are made in years of severe disease pressure (Bradshaw, *et al.*, 2000).

A number of new fungicides have been registered and approved for use in the UK during the last few years. These are C50, Consento, Electis, Epok, Sonata, Ranman TP and Tanos. As a result of the re-evaluation of registration data required for Annex 1 listing under Council Directive 91/414 EEC, the approval for a number of blight fungicides has been revoked and these are no longer available to UK potato growers. This may be either due to commercial considerations and the costs of providing new data packages, or the safety profile does not meet modern standards.

The revocation of the fentin based products was considered to be a major loss to the industry as they were regarded as having an important role in the control of tuber blight. Since the early/mid 1990's, as a result of Government R&D funding policy, there has been no independent evaluation and comparison of blight fungicides and their comparative effectiveness for the control of foliar and tuber blight. Both potato growers and agronomists value independently generated data, as it enables them to make an informed choice of fungicide when set beside the data generated by the fungicide manufacturers.

The British Potato Council is ideally placed to support such a programme of work to investigate the effectiveness and technical attributes of the new and some existing blight fungicides. This information will be of immediate value to GB potato growers, and through the BPC's continuing Knowledge Transfer programme the relevant data could readily be made available to the industry in support of the ongoing 'Fight against Blight' campaign. This activity also demonstrates to Government that both the BPC and British potato industry are committed to the optimum use of pesticides, and support the activity of the Voluntary Initiative as a means of minimising the environmental impacts of crop protection products.

Blight fungicide programmes will invariably contain several different products, because fungicide type is matched to the growth phase of the crop based on the innate properties of the different active ingredients. This approach is also essential as a resistance management strategy but can make comparisons of their efficacy difficult without embarking on a large and expensive research programme.

The work reported here concentrated on two areas. Firstly (Protocol 1), the comparative performance of fungicides applied very early in the development of the crop (from soon after emergence until the start of rapid haulm growth), well before the traditional start of the spray programmes (usually when haulm growth is meeting along the rows). Growers frequently ask what fungicide should be used to start programmes. In this part of the project two new fungicide products, Sonata and Tanos, were compared with three established fungicides often used at the start of programmes, Dithane, Invader and Shirlan. Secondly (Protocol 2), the performance of fungicides applied from the end of rapid canopy growth was compared because most of the new fungicides are recommended for this growth phase of the crop. In addition, this would allow their effectiveness in controlling tuber blight to be evaluated. The new fungicides Electis, Ranman and Sonata, were compared with established products, Curzate M, Invader and Shirlan. These fungicides were applied from the fourth spray of the programme until haulm desiccation. For specific products, it was decided to override label restrictions on the number of permitted applications and/or number of sequential applications to allow a robust and scientific evaluation of their efficacy against foliar and tuber blight.

In addition to the above comparisons, the following manufacturers of potato blight fungicides were invited to include their products in spray programmes: -

BASF plc
Belchim Crop Potection Ltd.
Dow Agrosciences Ltd,
DuPont (UK) Ltd,
Sipcam UK Ltd.
Syngenta Crop Protection UK Ltd.

Materials & methods

Spray programmes, active ingredients and rates of use

TABLE 1. EVALUATION OF EARLY SEASON FUNGICIDE APPLICATIONS (PROTOCOL 1) - SPRAY PROGRAMMES.

Treatment Number	Description
	Core treatments
T1	Dithane DF NT* (@ 1.7 kg/ha) (x 5 – 6 sprays)
T2	Epok (@ 0.375 L/ha) (x 2 sprays @ 10/11 days) followed by Dithane DF NT (@ 1.7 kg/ha) (x 2 –3 sprays)
T3	Shirlan* (@ 0.3 L/ha) (x 3 sprays) followed by Dithane DF NT (@ 1.7 kg/ha) (x 2 –3 sprays)
T4	Tanos* (@ 0.5 kg/ha)(x1 spray), followed by Tanos (@ 0.7 kg/ha) (x 2 sprays) then Dithane DF NT (@ 1.7 kg/ha) (x 2 –3 sprays)
T5	Sonata* (@1.5 kg/ha)(x 3 sprays) followed by Dithane DF NT (@ 1.7 kg/ha) (x 2 –3 sprays)
T6	Invader* (@ 2.0 kg/ha)(x 3 sprays) followed by Dithane DF NT (@ 1.7 kg/ha) (x 2 –3 sprays)
	Commercially sponsored spray programmes
T7 Syngenta	Fubol Gold (@ 1.9 kg/ha)(x 2 sprays @ 10/11 days) followed by Dithane DF NT (@ 1.7 kg/ha) (x 2 –3 sprays)
T8 Sipcam 1	Tairel + C50 (2.0 kg/ha + 0.1 kg/ha) (x 2 sprays @ 10/11 days) followed by Dithane DF NT (@ 1.7 kg/ha) (x 2 –3 sprays).
T9 Sipcam 2	Merlin + C50 (1.5 L/ha + 0.1 kg/ha) (x 2 sprays @ 10/11 days) followed by Dithane DF NT (@ 1.7 kg/ha) (x 2 –3 sprays)

*Spray programmes to start at 100% emergence and at **10- reducing to 7- day intervals** unless weather conditions are unsuitable and there is a risk of inaccurate spraying. The decision to delay spray application will be made by the Site Manager in conjunction with the Principal Investigator and recorded. The first three sprays should coincide with 100% emergence, rosette stage and haulm meeting along the rows.

Spray programmes should continue until differences in the level of foliar blight develop.

TABLE 2. EVALUATION OF EARLY SEASON FUNGICIDE APPLICATIONS (PROTOCOL 1) - FUNGICIDES, ACTIVE INGREDIENTS AND RATES OF USE.

Fungicide	**Active Ingredients (a.i.)**		**Rate (kg or L/ha)**	
	Common name	**g/kg (L) product**	**Active ingredient**	**Product**
Dithane DF NT	mancozeb	750	1.275	1.7
Epok*	metalaxyl M+ fluazinam	200+ 400	0.075+ 0.15	0.375 (L)
Invader WG*	dimethomorph + mancozeb	75 + 667	0.15 + 1.334	2.0
Shirlan 500SC	fluazinam	500/L	0.15	0.3 (L)
Sonata*	fenamidone + mancozeb	100+ 500	0.15+ 0.75	1.5
Tanos*	famoxadone + cymoxanil	250+ 250	0.125-0.175+ 0.125-0.175	0.5-0.7

*Formulated mixture

TABLE 3. EVALUATION OF FUNGICIDES & FUNGICIDE PROGRAMMES (PROTOCOL 2) - SPRAY PROGRAMMES.

Number	Description
T1	Untreated control. No fungicide.
T2	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Shirlan (@ 0.3 L/ha) applied throughout until desiccation
T3	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Rhapsody (Curzate M WG)(@ 2.0 kg/ha) applied throughout until desiccation
T4	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Invader (@ 2.0 kg/ha) applied throughout until desiccation
T5	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Ranman TP A +B (@ 0.20 + 0.15 L/ha) applied throughout until desiccation
T6	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Electis (@ 1.8 kg/ha) applied throughout until desiccation
T7	Tattoo* (@ 4.0 L/ha) (x 3 sprays) followed by Sonata (@ 1.5 kg/ha) applied throughout until desiccation
	Manufacturers spray programmes
T8 Dow 1	Epok* (@ 0.375 L/ha)(x 2 sprays), Shirlan + C50 (0.3L/ha + 0.18 kg/ha) (x1), Electis (1.8 kg/ha) (x1), Shirlan + C50 (0.3L/ha + 0.18 kg/ha) (x1), Electis (1.8 kg/ha) (x1), Shirlan + C50 (0.3L/ha + 0.18 kg/ha) (x1), Electis (1.8 kg/ha) (x1) then Shirlan (0.3L/ha)(x2) prior to desiccation. Applications are at 7 day intervals but where intervals are stretched to 9 days add C50 (@ 0.18 kg/ha) to the Electis component
T9 Dow 2	Epok* (@ 0.375 L/ha)(x 2 sprays), Rhapsody (2 kg/ha)(x2), Electis (1.8 kg/ha)(x1), Ranman TP A +B (@ 0.20 + 0.15 L/ha)(x1), Electis (1.8 kg/ha)(x1), Ranman TP A +B (@ 0.20 + 0.15 L/ha)(x1) then Shirlan (0.3L/ha)(x2) prior to desiccation. Applications are at 7 day intervals but where intervals are stretched to 9 days add C50 (@ 0.18 kg/ha) to the Electis &/or Ranman components.
T10 Sipcam 1	Micene DF* (@ 1.7 kg/ha)(x1), Tairel+C50 (2.0kg/ha+0.1kg/ha)(x3), Globe(1.5 kg/ha)(x4), Shirlan+C50(0.3L/ha+0.24kg/ha)(x1) then Shirlan (0.3L/ha) until desiccation. Treatments @ 10 day intervals reducing to 7 days after the last Tairel+C50.
T11 DuPont	Rhapsody ** (@ 2.0 kg/ha)(x4), Ranman TP A +B (@ 0.20 + 0.15 L/ha) alt Rhapsody (@ 2.0kg/ha) followed by two final applications of Ranman TP A +B (@ 0.20 + 0.15 L/ha) prior to desiccation.

	Treatments to be applied at 7 day intervals throughout.
T12 Syngenta	Fubol Gold *(@ 1.9 kg/ha)(x 3sprays), Shirlan (@ 0.3 L/ha) + cymoxanil (@ 90 g ai/ha)(up to 5 sprays) followed by Shirlan (@ 0.3 L/ha)(x 2 sprays) prior to desiccation.
T13 Dow/ Belchim 1	Epok* (@ 0.375 L/ha)(x 2 sprays) then Electis (@ 1.8 kg/ha) alternating with Ranman TP A+B (@ 0.2+0.15 L/ha) until desiccation. Final treatment with Ranman. Treatments to be applied at 7 day intervals throughout. If intervals are extended to 9 days or more add C50 (@ 0.18 kg/ha) to the Electis &/or Ranman components.
	Curative treatments * **
T14 Standard	Mancozeb* (as Micene DF) (@1.7 kg/ha) applied throughout @ 7 day intervals until desiccation.
T15 Sipcam 2	Mancozeb* (as Micene DF) (@ 1.7 kg/ha) applied @ 7 day intervals unless weather conditions are suitable for blight (see below) when C50 should be added to the Micene DF @ 0.24 kg/ha. Spray programme to continue until desiccation.
T16 BASF	Mancozeb* (as Micene DF) (@ 1.7 kg/ha) applied @ 7 day intervals unless weather conditions are suitable for blight (see below) when Invader (@ 2.0 kg/ha) should be used. Spray programme to continue until desiccation.

*Spray programmes to start at the first blight warning or when haulm meets along the rows, whichever is soonest. The first three spray treatments 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 **10- reducing to 7-day intervals** 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.

** Spray programmes to start at rosette stage.

*** Curative treatments: Spray programmes will consist of two fungicide products. The curative product will be applied if the spray is due within 2 days of a high-risk period (on day 2 or 3 in the table below). In the absence of a high risk or near miss period, mancozeb will be sprayed on all plots.

Day 0	Day 1	Day 2	Day 3
P	P		
P	NM		
NM	P		

P = Smith criteria met for the day
NM = Smith temperature criterion met but RH criterion missed by 1 hour

The core programme will consist of mancozeb only to provide a non-curative standard against which to compare the different curative fungicides.

TABLE 4. EVALUATION OF FUNGICIDES & FUNGICIDE PROGRAMMES (PROTOCOL 2) - FUNGICIDES, ACTIVE INGREDIENTS AND RATES OF USE.

Fungicide	**Active Ingredients (a.i.)**		**Rate (kg or L/ha)**	
	Common name	**g/kg (L) product**	**Active ingredient**	**product**
Rhapsody or Curzate M *	cymoxanil + mancozeb	45+ 680	0.09+ 1.36	2.0
C50	cymoxanil	500	0.10	0.20
Electis*	zoxamide + mancozeb	83 + 666.6	0.15 + 1.20	1.8
Epok*	fluazinam + metalaxyl M	400+ 200	0.15+ 0.075	0.375 (L)
Fubol Gold*	metalaxyl M + mancozeb	40 + 640	0.08 + 1.28	1.9
Globe	cymoxanil + mancozeb	60 + 700	0.09 + 1.050	1.5
Invader WG*	dimethomorph + mancozeb	75 + 667	0.15 + 1.334	2.0
Micene DF	mancozeb	770	1.30	1.7
Ranman A + Ranman B	cyazofamid + adjuvant	400 + 1000	0.08 + 150	0.20 (L) + 0.15 (L)
Sonata*	fenamidone + mancozeb	100+ 500	0.15+ 0.75	1.5
Shirlan 500SC	fluazinam	500/L	0.15	0.3 (L)
Tairel *	benalaxyl + mancozeb	80 + 650	0.16 + 1.30	2.0
Tattoo*	propamocarb HCl + mancozeb	248+ 301.6	0.992+ 1.20	4.0 (L)

*Formulated mixture

Spray treatment dates

TABLE 5. EARLY SEASON FUNGICIDE APPLICATIONS (PROTOCOL 1) - FUNGICIDES & TREATMENT DATES AT ADAS ROSEMAUND, 2005

Treatment No	**10 June**	**18 June**	**20 June**	**26 June**	**27 June**	**4 July**
Interval - days		**8**	**10**	**8**	**7**	**7/8**
Ground cover (%), date	40	40-50	40-50	60	70	80
Growth stage	305	305/306	307	308/510	310/410/525	323/410/535
1	Dithane DF NT	Dithane DF NT		Dithane DF NT	Dithane DF NT	Dithane DF NT
2	Epok		Epok		Dithane DF NT	Dithane DF NT
3	Shirlan	Shirlan		Shirlan	Dithane DF NT	Dithane DF NT
4	Tanos 0.5	Tanos 0.7		Tanos 0.7	Dithane DF NT	Dithane DF NT
5	Sonata	Sonata		Sonata	Dithane DF NT	Dithane DF NT
6	Invader	Invader		Invader	Dithane DF NT	Dithane DF NT
Sponsored programmes						
7	Fubol Gold		Fubol Gold		Dithane DF NT	Dithane DF NT
8	Tairel + C50		Tairel + C50		Dithane DF NT	Dithane DF NT
9	Merlin + C50		Merlin + C50		Dithane DF NT	Dithane DF NT

Table 5. (cont'd.) Early season fungicide applications (Protocol 1) - Fungicides & treatment dates at ADAS Rosemaund, 2005

Treatment No	**11 July**	**18 July**	**25 July**	**1 Aug**	**8 Aug**	**15 Aug**
Interval - days	**7**	**7**	**7**	**7**	**7**	**7**
Ground cover (%), date	90	90	>90	>90	>90	>90
Growth stage	325/420/540	325/420/540	333/422/540	333/540	333/540	335/540
1	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
2	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
3	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
4	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
5	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
6	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
7	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
8	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
9	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT

TABLE 6. EARLY SEASON FUNGICIDE APPLICATIONS (PROTOCOL 1) - FUNGICIDES & TREATMENT DATES AT SAC AUCHINCRUIVE, 2005

Treatment No	**28 June**	**5 July**	**8 July**	**12 July**	**22 July**	**1 Aug**
Interval - days		**7**	**10**	**7**	**14/10**	**10**
Ground cover (%), date	see graph below					
Growth stage	308-312 (1 July)		312-317	410 (15 July)	420	
1	Dithane DF NT	Dithane DF NT		Dithane DF NT	Dithane DF NT	Dithane DF NT
2	Epok		Epok		Dithane DF NT	Dithane DF NT
3	Shirlan	Shirlan		Shirlan	Dithane DF NT	Dithane DF NT
4	Tanos 0.5	Tanos 0.7		Tanos 0.7	Dithane DF NT	Dithane DF NT
5	Sonata	Sonata		Sonata	Dithane DF NT	Dithane DF NT
6	Invader	Invader		Invader	Dithane DF NT	Dithane DF NT
Sponsored programmes						
7	Fubol Gold		Fubol Gold		Dithane DF NT	Dithane DF NT
8	Tairel + C50		Tairel + C50		Dithane DF NT	Dithane DF NT
9	Merlin + C50		Merlin + C50		Dithane DF NT	Dithane DF NT
10	Dithane DF NT	Dithane DF NT		Dithane DF NT	Dithane DF NT	Dithane DF NT

Table 6 (cont'd). Early season fungicide applications (Protocol 1) - fungicides & treatment dates at SAC Auchincruive, 2005

Treatment No	**11 Aug**	**19 Aug**	**31 Aug**	**12 Sept**	**27 Sept**
Interval - days	**10**	**8**	**12**	**12**	**15**
1	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
2	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
3	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
4	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
5	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
6	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
7	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
8	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
9	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT	Dithane DF NT
10	Dithane DF NT	Dithane DF NT	Shirlan	Shirlan	Shirlan

Protocol 1 trial, 2005, Auchincruive, Spray application dates in relation to ground cover

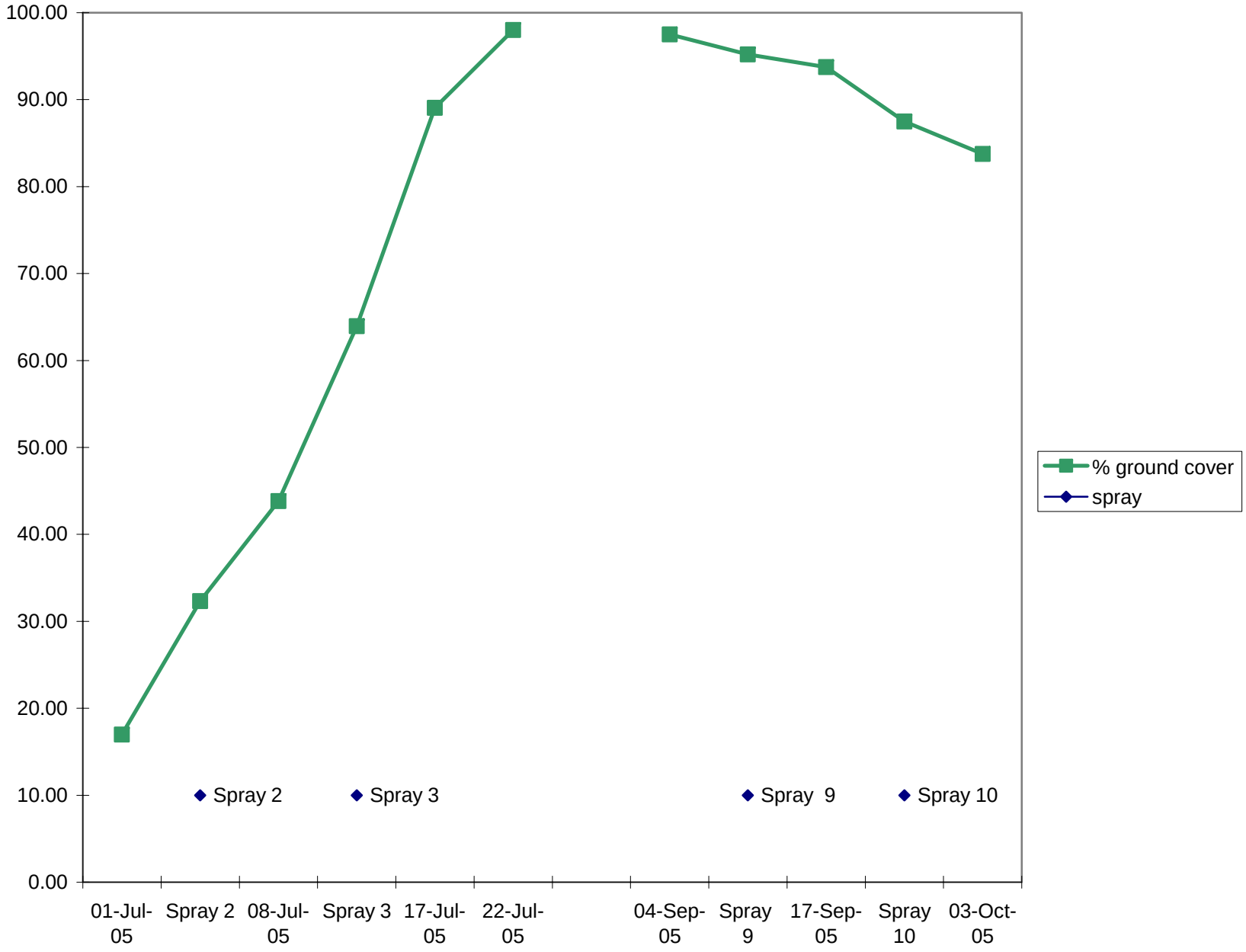

TABLE 7. EVALUATION OF FUNGICIDES & FUNGICIDE PROGRAMMES (PROTOCOL 2) – TREATMENT DATES AT ADAS ROSEMAUND, 2005.

Treatment No	**20 June**	**23 June**	**27 June**	**1 Jul**	**5 July**	**8 July**	**12 July**	**15 July**
Interval-days	**-**	**3**	**7**	**7**	**10**	**7**	**7**	**6**
Ground cover (%), date	40	60	60	60	80	80	85	90
Growth stage	307	308/510	308/510	310/410/525	323/410/535	323/410/535	323/410/535	325/415/540
1	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**
2		Tattoo			Tattoo			Tattoo
3		Tattoo			Tattoo			Tattoo
4		Tattoo			Tattoo			Tattoo
5		Tattoo			Tattoo			Tattoo
6		Tattoo			Tattoo			Tattoo
7		Tattoo			Tattoo			Tattoo
Manufacturer programmes								
8		Epok		Epok		Shirlan + C50		Electis
9		Epok		Epok		Curzate MWG		Curzate MWG
10		Micene DF			Tairel + C50			Tairel + C50
11*	Curzate MWG		Curzate MWG		Curzate MWG		Curzate MWG	
12		Fubol gold			Fubol Gold			Fubol gold
13		Epok		Epok		Electis		Ranman TP
Curative treatments								
14		Micene DF		Micene DF		Micene DF		Micene DF
15		Micene DF		Micene DF + C50		Micene DF		Micene DF
16		Micene DF		Invader		Micene DF		Micene DF

*** Spray schedules started at Rosette stage**

Core treatments

Table 7 (cont'd). Evaluation of fungicides & fungicide programmes (Protocol 2) - treatment dates at ADAS Rosemaund, 2005.

Treatment No **Interval-days**	**21 Jul** **13**	**22 Jul** **10/7**	**29 Jul** **9**	**7 Aug** **14**	**15 Aug** **8**	**23 Aug** **7**	**30 Aug** **11/7**	**6 Sept** **8**
Ground cover (%), date	>90	>90	>90	>95	>95	>95	>95	90
Growth stage	335/422/540	335/422/540	322-332/540	332-334/430-440/540	332-334/430-440/540	330-335/420-430/540	335/420-430/540	335/460/540
1	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**
2		Shirlan	Shirlan	Shirlan	Shirlan	Shirlan	Shirlan	Shirlan
3		Curzate MWG	Curzate MWG	Curzate M WG	Curzate MWG	Curzate MWG	Curzate M WG	Rhapsody
4		Invader	Invader	Invader	Invader	Invader	Invader	Invader
5		Ranman TP	Ranman TP	Ranman TP	Ranman TP	RanmanTP	Ranman TP	Ranman TP
6		Electis	Electis	Electis	Electis	Electis	Electis	Electis
7		Sonata	Sonata	Sonata	Sonata	Sonata	Sonata	Sonata
Manufacturer programmes								
8		Shirlan + C50	Electis	Shirlan + C50	Electis	Shirlan	Electis	Shirlan
9		Curzate M WG	Ranman TP	Electis +C50	Ranman TP	Shirlan	Electis	Shirlan
10		Tairel + C50	Globe	Globe	Globe	Globe	Shirlan + C50	Shirlan
11	Ranman TP	Ranman TP	Curzate M WG	Ranman TP	Curzate MWG	Ranman TP	Ranman TP	Ranman TP
12		Shirlan + C50	Shirlan + C50	Shirlan + C50	Shirlan + C50	Shirlan + C50	Shirlan	Shirlan
13		Electis	Ranman TP	Electis + C50	Ranman TP	Electis	Electis	Ranman TP
Curative treatments								
14		Micene DF	Micene DF	Micene DF	Micene DF	Micene DF	Micene DF	Micene DF
15		Micene DF	Micene DF	Micene DF	Micene DF	Micene DF	Micene DF	Micene DF
16		Micene DF	Micene DF	Micene DF	Micene DF	Micene DF	Micene DF	Miceme DF

Core treatments

TABLE 8. EVALUATION OF FUNGICIDES & FUNGICIDE PROGRAMMES (PROTOCOL 2) – TREATMENT DATES AT SAC AUCHINCRUIVE, 2005.

Treatment No	**25 June**	**28 June**	**2 July**	**5 July**	**8 July**	**9 July**	**12 Jul**	**15 Jul**
Interval-days	**-**	**3**	**7**	**7**	**10**	**7**	**7**	**6**
Ground cover (%), date	**16.6**		**45.3 (1 July)**		**78.8**			**98.4**
Growth stage	**307-309**		**311-316 (1 July)**		**314-319**			**420**
1	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**
2		Tattoo			Tattoo			
3		Tattoo			Tattoo			
4		Tattoo			Tattoo			
5		Tattoo			Tattoo			
6		Tattoo			Tattoo			
7		Tattoo			Tattoo			
Manufacturer programmes								
8		Epok		Epok			Shirlan + C50	
9		Epok		Epok			Curzate M WG	
10*	Micene DF	Tairel + C50			Tairel + C50			
11*	Curzate M WG		Curzate M WG			Curzate M WG		Curzate M WG
12		Fubol Gold			Fubol Gold			
13		Epok		Epok			Electis	
Curative treatments								
14		Micene DF		Micene DF			Micene DF	
15		Micene DF		Micene DF			Micene DF	
16		Micene DF		Micene DF			Micene DF	
17		Micene DF		Micene DF			Micene DF	

*** Spray schedules started at Rosette stage**

Core treatments

Table 8 (cont'd). Evaluation of fungicides & fungicide programmes - treatment dates at SAC Auchincruive, 2005.

Treatment No Interval-days	21 Jul 13	22 Jul 10/7	31 Jul 9	4 Aug 14	8 Aug 8	11 Aug 7	15 Aug 11/7	19 Aug 8
Ground cover (%), date		**100**						
Growth stage		**420-430**						
1	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**
2	Tattoo			Shirlan			Shirlan	
3	Tattoo			Curzate M WG			Curzate M WG	
4	Tattoo			Invader			Invader	
5	Tattoo			Ranman TP			Ranman TP	
6	Tattoo			Electis			Electis	
7	Tattoo			Sonata			Sonata	
Manufacturer programmes								
8		Electis	Shirlan+C50		Electis		Shirlan+C50	
9		Curzate M WG	Electis + C50		Ranman TP		Electis	
10	Tairel + C50			Globe		Globe		Globe
11		Ranman TP	Curzate M WG		Ranman TP		Curzate M WG	
12	Fubol Gold			Shirlan + C50			Shirlan+C50	
13		Ranman TP	Electis + C50		Ranman TP		Electis	
Curative treatments								
14		Micene DF	Micene DF		Micene DF		Micene DF	
15		Micene DF	Micene DF+C50		Micene DF		Micene DF	
16		Micene DF	Invader		Micene DF		Micene DF	
17		Micene DF	Micene DF+C50 + Shirlan		Micene DF		Micene DF	

Core treatments

Table 8 (cont'd). Evaluation of fungicides & fungicide programmes - treatment dates at SAC Auchincruive, 2005.

Treatment No	22 Aug	25 Aug	26 Aug	31 Aug	1 Sep	2 Sep	6 Sep	8 Sep
Interval-days	7	10	7	9	10	7	12	8 & 6 (T10)
Ground cover (%), date								
Growth stage								
1	Untreated	Untreated	Untreated	Untreated	Untreated	Untreated	Untreated	Untreated
2		Shirlan					Shirlan	
3		Curzate M WG					Curzate M WG	
4		Invader					Invader	
5		Ranman TP					Ranman TP	
6		Electis					Electis	
7		Sonata					Sonata	
8	Electis			Shirlan + C50				Shirlan
9	Ranman TP			Electis + C50				Shirlan
10			Globe			Shirlan + C50		Shirlan
11	Ranman TP			Curzate M WG				Ranman TP
12		Shirlan + C50					Shirlan + C50	
13	Ranman TP			Electis + C50				Ranman TP
14	Micene DF				Micene DF			
15	Micene DF + C50				Micene DF + C50			
16	Invader				Invader			
17	Micene DF + C50 + Shirlan				Micene DF + C50 + Shirlan			

Core treatments

Table 8 (cont'd). Evaluation of fungicides & fungicide programmes - treatment dates at SAC Auchincruive, 2005.

Treatment No	**12 Sept**	**20 Sept**	**23 Sept**	**30 Sept**	**3 Oct**
Interval-days	**11**	**12/14**	**11**	**10**	**10**
Ground cover (%), date					
Growth stage					
1	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**
2		Shirlan		Shirlan	
3		Curzate M WG		Curzate M WG	
4		Invader		Invader	
5		Ranman TP		Ranman TP	
6		Electis		Electis	
7		Sonata		Sonata	
8		Electis		Shirlan	
9		Electis		Shirlan	
10		Shirlan		Shirlan	
11		Ranman TP		Ranman TP	
12		Shirlan		Shirlan	
13		Electis		Ranman TP	
14	Micene DF		Micene DF		Micene DF
15	Micene DF		Micene DF		Micene DF
16	Micene DF		Micene DF		Micene DF
17	Micene DF		Micene DF		Micene DF

Core treatments

Site details

TABLE 9. DETAILS OF SOIL TYPE, NUTRIENT STATUS, CULTIVATIONS AND AGRONOMY AT EACH SITE.

	ADAS Rosemaund	**SAC Auchincruive**
Soil Series:	Bromyard Series	-
Soil Texture:	Silty Clay Loan	Clayey sand
Soil Analysis:		
P index	4	Low
K index	3	Low
pH	6.8	5.6
Previous Cropping:		
2004	Winter Wheat	Grass
2003	Winter Oilseed Rape	Grass
2002	Winter Wheat	Grass
Previous Cultivations:	Ploughed Flatlift Rotospike Rotavate	Ploughed Rotovate x 2
Cultivar:	King Edward	King Edward
Seed health status:	SE2	SE2
Planting date:	5 May	31 May (Protocol 1) 17 May (Protocol 2)
Harvesting date:	28 Sept	16 November
Fertiliser (kg/ha):		
N	203	
P	60	740 kg 14 14 21 /ha (broadcast pre-planting)
K	223	650 kg 14 14 21 /ha (placed at planting)
FYM (t/ha)	None	
Herbicides:	Sencorex @ 1.0 kg/ha	
	PDQ @ 0.5l/ha (All applied pre-em on 4 June)	Lexone @ 1.4 kg + PDQ @ 1.925 l in 250 l water/ha (18 June)
Insecticides:	Dovetail @ 1.5l/ha on 14 & 26 June Hardy Slug Pellets @ 15 kg/ha on 19 July	
Desiccant:	Reglone @ 4.0 L/ha on 14 Sept	Reglone @ 4.0 l in 300 l water/ha (3 October)
Trace elements	None	None

TABLE 10. MISTING REGIME APPLIED AT ADAS ROSEMAUND, 2005

Date	Area applied	Duration
19/06/2005	Early Trial	90 mins
21/06/2005	Early Trial	120 mins
23/06/2005	Early Trial	120 mins
28/06/2005	Early Trial	70 mins
13/07/2005	Whole Area	20mm applied with boom irrigator
14/07/2005	Whole Area	20mm applied with boom irrigator
17/07/2005	Early Trial	120 mins
20/07/2005	Early Trial	90 mins
21/07/2005	Early Trial	120 mins
03/08/2005	Main Trial	90 mins
10/08/2005	Main Trial	45 mins
11/08/2005	Main Trial	130 mins
31/08/2005	Main Trial	90 mins
01/09/2005	Main Trial	90 mins
02/09/2005	Main Trial	90 mins
08/09/2005	Main Trial	90 mins

TABLE 11. IRRIGATION REGIME APPLIED AT SAC AUCHINCRUIVE, 2005.

Date	Area applied	Mm
Various	Infector plots	3mm

Experiment design & fungicide application

Design

The fungicide treatments were applied to plots of the variety King Edward arranged in a fully randomised complete block design. The evaluation of early season fungicides consisted of six replicates. The comparison of fungicides and fungicide programmes used four replicates. The plots at both sites were four rows wide, measuring 3.2 m at Rosemaund and 3.4 m at Auchincruive. Plot lengths were 8.0 m at Rosemaund and at Auchincruive, 6.0 m for Protocol 1 and 7.35 m for Protocol 2.

At Rosemaund, the experimental plots were surrounded either by 2 rows or a 2.0 m wide headland. The headlands were sprayed with Sonata applied at 10-day intervals. At Auchincruive, plots were separated along their length by 2.6 m of bare ground. Unsprayed infector areas 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 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 early season fungicide trials for Rosemaund & Auchincruive are given in Tables 5 and 6 respectively.

The details of spray timings for the fungicide programme comparison trials for Rosemaund & Auchincruive are given in are given in Tables 7 and 8 respectively.

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 (Protocol 2 only). 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 Protocol 2 trial. Tubers were assessed for blight within a few weeks of harvest. The remaining healthy tubers were stored until mid-February and assessed for any blight that had developed during storage.

The Protocol 1 trial at Auchincruive was harvested by hand using forks. All of the tubers from eight plants per plot (2 samples of four consecutive plants) were harvested. All tubers greater than 35 mm were assessed once for tuber blight within a few weeks of harvest.

Assessment of yield

At both sites, plot yields were taken from the centre two rows of the protocol 2 trial. At Rosemaund, the plots were harvested using a two row mechanical lifter. At Auchincruive, the plots were hand lifted. All tubers >35 mm were included in the yield totals excluding splits, greens and rotted tubers. Harvested row lengths were 8.0 m at Rosemaund and 7.5 m (Protocol 2) at Auchincruive. Please see the paragraph above for harvest details for the Protocol 1 trial at Auchincruive in 2004.

Assessment of growth stage

Crop growth stage was recorded at each assessment date at both sites (Jeffries & Lawson, 1991).

Statistical Analysis

Differences between foliar blight means at each assessment date, tuber blight levels and ware yield were subjected to Analysis of Variance using transformations 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%).

Results

Blight epidemic at ADAS Rosemaund, Herefordshire

The crop at Rosemaund was planted on 5 May and emergence occurred from 29 May onwards reaching 100% emergence by approximately 10 June. The daily rainfall recorded at the site together with foliar blight progress in the untreated plots of the fungicide programme comparison trial 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 (potatocrop.com) which uses interpolation routines based on data from synoptic meteorological Stations. The data for the Rosemaund site used the HR1 postcode cell.

Unsprayed areas within and surrounding the site were inoculated on 17 June (for Protocol 1) and again on 4 & 23 July (for Protocol 2). Infection and subsequent epidemic development was encouraged by misting/irrigation. Despite this, blight development in the early fungicide application trial was extremely slow. This is because weather conditions in England and Wales generally were unfavourable for blight activity as a result of hot dry conditions in late June and early July. The weather during 2005 was not conducive for blight as measured by Smith Period criteria. 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 2005 season at Rosemaund should therefore be regarded as a low disease year.

The epidemic was stimulated to develop by using overhead misting which allowed infection to become established in the untreated plots on 23 July and which developed to complete haulm destruction by early September. Although blight was also recorded in some treatments on 23 July, the epidemic failed to develop and in all treatments infection levels were below 5% haulm destroyed when the haulm was desiccated on 14 September. Nevertheless, such a rapid development in the untreated plots indicates that there was a significant disease challenge in the main season trial. However, despite this it was insufficient to draw out treatment effects on control of the foliar epidemic. Such a 'slow blight epidemic' did provide conditions suitable for tuber infection and treatment differences were recorded.

Blight epidemic at Auchincruive, Ayrshire

The trials at Auchincruive were planted on 31 May (Protocol 1) and 17 May (Protocol 2). The infector blocks in the protocol 1 trial were inoculated with sporangial suspensions containing phenylamide-insensitive sporangia (isolate 2100) and sensitive sporangia (isolate 7102) on 29 June, one day after the first application of fungicide. The sensitive isolate did not establish well and therefore re-inoculation with this isolate took place on 15 July. The re-inoculation was successful. The protocol 2 trial infector blocks were inoculated with the same isolates separately on 9 July, 11 to 14 days after the first fungicide spray. The insensitive isolate did not establish as well as expected and therefore re-inoculation took place the week beginning the 18th of July. The re-inoculation was successful. The *P. infestans* used was mating type A1 and had been isolated from locations in northern UK in 2002.

There were no untreated plots in the protocol 1 trial and foliar blight was first observed in mid-August. The disease severity only increased slightly by mid-September.

Blight was first recorded in the protocol 2 trial at the end of July. In the untreated control plots the disease progressed steadily during the growing season and reached greater than 85% defoliation by mid-September. However, foliar disease pressure in 2005 was uncharacteristically low. No Smith Periods were recorded at the met. station at Auchincruive but there were Near Misses on 22 to 23 July, 10 to 11 August and 11 to 12 September. Although there was a lot of blight inoculum in the trial, in the untreated plots and the infector blocks, all of the fungicides applied at these intervals gave good control of foliar disease.

The daily rainfall recorded at the site together with a record of high risk conditions and foliar blight progress in the untreated plots of the fungicide programme comparison trial are given in Fig. 2. The meteorological data were recorded at the Meteorological Office site on Auchincruive Estate. The 2005 season at Auchincruive can be described as low risk for foliar blight.

Evaluation of early season fungicide applications (Protocol 1)

Details of the foliar blight progress for each of the treatments in these experiments are given in Tables 12 (Rosemaund) and 13 (Auchincruive) and are expressed as the mean percentage leaf area destroyed by blight at each assessment date. Comments on the statistical significance of differences between treatment means are based on the LSD (5%) from the Analysis of Variance at each assessment date.

The plot layouts showing the spatial location of the individual treatments in both experiments are given in Appendix I. The application dates for the early season fungicides at Rosemaund Auchincruive are given in Tables 5 and 6 respectively. At both sites, comparisons were made between two applications of Epok, Fubol Gold (Syngenta), Tairel + C50 (Sipcam) and Merlin + C50 (Sipcam), and four applications of Dithane DF NT, Shirlan, Tanos, Sonata and Invader.

Rosemaund

At Rosemaund, the spray programmes started at approximately 100% emergence on 10 June. The second application of Epok, Fubol Gold, Tairel + C50 and Merlin + C50 was made on 20 June. Subsequent applications of the three spray comparisons were made on18 June (approximately rosette stage) and 26 June (approx. haulm meeting along the rows). Weekly oversprays with Dithane DF NT followed these treatments.

The unsprayed guard areas surrounding the experiment were inoculated with a mixture of isolates of *Phytophthora infestans* on 17 June. Overhead misting of the guard areas and the experimental area was applied to stimulate the early development of an epidemic as well as providing inoculum for the site as a whole. The mean severity of foliar blight and disease progress in each of the fungicide treatments is shown in Table 12.

Blight was first recorded in the experiment on 13 July after the second Dithane DF NT overspray. Foliar blight remained at low levels in this experiment at levels below 1% haulm destroyed. Because disease levels in this experiment were very low, statistical analysis was not considered appropriate. Nevertheless, products containing metalaxyl-M had the lowest infection when the experiment was terminated on 31 August. The final Dithane DF NT overspray was made on 15 August.

Auchincruive

Blight pressure was low throughout the growing season and there were no significant differences in foliar blight control between the different treatments (Table 13).

Tuber blight incidences were surprisingly high for some fungicide treatments considering the small amount of foliar blight recorded (Table 14). The incidence of tuber blight was significantly influenced by fungicide treatment ($P<0.001$). The following comments refer to the incidence (%) tuber blight by weight. Only the two programmes with metalaxyl-based products, i.e. T2 Epok and T7 Fubol Gold, and the Tanos-based programme (T4) gave tuber blight control not significantly poorer than the standard tuber blight treatment of Dithane NT followed by three applications of Shirlan to finish the programme. The effect of the phenylamide products was long lasting. The second and final applications of Epok and Fubol Gold were made on 8 July. No visible symptoms of foliar blight were observed until 6 weeks later on 19 August. The development of the tuber blight epidemic was monitored in another trial in the same field. No tuber blight was detected until 21 September, i.e. c. 11 weeks after the final application of metalaxyl-based products. The very good control of tuber blight with two early applications of Epok or Fubol Gold was achieved in spite of the trial being inoculated with a 50:50 ratio of phenylamide-sensitive and insensitive sporangia.

Figure 1. Daily Rainfall recorded at ADAS Rosemaund and Smith Periods recorded on BlightWatch, and Blight Progress in untreated plots 2005.

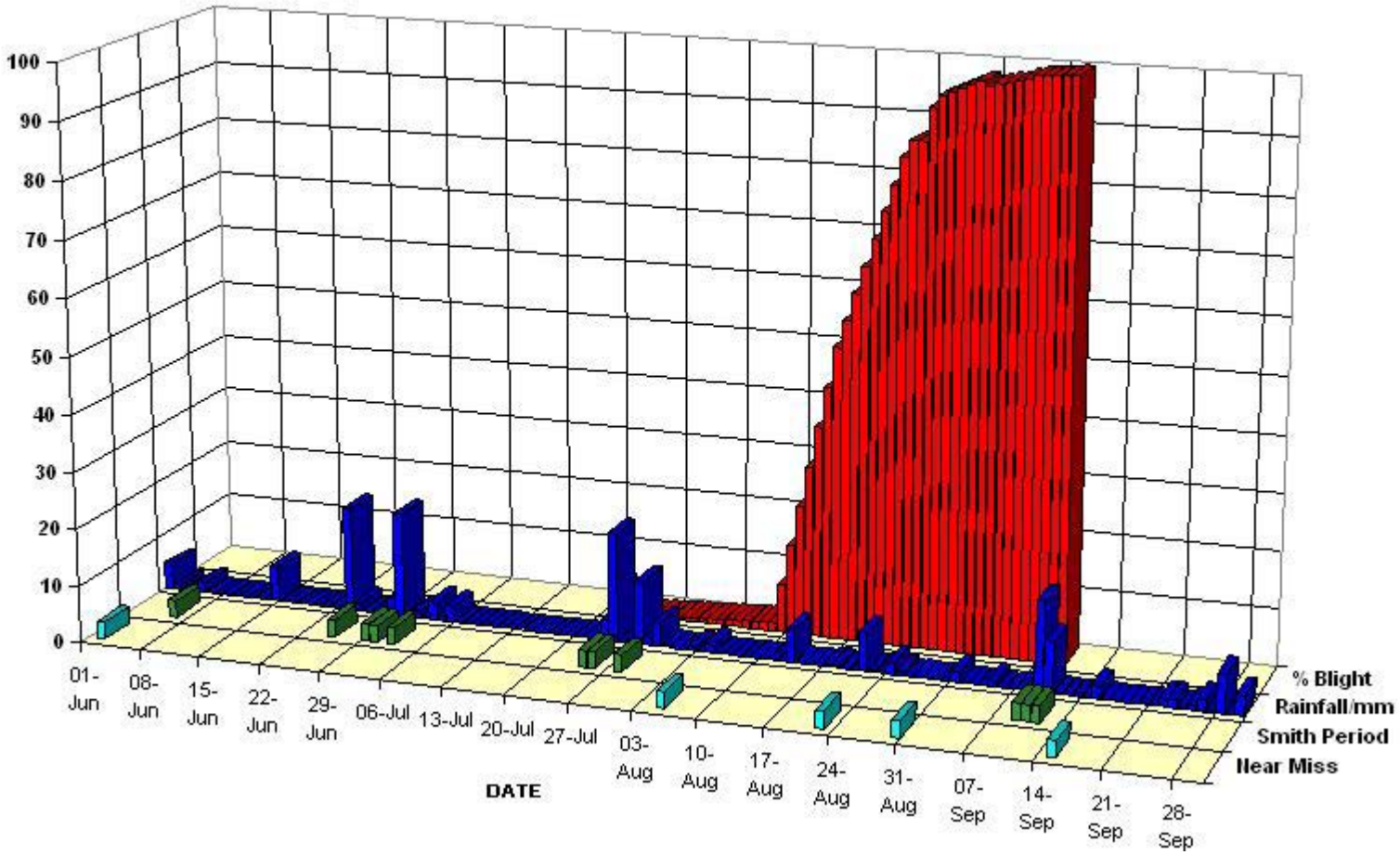

Figure 2. Daily Rainfall and Smith periods recorded at SAC, Auchincruive and Blight Progress in untreated plots 2005

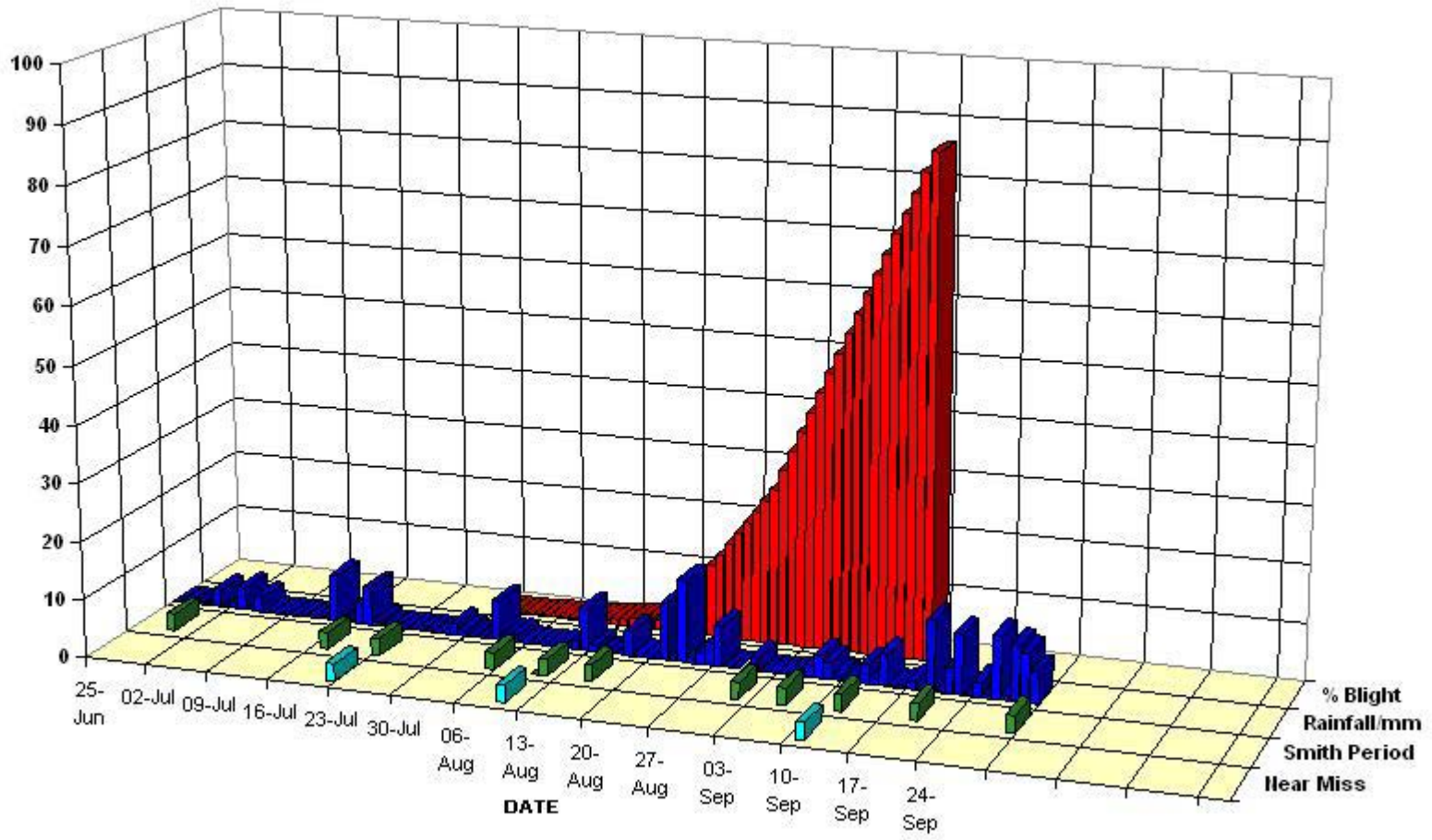

TABLE 12. EARLY FUNGICIDES APPLICATIONS - FOLIAR BLIGHT ASSESSMENTS, ADAS ROSEMAUND, 2005.

Mean Percentage Leaf Area Destroyed by Blight – MAFF Key 2.1.1								
Spray Pogramme	**13 July**	**20 July**	**27 July**	**3 Aug**	**11 Aug**	**17 Aug**	**23 Aug**	**31 Aug**
Dithane NT DF	0.07	0.10	0.10	0.18	0.48	0.58	0.67	0.88
Epok/Dithane NT DF	0.03	0.05	0.07	0.10	0.10	0.20	0.25	0.43
Shirlan/Dithane NT DF	0.03	0.05	0.08	0.15	0.42	0.50	0.58	0.73
Tanos/Dithane NT DF	0.05	0.10	0.10	0.20	0.48	0.73	0.85	0.92
Sonata/Dithane NT DF	0.08	0.10	0.10	0.20	0.47	0.58	0.67	0.85
Invader/Dithane NT DF	0.05	0.83	0.10	0.17	0.37	0.47	0.57	0.75
Sponsors programmes								
Fubol Gold/Dithane NT DF	0.05	0.07	0.07	0.08	0.18	0.28	0.33	0.47
Tairel + C50/Dithane NT DF	0.07	0.08	0.08	0.13	0.37	0.58	0.68	0.83
Merlin + C50/Dithane NT DF	0.08	0.10	0.10	0.17	0.37	0.58	0.67	0.83
F pr.	-	-	-	-	-	-	-	-
LSD (P=0.05)	-	-	-	-	-	-	-	-

TABLE 13. EARLY FUNGICIDE APPLICATIONS - FOLIAR BLIGHT ASSESSMENTS, SAC AUCHINCRUIVE, 2005.

Mean Percentage Leaf Area Destroyed by Blight – MAFF Key 2.1.1							
Spray Pogramme	**30 July**	**8 Aug**	**19 Aug**	**27 Aug**	**3 Sep**	**9 Sep**	**15 Sep**
Dithane NT DF	0.0	0.0	0.07	0.08	0.08	0.22	0.32
Epok/Dithane NT DF	0.0	0.0	0.05	0.07	0.07	0.15	0.15
Shirlan/Dithane NT DF	0.0	0.0	0.10	0.10	0.08	0.17	0.20
Tanos/Dithane NT DF	0.0	0.0	0.10	0.05	0.03	0.18	0.25
Sonata/Dithane NT DF	0.0	0.0	0.13	0.15	0.13	0.27	0.33
Invader/Dithane NT DF	0.0	0.0	0.08	0.05	0.05	0.18	0.23
Sponsors programmes							
Fubol Gold/Dithane NT DF	0.0	0.0	0.05	0.00	0.00	0.10	0.13
Tairel + C50/Dithane NT DF	0.0	0.0	0.08	0.05	0.05	0.13	0.18
Merlin + C50/Dithane NT DF	0.0	0.0	0.07	0.07	0.07	0.17	0.22
Dithane NT DF/Shirlan	0.0	0.0	0.07	0.05	0.05	0.18	0.27
F pr.	-	-	0.894	0.297	0.313	0.141	0.091
LSD (P=0.05)	-	-	0.109	0.101	0.091	0.102	0.139

TABLE 14. EARLY FUNGICIDE APPLICATIONS - INCIDENCE (%) PRE-STORAGE TUBER BLIGHT AT AUCHINCRUIVE, 2005.

Spray Programme	Tuber blight			
	% by weight	**% Weight (1)**	**% by number**	**%Number (1)**
Dithane DF NT	6.1	13.2	6.7	14.3
Epok/Dithane NT DF	0.4	1.9	0.6	2.2
Shirlan/Dithane DF NT	3.7	10.1	6.1	13.2
Tanos/Dithane NT DF	2.3	6.8	3.1	8.0
Sonata/Dithane NT DF	4.0	8.3	4.6	9.3
Invader/Dithane NT DF	5.9	12.4	6.1	12.9
Sponsors Programmes				
Fubol Gold/ Dithane NT DF	0.2	1.1	0.3	1.3
Tairel + C50/ Dithane NT DF	4.7	11.3	6.8	13.9
Merlin + C50/ Dithane NT DF	4.9	12.3	8.0	16.0
Dithane NT DF/Shirlan	0.5	1.9	1.0	2.8
F pr	<0.001	<0.001	<0.001	<0.001
LSD (5% level)	2.98	4.87	3.32	5.45

(1) Angular transformation.

Evaluation of fungicides and fungicide programmes (Protocol 2)

The application dates for the fungicides at the Rosemaund and Auchincruive sites are given in Table 7 and 8 respectively. Comparisons were made between applications of Shirlan, Curzate M WG, Invader, Ranman TP, Electis and Sonata as canopy stable treatments following three initial applications of Tattoo. The Tattoo treatments started as the haulm began to meet along the rows. Comparisons were also made between commercial spray programmes sponsored by agrochemical manufacturers.

Details of the foliar blight progress for each of the spray programmes in these experiments are given in Tables 15 (Rosemaund) and 16 (Auchincruive) and are expressed as the mean percentage leaf area destroyed by blight at each assessment date. Comments on the statistical significance of differences between treatment means are based on the LSD (5%). Tuber blight and yield data are given in Table 17 (Rosemaund) and Tables 18-20 (Auchincruive).

The plot layouts showing the spatial location of the individual treatments in both experiments are given in Appendix I.

Rosemaund

The mean severity of foliar blight from each of the fungicide treatments is shown in Table 15. Blight was first recorded in the experiment on 23 July. Only one Full Smith Periods was recorded in July (24/25 July) and despite Smith criteria being met spradically on the occasional days no further Smith Periods were recorded until just prior to desiccation (9/10/11 September (See Fig 1). Disease development was encouraged by overhead misting and as a result, foliar blight reached complete haulm destruction in the unsprayed plots by 5 September indicating that there was a disease challenge at the site.

All spray programmes reduced the severity of the foliar blight epidemic compared with the unsprayed control. The untreated control plots were excluded from the Analysis of Variance. Foliar blight levels were low in the treated plots and remained below 5% foliage infected until the experiment was desiccated. Although there were statistically significant differences between the different core treatments on some assessment dates, firm conclusions should not be drawn because of the low levels of infection. This also applies to the manufacturer sponsored spray programmes.

Because of the dry conditions in 2005 and the low frequency of Smith Criteria, there was only one occasion when a fungicide with curative activity was justified. This occurred on 1 July following the Full Smith Period recorded on 29/30 June. Because of this, mancozeb was used throughout the remainder of the spray programme.

In view of the low level of foliar blight in this experiment, the data should be treated with caution.

The incidence of tuber blight measured after a period of ambient storage is expressed as both the percentage by weight and percentage by number of infected tubers (Table 17). Inspection of the residual values in the Analysis of Variance did not indicate a need to transform the data prior to statistical analysis.

In commercial production, the incidence of tuber blight at 5% infection was substantial but was not as high as in 2004. Although none of the spray programmes significantly reduced tuber infection measured either as the percentage by number or weight of infected tubers, there were some differences between treatments. In the Core spray programmes, Tattoo/Invader had significantly lower tuber blight incidence compared with Tattoo/ Curzate M ($P<0.05$).The Dow/Belchim spray programme (T13) also had a lower incidence of tuber infection compared with the Sipcam 1 programme (T10) ($P<0.05$).

Although there were no significant differences between the curative treatments ($P<0.05$), the tuber blight incidence in what were predominantly mancozeb spray programmes was higher than a number of other fungicide programmes ($P>0.05$).

The effect of fungicide treatments on ware yield is also given in Table 17. As the foliar epidemic in the untreated plots occurred during the tuber-bulking phase of crop development, the yield was reduced and was lower than from the spray programmes. The untreated control was included in the statistical analysis and all spray programmes significantly increased total ware yield ($P>0.05$). There were no significant differences in yield between the canopy stable fungicide comparisons or between manufacturer's spray programmes ($P>0.05$). However, the mancozeb programme used as a standard in the curative investigation did have a significantly lower yield compared with a number of the core and manufacturer programmes ($P>0.05$).

Auchincruive

Blight was first recorded at the end of July. In the untreated control plots the disease progressed steadily during the growing season and reached greater than 85% defoliation by mid-September. However, foliar disease pressure in 2005 was uncharacteristically low. No Smith Periods were recorded at the met. station at Auchincruive but there were Near Misses on 22 to 23 July, 10 to 11 August and 11 to 12 September (Fig. 2). Although there was a lot of blight inoculum in the trial, in the untreated plots and the infector blocks, all of the fungicides applied at these intervals gave good control of foliar disease.

For the curative treatments the relative timings of Smith Periods and spray applications are summarised below. Only Near Misses were recorded by the Met. Office but it should be noted that there were problems with this station and data were not available between 9 and 13 July and 20 and 23 August. The decision over whether to apply the different treatments or a blanket mancozeb treatment was further complicated by the lack of agreement between BlightWatch and the Met. Office station.

Spray dates, treatment	Smith Period (Met. Office)	Smith Period (BlightWatch)
28 June, mancozeb		
5 July, mancozeb		
12 July, mancozeb		
22 July, mancozeb	22-23 July NM	
31 July, treatments		28-31 July NM, SP
8 August, mancozeb	10-11 August NM	10-12 August SP
15 August, mancozeb		14-16 August SP (data not available until 16 August)
22 August, treatments	(no data for 20 to 23 August)	Smith criteria met on 22 August
1 September, treatments		Smith criteria met on 1 September
12 September, mancozeb	11-12 September NM (data not available before spray applied)	
23 September, mancozeb		
3 October, mancozeb		

Within the three groups of programmes, i.e. core, manufacturer and curative, there were no significant differences in foliar blight between individual programmes (Table 16).

There were few significant differences between programmes in the pre-storage (Table 18) and total incidences of tuber blight (Table 20). The following comments refer to the incidence (%) tuber blight by weight. At the first assessment the Ranman core treatment gave significantly better control than Curzate M WG. Of the curative treatments, the SAC, Sipcam 2 and BASF treatments had less tuber blight than the Standard. There were fewer significant differences for total tuber blight (Table 20). Control was significantly better for the curative BASF and SAC treatments compared with the Standard.

There was a significant correlation between the programme incidences of tuber blight recorded in the Rosemaund trial and the total tuber blight incidences at Auchincruive (r^2=0.80, F pr.=0.005).

There were no significant differences in yield between fungicide programmes.

TABLE 15. COMPARISON OF FUNGICIDE PROGRAMMES - FOLIAR BLIGHT ASSESSMENTS, ADAS ROSEMAUND, 2005.

	Mean Percentage Leaf Area Destroyed by Blight - MAFF Key 2.1.1									
Spray programme*	**23 July**	**31 July**	**08 Aug**	**15 Aug**	**22 Aug**	**25 Aug**	**31 Aug**	**05 Sept**	**09 Sept**	**12 Sept**
Untreated control	0.05	0.75	0.48	51.25	84.5	93.0	97.25	99.50	100	100
Core Programmes										
Tattoo(x3), Shirlan	0.0	0.05	0.10	0.28	0.55	1.08	1.23	1.48	1.63	2.38
Tattoo(x3), Curzate M68	0.0	0.0	0.08	0.25	0.40	0.50	0.63	0.65	0.75	1.20
Tattoo(x3), Invader	0.0	0.03	0.08	0.20	0.35	0.40	0.58	0.58	0.75	0.85
Tattoo(x3), Ranman TP	0.0	0.03	0.05	0.18	0.55	0.70	1.15	1.48	1.63	2.00
Tattoo(x3), Electis	0.0	0.08	0.10	0.25	0.48	0.58	0.75	0.75	0.90	1.25
Tattoo(x3) Sonata	0.0	0.03	0.05	0.18	0.38	0.48	0.58	0.60	0.75	1.00
Manufacturers programmes										
Dow 1	0.0	0.0	0.00	0.10	0.23	0.38	0.48	0.65	0.68	1.03
Dow 2	0.0	0.0	0.0	0.10	0.25	0.30	0.40	0.45	0.58	0.83
Sipcam 1	0.0	0.05	0.08	0.45	0.85	1.30	1.50	1.65	2.35	3.45
DuPont	0.03	0.05	0.10	0.25	0.58	0.80	1.05	1.25	1.63	2.08
Syngenta	0.0	0.0	0.00	0.10	0.23	0.30	0.45	0.65	0.78	0.88
Dow/Belchim	0.0	0.0	0.03	0.10	0.33	0.43	0.50	0.60	0.68	0.93
Curative treatments										
Standard	0.05	0.05	0.08	0.45	0.65	1.08	1.28	1.80	2.28	3.93
Sipcam 2	0.05	0.05	0.10	0.28	0.73	1.25	1.38	1.40	1.80	2.25
BASF	0.03	0.08	0.10	0.30	0.6	0.90	0.95	1.08	1.25	1.78
F pr (45 df)	0.080	0.131	<0.001	<0.001	<0.001	0.015	<0.001	0.017	0.004	0.012
LSD (5% level)	0.040	0.063	0.051	0.153	0.211	0.644	0.584	0.863	1.021	1.784

*The six core programmes had common spray dates, as did the four curative treatments. This was not the case for the manufacturers' programmes. For these programmes see Tables 3 and 7 for full details and spray dates to identify valid comparisons.
The untreated control was not included in the statistical analysis.
Inspection of the residual values did not indicate the need to transform the data.

TABLE 16. COMPARISON OF FUNGICIDE PROGRAMMES - FOLIAR BLIGHT ASSESSMENTS, SAC AUCHINCRUIVE , 2005

Spray programme*	**30 July**	**8 Aug**	**18 Aug**	**24 Aug**	**30 Aug**	**7 Sep**	**16 Sep**
Untreated control	0.03	0.33	2.00	14.5	26.9	54.8	86.3
Core Programmes							
Tattoo(x3), Shirlan	0.0	0.0	0.20	0.20	0.18	0.20	0.25
Tattoo(x3), Curzate M68	0.0	0.0	0.13	0.15	0.13	0.12	0.20
Tattoo(x3), Invader	0.0	0.0	0.15	0.20	0.20	0.22	0.27
Tattoo(x3), Ranman TP	0.0	0.0	0.25	0.28	0.28	0.27	0.22
Tattoo(x3), Electis	0.0	0.0	0.18	0.18	0.15	0.20	0.32
Tattoo(x3) Sonata	0.0	0.0	0.18	0.18	0.15	0.15	0.15
Manufacturers programmes							
Dow 1	0.0	0.0	0.05	0.08	0.08	0.05	0.02
Dow 2	0.0	0.0	0.05	0.12	0.18	0.12	0.05
Sipcam 1	0.0	0.0	0.08	0.10	0.08	0.07	0.15
DuPont	0.0	0.0	0.15	0.15	0.15	0.15	0.15
Syngenta	0.0	0.0	0.03	0.10	0.13	0.10	0.05
Dow/Belchim	0.0	0.0	0.03	0.05	0.08	0.05	0.05
Curative treatments							
Standard	0.0	0.0	0.03	0.05	0.05	0.07	0.15
Sipcam 2	0.0	0.0	0.08	0.10	0.13	0.15	0.20
BASF	0.0	0.0	0.10	0.10	0.08	0.07	0.15
SAC	0.0	0.0	0.10	0.10	0.08	0.10	0.10
F pr (45 df)	-	-	0.065	0.050	0.052	0.003	<0.001
LSD (5% level)	-	-	0.1893	0.1651	0.1557	0.1482	0.1675

*The six core programmes had common spray dates, as did the four curative treatments. This was not the case for the manufacturers' programmes. For these programmes see Tables 3 and 8 for full details and spray dates to identify valid comparisons.

Untreated excluded from the analyses of variance.

TABLE 17. COMPARISON OF FUNGICIDE PROGRAMMES - TUBER BLIGHT & YIELD ASSESSMENTS AT ADAS ROSEMAUND, 2005.

Spray Programme*	Tuber Blight		Total yield (>35 mm)
	% affected tubers by weight**	% affected tubers by number**	(t/ha)
Untreated control	5.11	5.00	23.94
Core programmes			
Tattoo(x3), Shirlan	3.66	3.50	52.34
Tattoo(x3), Rhapsody (Curzate M WG)	5.55	5.55	55.94
Tattoo(x3), Invader	1.49	1.49	59.40
Tattoo(x3), Ranman TP	2.36	2.36	55.20
Tattoo(x3), Electis	4.30	4.30	58.26
Tattoo(x3) Sonata	2.94	2.94	58.62
Manufacturers programmes			
Dow 1	4.85	4.85	56.21
Dow 2	2.04	2.04	56.16
Sipcam 1	5.84	5.75	53.90
DuPont	3.02	3.25	55.36
Syngenta	5.29	5.00	59.69
Dow/Belchim	0.97	1.50	59.53
Curative treatments			
Standard	7.66	7.00	49.79
Sipcam 2	9.23	8.25	51.46
BASF	5.18	5.75	57.59
F pr (45 df)	0.042	0.010	<0.001
LSD (5% level)	4.531	3.572	8.801

*The six core programmes had common spray dates, as did the four curative treatments. This was not the case for the manufacturers' programmes. For these programmes see Tables 3 and 7 for full details and spray dates to identify valid comparisons.

** The residual fit did not indicate the need for a transformation of the data

TABLE 18. COMPARISON OF FUNGICIDE PROGRAMMES - TUBER BLIGHT , SAC AUCHINCRUIVE, 2005.

Spray Programme*	TUBER BLIGHT			
	% affected tubers by weight	% affected tubers by weight**	% affected tubers by number	% affected tubers by number**
Untreated control	7.2	13.1	6.8	12.9
Core programmes				
Tattoo(x3), Shirlan	0.8	3.2	1.0	3.5
Tattoo(x3), Rhapsody (Curzate M WG)	2.9	7.5	2.7	7.3
Tattoo(x3), Invader	1.3	4.5	1.3	4.5
Tattoo(x3), Ranman TP	0.0	0.0	0.0	0.0
Tattoo(x3), Electis	1.3	3.2	1.0	2.8
Tattoo(x3) Sonata	0.6	2.2	1.0	2.8
Manufacturers programmes				
Dow 1	0.0	0.0	0.0	0.0
Dow 2	0.1	0.6	0.3	1.0
Sipcam 1	1.9	5.5	2.3	5.8
DuPont	0.2	1.0	0.3	1.0
Syngenta	0.0	0.0	0.0	0.0
Dow/Belchim	0.3	1.1	0.3	1.0
Curative treatments				
Standard	5.2	10.7	6.2	11.9
Sipcam 2	2.3	7.3	3.0	8.5
BASF	1.0	4.0	1.5	4.9
SAC	0.5	2.0	1.0	2.8
F pr (45 df)	0.010	0.011	0.005	0.007
LSD (5% level)	2.471	5.672	2.742	5.912

*The six core programmes had common spray dates, as did the four curative treatments. This was not the case for the manufacturers' programmes. For these programmes see Tables 3 and 8 for full details and spray dates to identify valid comparisons.

Untreated excluded from analyses of variance

** Angular transformation

TABLE 19. COMPARISON OF FUNGICIDE PROGRAMMES – YIELD ASSESSMENTS, SAC AUCHINCRUIVE, 2005.

Spray Programme*	Yield (t/ha)	
	Total (>35 mm)	**Blight free (marketable yield)**
Untreated control	40.08	37.09
Core programmes		
Tattoo(x3), Shirlan	57.43	56.99
Tattoo(x3), Rhapsody (Curzate M WG)	58.72	57.01
Tattoo(x3), Invader	57.83	57.08
Tattoo(x3), Ranman TP	58.57	58.57
Tattoo(x3), Electis	58.04	57.26
Tattoo(x3) Sonata	54.99	54.62
Manufacturers programmes		
Dow 1	61.90	61.90
Dow 2	61.41	61.36
Sipcam 1	58.19	57.13
DuPont	58.14	58.01
Syngenta	56.32	56.32
Dow/Belchim	58.87	58.69
Curative treatments		
Standard	57.90	54.89
Sipcam 2	58.48	57.10
BASF	57.68	57.09
SAC	56.04	55.80
F pr (45 df)	0.792	0.610
LSD (5% level)	6.020	6.067

*The six core programmes had common spray dates, as did the four curative treatments. This was not the case for the manufacturers' programmes. For these programmes see Tables 3 and 8 for full details and spray dates to identify valid comparisons.

Untreated excluded from analyses of variance

TABLE 20. COMPARISON OF FUNGICIDE PROGRAMMES - TUBER BLIGHT AT ADAS ROSEMAUND AND SAC AUCHINCRUIVE (TOTAL TUBER BLIGHT), 2005.

Spray Programme*	**Tuber Blight**	
	% affected tubers by weight Rosemaund	**% affected tubers by weight Auchincruive**
Untreated control	5.11	10.1
Core programmes		
Tattoo(x3), Shirlan	3.66	2.0
Tattoo(x3), Rhapsody (Curzate M WG)	5.55	4.2
Tattoo(x3), Invader	1.49	2.2
Tattoo(x3), Ranman TP	2.36	1.2
Tattoo(x3), Electis	4.30	2.2
Tattoo(x3) Sonata	2.94	3.6
Manufacturers programmes		
Dow 1	4.85	0.6
Dow 2	2.04	0.2
Sipcam 1	5.84	5.9
DuPont	3.02	1.2
Syngenta	5.29	0.0
Dow/Belchim	0.97	1.0
Curative treatments		
Standard	7.66	14.0
Sipcam 2	9.23	7.8
BASF	5.18	2.4
SAC	-	3.9
F pr	0.042	0.011
LSD (5% level)	4.531	6.99

*The six core programmes had common spray dates, as did the four curative treatments. This was not the case for the manufacturers' programmes. For these programmes see Tables 3, 7 and 8 for full details and spray dates to identify valid comparisons.

DISCUSSION

Early season fungicide use

The choice of fungicide for the first few sprays in a programme is often difficult for growers. This is because initially there is little crop present to intercept the fungicide spray, and growers are often reluctant to use the more expensive fungicides at early growth stages when most falls onto the soil. The results from both Rosemaund and Auchincruive in 2003 and 2004 clearly demonstrated that early fungicide treatments in the presence of blight inoculum could have an impact on the subsequent development of an epidemic.

In 2005, in conditions not conducive to an aggressive foliar epidemic, there were no differences in foliar blight between any of the fungicide treatments. However, at Auchincruive, two early applications of Epok or Fubol Gold resulted in very good control of tuber blight. This level of control was not achieved when the systemic product used was either Merlin or a phenylamide–based product not containing metalaxyl.

At Auchincruive in 2003, where foliar blight risk was generally low, the application of Shirlan four times from c. 100% emergence gave significantly better control of tuber blight than some other fungicide treatments. This result was not repeated in the 2004 trial, most likely because the fungicide treatments were overwhelmed by the very large number of zoospores being washed down into the soil during the 2004 growing season. The 2005 growing season was not favourable for foliar blight development but the early application of Shirlan three times did not give good control of tuber blight. The different results obtained with early Shirlan application in the three years are difficult to explain. It is now clear that the effectiveness of Shirlan applied at this timing against tuber infection later in the season does not just depend on the severity of foliar blight and therefore the number of zoospores challenging tubers. Further work would be required to investigate this. The clear message for growers is that Shirlan applied prior to canopy closure may in some circumstances contribute to the direct control of tuber blight but the effect does not appear to be consistent in different conditions.

Evaluation of fungicides and fungicide programmes.

In these trials the number of fungicide treatments applied throughout the canopy stable period through to senescence for the core treatments sometimes contravened the label recommendation. This was planned to allow scientifically valid comparisons between different fungicide chemistry. **Neither ADAS nor SAC recommend the use of fungicides in such a way that contravenes label recommendations**.

Although the foliar blight epidemic in the untreated plots at both Auchincruive and Rosemaund demonstrated the sites were subjected to a disease challenge in 2005 the

fungicide programmes were too robust for such low disease pressure. Differences in the levels of foliar blight between the core treatments and the manufacturer's programmes were minimal and as such should be treated with caution.
Although the severities of foliar blight in most of the trials were low, the disease threat in each was considerably higher than that in the vast majority of commercial crops. The variety of potato used for the trials, King Edward, has a NIAB resistance rating of 3 for foliar blight. In 2004 only 17.6% of the potato crop area grown in GB had a rating equal to or less than 3 (Bradshaw & Bain, 2005). In addition, the untreated plots together with very many non-sprayed infector areas in the trials provided a much greater in-crop inoculum source than is common in commercial practice. It should be noted that under these conditions most of the fungicide programmes and products provided good control of foliar blight. This suggests that under the blight threat conditions in which most growers' crops are grown most of the fungicide products tested will give good control of foliar blight. However, either when disease pressure is very high, for example as at Auchincruive in 2004, or fungicides are badly timed or poorly applied then the potentially large differences between fungicides are revealed.

The low levels of foliar blight at both sites and the 'slow blight epidemic' resulted in a high incidence of tuber infection. As in 2004 at Rosemaund, this demonstrates the relationship between the amount of inoculum available to infect tubers at different times during the growing season and tuber infection and is a strong knowledge transfer message to the GB industry. It is a reminder of the need to maintain fungicide programmes up to and after haulm desiccation treatment.

For the core treatments the control of tuber blight was generally consistent across sites and years. The most obvious exception was Invader. At Rosemaund this fungicide gave poor control of tuber blight in 2004 but very good control the following year. It should be noted that the generally consistent results may be partly due to small differences in foliar blight between core treatments in most of the trials. Tuber blight was therefore generally not confounded by differences in foliar blight in some trials and not others. It is interesting to note that there was a strong relationship for tuber blight control between the two trials in 2004. In the Auchincruive trial there were very large differences in foliar blight between treatments whereas differences were small in the Roseamaund trial.

Future work should continue with greater flexibility in the spray intervals of the fungicide programmes to allow differences between fungicides to be demonstrated. There is a strong case for evaluating fungicides at both high and low blight risk intervals i.e. at both 7 and 10 days. This would 'stretch' products and would also allow for a better assessment of the different chemistry. Consideration should also be given to the use of Plant Plus at the two sites to allow 'in-crop' blight risk to be forecast.

CONCLUSIONS

Evaluation of early season fungicide applications (Protocol 1)

Rosemaund

- At Rosemaund in 2005 the control plots were omitted to allow other treatments to be included.
- The levels of foliar blight infection were low and there were no detectable differences in effectiveness between the various treatments tested.

Auchincruive

- Blight pressure was low throughout the growing season and there were no significant differences in foliar blight control between the different treatments.
- Tuber blight incidences were surprisingly high for some fungicide treatments considering the small amount of foliar blight recorded.
- Two applications of metalaxyl-based products gave very good control of tuber blight.
- The effect of the two phenylamide products was long lasting, approximately 11 weeks.
- Early application of Shirlan did not give good control of tuber blight in 2005.

These results do not change the current advice to UK growers. This is to use systemic fungicides early in the life of a crop to take full advantage of their mobility within the plant during the rapid growth phase of the crop. In addition, the first fungicide application in a spray programme should be made when the haulm is meeting along the rows and not as early as 100 % emergence unless local risk is judged to be extremely high. Defining this level of risk remains very much a local decision.

Evaluation of fungicides and fungicide programmes (Protocol 2)

Rosemaund

- Under low blight risk conditions all of the fungicide programmes evaluated gave good control of foliar blight.

- Although there were significant differences in foliar blight severity between some treatments, these results should be treated with caution because of the low severity of foliar blight in the experiment

- There were high levels of tuber blight in this experiment and this it likely to be a function of the speed of the foliar blight epidemic. A relatively slow blighting epidemic extends the period of exposure of tubers to inoculum.

- Good control of tuber blight was given by core treatments containing Invader and Ranman TP and the manufacturers spray programmes containing Electis & Ranman TP

- Curzate M 68 and mancozeb were the least effective treatments for tuber blight control.

- There was limited opportunity to test the benefit of using a fungicide with curative properties because very few Smith Periods occurred at Rosemaund 2005.

Auchincruive

- Although there was a lot of blight inoculum in the trial, in the untreated plots and the infector blocks, there were no significant differences in foliar blight between individual programmes within the three groups, i.e. core, manufacturer and curative programmes. All programmes gave good control of foliar blight.

- There were high incidences of tuber blight for some programmes given that foliar blight severities were low.

- At the first assessment of tuber blight the Ranman core treatment gave significantly better control than Curzate M WG. Of the curative treatments, the SAC, BASF and Sipcam 2 treatments had significantly less tuber blight than the core mancozeb treatment.

- Although differences were not significant, the ranking order of the core treatments for the control of total (pre- plus post-storage) tuber blight was Ranman, Shirlan, Electis, Invader, Sonata and Curzate M.

- The incidence of total tuber blight was significantly lower for the curative BASF and SAC treatments compared with the core mancozeb treatment.

- The individual incidences of tuber blight recorded in the Rosemaund and Auchincruive trials were significantly correlated.

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APPENDIX I

Plot layout of the early season fungicide trial at ADAS Rosemaund 2005

2	**7**	**6**	**9**	**2**	**9**
4	**9**	**8**	**5**	**5**	**4**
7	**3**	**7**	**1**	**9**	**2**
1	**2**	**9**	**8**	**4**	**1**
8	**5**	**3**	**2**	**6**	**5**
9	**6**	**2**	**4**	**7**	**8**
5	**1**	**4**	**6**	**8**	**3**
6	**4**	**5**	**7**	**3**	**6**
3	**8**	**1**	**3**	**1**	**7**

Plot layout of the early season fungicide trial at SAC Auchincruive 2005

Orientation: ↑ Met. Office station

4	**1**	9	10
8	**10**	3	4
6	**7**	6	2
5	**2**	1	8
3	**9**	7	5
8	3	**9**	**4**
9	10	**7**	**2**
2	4	**3**	**5**
6	1	**10**	**1**
7	5	**6**	**8**
3	**4**	10	3
2	**7**	7	6
9	**8**	9	5
6	**1**	8	2
5	**10**	4	1

Appendix I (Cont'd)

Plot layout of the fungicide programme evaluation trial at ADAS Rosemaund, 2005

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

Plot layout of the fungicide programme evaluation trial at SAC, Auchincruive, 2005

Orientation: ↑ Met. Office station

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