Project Report

Comparative efficacy of available and new blight fungicide active ingredients in GB

Ref: 807/242

Interim Report : March 2005

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2005

Project Report 2005/7

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PREFACE

In 2003, the BPC commissioned SAC and ADAS to carry out an evaluation of potato blight fungicides and fungicide programmes. At that time it was over 10 years since the last independent evaluation of blight fungicides and new active substances had been developed whilst others were no longer approved for use. This report provides the results from the second year of evaluations of the benefits of early season applications and comparisons of the effects of commercially available fungicides and spray programmes on foliar, stem and tuber blight.

The data generated so far shows that there is a benefit in disease control from early fungicide treatment when blight is present in a locality. However, these findings are based on a limited data set and should be treated with some caution. The results also showed that there is some very effective fungicide chemistry available to GB growers but when disease pressure is intense and weather conditions delay sprays being applied, blight is very difficult to contain.

The trials continue in 2005/06.

British Potato Council

SUMMARY

Project aims

Under conditions of a natural blight epidemic, but using inoculation and overhead misting if necessary to initiate and stimulate an epidemic: -

Protocol 1: Evaluation of early season fungicide applications

To evaluate the benefit of early applications of fungicides on the subsequent development and control of foliar blight

To compare commercially available fungicides applied early in spray programmes for the control of foliar and stem blight

Protocol 2: Evaluation of fungicides & fungicide programmes

To compare commercially available fungicides in spray programmes for the control of foliar (including stem) blight and tuber blight.

To measure the effects of the control of foliar blight on total marketable ware yield (>35 mm).

Work undertaken & key findings

In 2004, a range of fungicide spray programmes were evaluated in two field experiments at each of two sites for the control of potato blight. The sites were located at ADAS Rosemaund, 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 a crop (protocol 1) and (ii) commercial spray programmes from agrochemical manufacturers and an evaluation of recently introduced blight fungicides as main season fungicide treatments (protocol 2). The fungicides were applied to the blight susceptible variety King Edward. Unsprayed guard areas surrounding the trials at both sites were inoculated to stimulate an early epidemic. At Rosemaund, overhead misting was also used to encourage the epidemic to develop and progress into the trial plots. At Rosemaund, the trial area was surrounded by maize to reduce the effects of winds and increase the spray days and help maintain leaf wetness and humidity at the site.

Progress of the foliar blight epidemic was visually assessed throughout the season (protocols 1 and 2) and the effect of the treatments on the incidence of tuber blight and total ware yield was measured (protocol 2).

ADAS Rosemaund

The crop at Rosemaund was planted on 17 May and emergence occurred from 4 June onwards reaching 100% emergence by approximately 12 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 met. Stations. The data for the Rosemaund site used the HR1 postcode cell.

Unsprayed guard areas within & surrounding the site were inoculated on 25 June (for protocol 1) and again on 22 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 slow because weather conditions in England & Wales generally were unfavourable for blight activity as a result of drying winds and cold night temperatures (<10ºC) in June & early July. No Full Smith Periods were recorded in June and July.

However, from mid July and through most of August, weather conditions became more favourable for blight development and there was a significant disease challenge in the main season trial as indicated by the epidemic in the untreated control plots. Almost complete haulm destruction was recorded in the unsprayed control plots of this experiment by early September. Full Smith Periods were recorded on 4/5 & 9/10 August with Near Miss conditions on 12/13/14 & 24 August. 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.

N.B. Although not part of the protocol, applications of Dithane oversprays continued until desiccation at Rosemaund. It was noticed on one of the later applications that there was uneven application across the plots. This has not been seen on other experiments at the site in either 2003 or 2004. Investigations have shown that the problem may have been associated with sedimentation of the Dithane in the sprayer cannister. This occurred when canisters were completely full with no headage space making routine shaking ineffective.

SAC Auchincruive

The trials at Auchincruive were planted on 11 May (protocol 1) and 13 May (protocol 2). The early sprays trial (protocol 1) was inoculated with four UK isolates (three 2003 isolates and one from 2001) on 28 June, the day that the second fungicide application was made. The programmes trial (protocol 2) was inoculated the following day.

The daily rainfall recorded at the site together with a record of Smith Periods 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 Met. office site on Auchincruive Estate. The 2004 season at Auchincruive can be described as low risk until the end of July. From 26 July until mid-September there were nine Smith Periods. Characteristic of 2004 was the occurrence of several extended periods of high risk, i.e. high-risk conditions for between 3 and 5 consecutive days. One consequence of this was that there were very few opportunities

for curative activity by fungicides. A key event in 2004 was 3 days of exceptionally heavy rain. On 8-10 August over 100 mm was recorded.

Foliar blight developed very rapidly from the second half of August onwards. Fungicide programmes were severely tested. As a result there were large differences in blight-free yields. A moderate amount of tuber blight was recorded pre-storage. Many tubers developed blight during storage and in fact a higher incidence was generally recorded at the second assessment.

Conclusions

Evaluation of early season fungicide applications (protocol 1) - Rosemaund

- As shown in 2003, there was a clear benefit in 2004 from the early use of fungicides for the control of foliar blight even where disease pressure was not severe.

- The benefit of early fungicide use remained evident for a period of time and treatment effects were recorded well after they had been applied. This suggests that fungicides were suppressing blight inoculum before visible symptoms became evident.

- There were no differences in the effectiveness between any of the fungicides tested.

Evaluation of early season fungicide applications (protocol 1) - Auchincruive

- Where disease pressure was low during the period that the fungicides were applied but high afterwards there was a clear benefit from the early use of fungicides for the control of foliar blight but no benefit for tuber blight control.

- Sonata gave prolonged good control of foliar blight compared with the other fungicides. This confirmed a similar result with Sonata at Rosemaund in 2003.

- Unlike in the Auchincruive trial in 2003 the different fungicide treatments had no effect on the incidence of tuber blight.

These results do not change the current advice to UK 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 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 & fungicide programmes (protocol 2) - Rosemaund

- Under low blight risk conditions almost all of the fungicide programmes evaluated at Rosemaund 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 is likely to be 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.

- Good control of tuber blight was given by Ranman TP, Electis, Shirlan and combinations of these fungicides in the manufacturers' spray programmes.

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

Evaluation of fungicides & fungicide programmes (protocol 2) - Auchincruive

- There were many, often large, differences between fungicide programmes in the control of foliar and tuber blight.

- The results obtained in the experiment may not be typical for the fungicide products. The weather pattern in 2004 was unusual and the experiment tested the persistence of products and their ability to withstand removal from the plant by exceptionally high rainfall. There were no opportunities for kick back activity.

- The effectiveness of the core treatments in terms of foliar blight control quite closely reflected the relative rainfastness of the fungicides.

- Fungicides with curative activity can only be curative if applied sufficiently soon after high-risk conditions.

- There was a close relationship between the severity of foliar blight in September and the total incidence of tuber blight.

- There was a strong correlation between the tuber blight results for the fungicide treatments at Rosemaund and Auchincruive.

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 £30/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*, 2004).

A number of new fungicides have been registered and approved for use in the UK during the last few years, i.e. C50, Consento, Electis, Epok, Sonata, Ranman TP and Tanos. As a result of 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 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 to make an informed choice of fungicide to support that 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 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.

It was decided to concentrate on two areas initially. Firstly, the performance of fungicides applied early in the development of the crop was compared i.e. soon after emergence and up to the start of rapid haulm growth (protocol 1) and well before the traditional start of the spray programmes 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, the performance of fungicides applied from the end of rapid canopy growth (protocol 2) 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 to allow a robust and scientific evaluation of 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
Bayer CropScience Ltd
Belchim Crop Protection 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 - SPRAY PROGRAMMES

Treatment Number	Description
T1	Dithane DF NT** (@ 1.7 kg/ha)
T2	Dithane DF NT (@ 1.7 kg/ha) (x 5 – 6 sprays)
T3	Shirlan (@ 0.3 L/ha) (x 4 sprays) followed by Dithane DF NT (@ 1.7 kg/ha)
T4	Tanos (@ 0.5 kg/ha) (x1 spray), followed by Tanos (@ 0.7 kg/ha) (x 3 sprays) then Dithane DF NT (@ 1.7 kg/ha)
T5	Sonata (@1.5 kg/ha) (x 4 sprays) followed by Dithane DF NT (@ 1.7 kg/ha)
T6	Invader (@ 2.0 kg/ha) (x 4 sprays) followed by Dithane DF NT (@ 1.7 kg/ha)

*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 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.

**The first application of Dithane in this treatment should be made at the same time as the fifth treatment is being applied in T2 - 6

TABLE 2. EVALUATION OF EARLY SEASON FUNGICIDE APPLICATIONS - 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
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-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 Curzate M 68 (@ 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
T8 BASF 1	Invader* (@ 2.0 kg/ha)(x 3 sprays) followed by Shirlan (@ 0.3 L/ha) until desiccation.

T9 BASF 2	Invader* (@ 2.0 kg/ha) (x 3 sprays) followed by Curzate M (@2.0 kg/ha) alternating with Invader (@ 2.0 kg/ha) then Ranman TP A +B (@ 0.20 + 0.15 L/ha) (x1) prior to desiccation.
T10 Bayer 1	Consento* (@ 2.0L/ha) (x 3 sprays) followed by Curzate M (@2.0 kg/ha) (x 4-5 sprays) then Sonata (@1.5 kg/ha) (x 3 sprays) prior to desiccation. **Treatments to be applied at 7 day intervals throughout**
T11 Bayer 2	Consento* (@ 2.0L/ha) (x 3 sprays) followed by Curzate M (@ 2.0 kg/ha) (x 2-3 sprays) then Sonata (@ 1.5 kg/ha) alternating with Curzate M until desiccation to finish with Sonata. **Treatments to be applied at 7 day intervals throughout**
T12 Sipcam 1	Tattoo* (@ 3.0 L/ha) (x 1spray) followed by Tattoo (@ 3.0 L/ha) + C50 (@ 0.2kg/ha) (x 2 sprays) followed by Electis (@ 1.8 kg/ha)(x 2 sprays) followed by Electis (@ 1.8 kg/ha) + C50 (@ 0.2Kg/ha) (x 2 sprays) followed by Electis (@ 1.8 kg/ha) applied throughout until desiccation
T13 Sipcam 2	Tairel* (@ 2.0Kg/ha) (x 1spray) followed by Tairel (@ 2.0 Kg/ha) + C50 (@ 0.2kg/ha) (x 2 sprays) followed by an alternating programme of Sonata (@ 1.5 kg/ha) followed by Globe (@ 1.5kg/ha) applied throughout until desiccation – alternate sprays but last application to be Sonata.
T14 DuPont 1	Curzate M 68 ** (@ 2.0 kg/ha) (x 6 sprays), Shirlan (@ 0.3 L/ha) (x1 spray), Curzate M 68 ** (@ 2.0 kg/ha) (x 1 spray), Shirlan (@ 0.3 L/ha) (x2 sprays) **At 7 day intervals until desiccation.**
T15 DuPont 2	Tanos ** (@ 0.7 kg/ha) (x 2 sprays), Curzate M 68 ** (@ 2.0 kg/ha) (X4 sprays), Ranman TP A+B (@ 0.20 + 0.15 L/ha) (x 1 spray), Curzate M 68 (@ 2.0 kg/ha) (x 1 spray), Ranman TP A+B (@ 0.20 + 0.15 L/ha) (x 2 sprays) **At 7 day intervals until desiccation.**
T16 Syngenta 1	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.
T17*** Syngenta 2	Fubol Gold *(@ 1.9 kg/ha) (x 3sprays), Ranman TP A+B (@ 0.20 + 0.15 L/ha) (x 3 sprays), Shirlan (@ 0.3 L/ha) + cymoxanil (@ 90 g ai/ha)(x 2 sprays) followed by Shirlan (@ 0.3 L/ha)(x 2 sprays) prior to desiccation.
T18 Belchim	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.**

*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
*** Rosemaund only

TABLE 4. EVALUATION OF FUNGICIDES & FUNGICIDE PROGRAMMES - 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
Consento	Fenamidone + Propamocarb HCl	75+ 375	0.15+ 0.75	2.0
Curzate M 68*	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
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 – FUNGICIDES & TREATMENT DATES AT ADAS ROSEMAUND, 2004

Treatment No	19 June	25 June	5 July	12 July	19 July	26 July
Interval - days		6	10	7	7	7
Ground cover (%), date		50, 25th	70, 5th	90, 12th	90, 19rd	100, 26nd
Growth stage		324	324	324/410	324/410	324410
1	Untreated	Untreated	Untreated	Untreated	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	Shirlan	Shirlan	Shirlan	Shirlan	Dithane DF NT	Dithane DF NT
4	Tanos 0.5	Tanos 0.7	Tanos 0.7	Tanos 0.7	Dithane DF NT	Dithane DF NT
5	Sonata	Sonata	Sonata	Sonata	Dithane DF NT	Dithane DF NT
6	Invader	Invader	Invader	Invader	Dithane DF NT	Dithane DF NT

Treatment No	3 Aug	10 Aug	19 Aug	26 Aug	4 Sept	9 Sept
Interval - days	8	7	9	7	9	5
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

TABLE 6. EARLY SEASON FUNGICIDE APPLICATIONS – FUNGICIDES & TREATMENT DATES AT SAC AUCHINCRUIVE, 2004

Treatment No	**16 June**	**28 June**	**6 July**	**15 July**	**26 July**	**4 Aug**
Interval - days		**12**	**8**	**9**	**11**	**9**
Ground cover (%), date	**12, 15th**	**30, 24 th**	**91, 9th**	**100, 16 th**	**100, 23rd**	**100, 2nd**
Growth stage	**311**	**312**	**414**	**420**	**430**	**440**
1	Untreated	Untreated	Untreated	Untreated	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	Shirlan	Shirlan	Shirlan	Shirlan	Dithane DF NT	Dithane DF NT
4	Tanos 0.5	Tanos 0.7	Tanos 0.7	Tanos 0.7	Dithane DF NT	Dithane DF NT
5	Sonata	Sonata	Sonata	Sonata	Dithane DF NT	Dithane DF NT
6	Invader	Invader	Invader	Invader	Dithane DF NT	Dithane DF NT

Treatment No	**13 Aug**	**21 Aug**	**31 Aug**	**9 Sept**	**15 Sept**
Interval - days	**9**	**8**	**10**	**9**	**6**
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

TABLE 7. EVALUATION OF FUNGICIDES & FUNGICIDE PROGRAMMES – TREATMENT DATES AT ADAS ROSEMAUND, 2004

Treatment No	25-Jun	5-Jul	12-Jul	16- Jul	19-Jul	26-Jul	2-Aug
Interval-days		**10**	**7**	**4**	**3**	**7**	**7**
Ground cover (%), date	**50, 25th**	**70, 5 th**	**90, 12th**	**100, 16 th**	**100, 19rd**	**100, 26nd**	**100 2nd**
Growth stage	**324**	**324**	**324/410**	**324/410**	**324/410**	**324/410**	**324/410**
1	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**
2		Tattoo		Tattoo		Tattoo	Shirlan
3		Tattoo		Tattoo		Tattoo	Curzate M68
4		Tattoo		Tattoo		Tattoo	Invader
5		Tattoo		Tattoo		Tattoo	Ranman A+B
6		Tattoo		Tattoo		Tattoo	Electis
7		Tattoo		Tattoo		Tattoo	Sonata
8		Invader		Invader		Invader	Shirlan
9		Invader		Invader		Invader	Curzate M68
10		Consento	Consento		Consento	Curzate M68	Curzate M68
11		Consento	Consento		Consento	Curzate M68	Curzate M68
12		Tattoo		Tattoo+C50		Tattoo+C50	Electis
13		Tairel		Tairel+C50		Tairel+C50	Sonata
14	Curzate M68*	Curzate M68	Curzate M68		Curzate M68	Curzate M68	Curzate M68
15	Tanos*	Tanos	Curzate M68		Curzate M68	Curzate M68	Curzate M68
16		Fubol Gold		Fubol Gold		Fubol Gold	Shirlan+C50
17		Fubol Gold		Fubol Gold		Fubol Gold	Ranman A+B
18		Epok	Epok		Electis	Ranman A+B	Electis

*** Spray schedules started at Rosette stage**

Core treatments

TABLE 7 (CONT.). EVALUATION OF FUNGICIDES & FUNGICIDE PROGRAMMES – TREATMENT DATES AT ADAS ROSEMAUND, 2004

Treatment No	10-Aug	19-Aug	26-Aug	2-Sep	9-Sep	16-Sep
Interval-days	8	9	7	7	7	7
1	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**
2	Shirlan	Shirlan	Shirlan	Shirlan	Shirlan	Shirlan
3	Curzate M68	Curzate M68	Curzate M68	Curzate M68	Curzate M68	Curzate M68
4	Invader	Invader	Invader	Invader	Invader	Invader
5	Ranman A+B	Ranman A+B	Ranman A+B	Ranman A+B	Ranman A+B	Ranman A+B
6	Electis	Electis	Electis	Electis	Electis	Electis
7	Sonata	Sonata	Sonata	Sonata	Sonata	Sonata
8	Shirlan	Shirlan	Shirlan	Shirlan	Shirlan	Shirlan
9	Invader	Curzate M68	Invader	Curzate M68	Invader	Ranman A+B
10	Curzate M68	Curzate M68	Sonata	Sonata	Sonata	
11	Sonata	Curzate M68	Sonata	Curzate M68	Sonata	
12	Electis	Electis+C50	Electis+c50	Electis	Electis	Electis
13	Globe	Sonata	Globe	Sonata	Globe	Sonata
14	Shirlan	Curzate M68	Shirlan	Curzate M68	Shirlan	Shirlan
15	Ranman A+B	Curzate M68	Ranman A+B	Curzate M68	Ranman A+B	Ranman A+B
16	Shirlan+C50	Shirlan+C50	Shirlan+C50	Shirlan+C50	Shirlan	Shirlan
17	Ranman A+B	Ranman A+B	Shirlan+C50	Shirlan+C50	Shirlan	Shirlan
18	Ranman A+B	Electis	Ranman A+B	Electis	Ranman A+B	Ranman A+B

Core treatments

TABLE 8. EVALUATION OF FUNGICIDES & FUNGICIDE PROGRAMMES – TREATMENT DATES AT SAC AUCHINCRUIVE, 2004

Treatment No	18-Jun	28-Jun	5-Jul	8-Jul	12-Jul	21-Jul	30-Jul	2- Aug	11-Aug
Interval-days	**-**	**10**	**7**	**10**	**7**	**9**	**9**	**12**	**12**
Ground cover (%), date	**15, 15th**	**36, 24 th**	**89, 2 nd**	**96, 9 th**	**-**	**100, 23 rd**			
Growth stage	**309**	**313**	**314**	**414**	**-**	**430**			
1	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**
2		Tattoo		Tattoo		Tattoo		Shirlan	Shirlan
3		Tattoo		Tattoo		Tattoo		Curzate M68	Curzate M68
4		Tattoo		Tattoo		Tattoo		Invader	Invader
5		Tattoo		Tattoo		Tattoo		Ranman A+B	Ranman A+B
6		Tattoo		Tattoo		Tattoo		Electis	Electis
7		Tattoo		Tattoo		Tattoo		Sonata	Sonata
8		Invader		Invader		Invader		Shirlan	Shirlan
9		Invader		Invader		Invader		Curzate M68	Invader
10		Consento	Consento		Consento	Curzate M68	Curzate M68		Curzate M68
11		Consento	Consento		Consento	Curzate M68	Curzate M68		Curzate M68
12		Tattoo		Tattoo+C50		Tattoo+C50		Electis	Electis
13		Tairel		Tairel+C50		Tairel+C50		Sonata	Globe
14	Curzate M68	Curzate M68	Curzate M68		Curzate M68	Curzate M68	Curzate M68		Shirlan
15	Tanos	Tanos	Curzate M68		Curzate M68	Curzate M68	Curzate M68		Ranman A+B
16		Fubol Gold		Fubol Gold		Fubol Gold		Shirlan+C50	Shirlan+C50
17		Epok	Epok		Electis	Ranman A+B	Electis		Ranman A+B

*** Spray schedules started at Rosette stage**

Core treatments

TABLE 8 (CONT.) EVALUATION OF FUNGICIDES & FUNGICIDE PROGRAMMES – TREATMENT DATES AT SAC AUCHINCRUIVE, 2004

Treatment No	19-Aug	20-Aug	26-Aug	28-Aug	2-Sep	6-Sep	9-Sep	14-Sep	15-Sep
Interval-days	**8**	**9**	**7**	**8**	**8**	**9**	**7**	**8**	**6**
1	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**	**Untreated**
2		Shirlan		Shirlan		Shirlan		Shirlan	
3		Curzate M68		Curzate M68		Curzate M68		Curzate M68	
4		Invader		Invader		Invader		Invader	
5		Ranman A+B		Ranman A+B		Ranman A+B		Ranman A+B	
6		Electis		Electis		Electis		Electis	
7		Sonata		Sonata		Sonata		Sonata	
8		Shirlan		Shirlan		Shirlan		Shirlan	
9		Curzate M68		Invader		Curzate M68		Ranman A+B	
10	Curzate M68		Curzate M68		Sonata		Sonata		Sonata
11	Sonata		Curzate M68		Sonata		Curzate		Sonata
12		Electis+C50		Electis+C50		Electis		Electis	
13		Sonata		Globe		Sonata		Sonata	
14	Curzate M68		Shirlan		Curzate M68		Shirlan		Shirlan
15	Curzate M68		Ranman A+B		Curzate M68		Ranman A+B		Ranman A+B
16		Shirlan+C50		Shirlan+C50		Shirlan+C50		Shirlan	
17	Electis		Ranman A+B		Electis		Ranman A+B		Ranman A+B

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	Dreghorn Series
Soil Texture:	Silty Clay Loan	Sandy Loam
Soil Analysis:		
P index	5	Low
K index	4	Low
pH	7.1	6.0
Previous Cropping:		
2003	Winter Barley	Winter wheat
2003	Winter Wheat	
2001	Winter Oilseed Rape	
Previous Cultivations:	Plough Flatlift Pegasus Power Harrow (x2)	Plough Rotovate x 2
Cultivar:	King Edward	King Edward
Seed health status:	SE2	SE3
Planting date:	17 May	11 May (protocol 1) 13 May (protocol 2)
Harvesting date:	6-7 October	29 October (protocol 1) 2-3 November (protocol 2)
Fertiliser (kg/ha):		
N	103.50kg/ha N	228
P	None	251
K	None	251
FYM (t/ha)	None	None
Herbicides:	Lexone @ 1.0l/ha	Lexone @ 1.0 kg + PDQ @ 1.5 l/ha
(All applied pre-em on 08/06/04)	PDQ @ 0.5l/ha Gramoxone 100 @ 2.0l/ha	Applied 5 June 04
Insecticides:	Cypermethyrin @ 0.25l/ha On 6 August	None
Desiccant:	Reglone @ 3.75l/ha on 16 September	Reglone @ 4 l/ha on 15 September
Trace elements	None	None

TABLE 10. MISTING REGIME APPLIED AT ADAS ROSEMAUND, 2004

Date	Area applied	Duration (hours)
25/07/04	Whole trial	1
28/07/04	Whole trial	1
07/08/04	Whole trial	1
05/08/04	Whole trial	1
11/08/04	Whole trial	1

TABLE 11. IRRIGATION REGIME APPLIED AT SAC AUCHINCRUIVE, 2004

Date	Area applied	Mm
None		

Experiment design & fungicide application

Layout

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 was replicated four times. The plots at both sites were four rows wide, measuring at Rosemaund 3.2 m and at Auchincruive 2.8 m (protocol 1) and 3.4 m (protocol 2). Plot lengths were 8.0 m at Rosemaund and 7.5 m (protocol 2) and 6.0 m (protocol 1) at Auchincruive.

At Rosemaund, the experimental plots were surrounded either by 2 rows or a 2.0m wide headland. The headlands were sprayed with Electis applied at 10-day intervals. At Auchincruive, plots were separated along their length by 2.6m 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. The samples were stored in hessian sacks in ambient conditions for approximately 6 weeks before washing and assessing for tuber blight (protocol 2 only).

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 late January or February and assessed for any blight that had developed during storage.

The protocol 1 trial at Auchincruive was in a wetter part of the field than protocol 2 and was harvested later. Consequently the very wet conditions at harvest prevented the centre two rows of each plot being harvested mechanically. Instead all of the tubers from 9 plants per plot were dug by hand. Seventy randomly selected tubers per plot 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 2 rows. At Rosemaund, the plots were harvested using a 2 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

Observations on the blight epidemic at ADAS Rosemaund, Herefordshire in 2004

The crop at Rosemaund was planted on 17 May and emergence occurred from 4 June onwards reaching 100% emergence by approximately 12 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 met. Stations. The data for the Rosemaund site used the HR1 postcode cell.

Unsprayed guard areas within & surrounding the site were inoculated on 25 June (for protocol 1) and again on 22 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 slow because weather conditions in England & Wales generally were unfavourable for blight activity as a result of drying winds and cold night temperatures (<10ºC) in June & early July. No Full Smith Periods were recorded in June and July.

However, from mid July and through most of August, weather conditions became more favourable for blight development and there was a significant disease challenge in the main season trial as indicated by the epidemic in the untreated control plots. Almost complete haulm destruction was recorded in the unsprayed control plots of this experiment by early September. Full Smith Periods were recorded on 4/5 & 9/10 August with Near Miss conditions on 12/13/14 & 24 August. 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.

Observations on the blight epidemic at Auchincruive, Ayrshire in 2004

The trials at Auchincruive were planted on 11 May (protocol 1) and 13 May (protocol 2). The early sprays trial (protocol 1) was inoculated with four UK isolates (three 2003 isolates and one from 2001) on 28 June, the day that the second fungicide application was made. The programmes trial (protocol 2) was inoculated the following day.

The daily rainfall recorded at the site together with a record of Smith Periods 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 Met. Office site on Auchincruive Estate. The 2004 season at Auchincruive can be described as low risk until the end of July. From 26 July until mid-September there were nine Smith Periods. Characteristic of 2004 was the occurrence of several extended periods of high risk, i.e. high-risk conditions for between 3 and 5 consecutive days. One consequence of this was that there were very few opportunities for curative activity by fungicides. A key event in 2004 was 3 days of exceptionally heavy rain. On 8-10 August well over 100 mm was recorded.

Foliar blight developed very rapidly from the second half of August onwards and fungicide programmes were severely tested. As a result there were large differences in blight-free yields. A moderate amount of tuber blight was recorded pre-storage. Many tubers developed blight during storage and in fact a higher incidence was generally recorded at the second assessment.

Figure 1. Daily Rainfall recorded at ADAS Rosemaund and Smith Periods recorded on BlightWatch, and Blight Progress in untreated plots 2004.

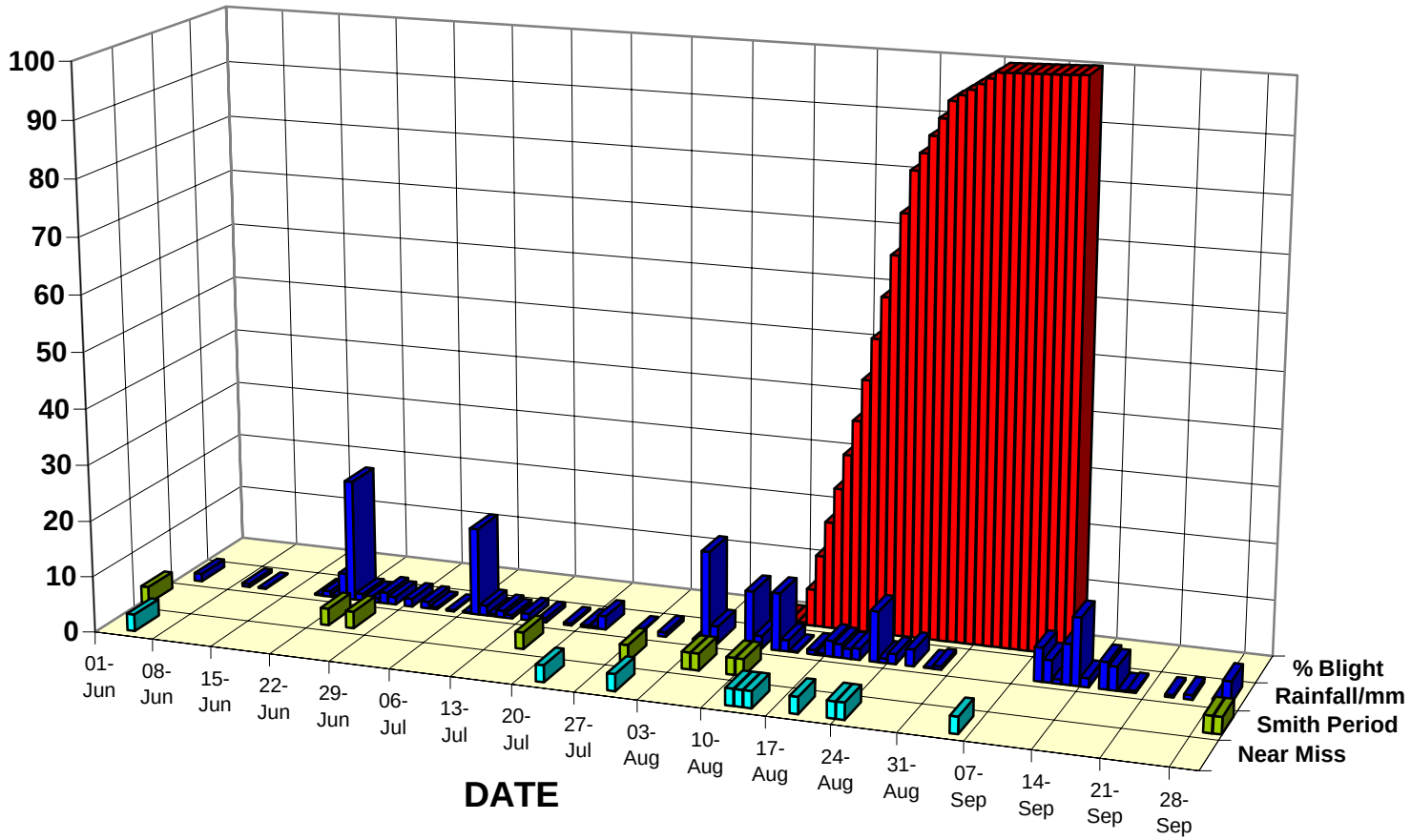
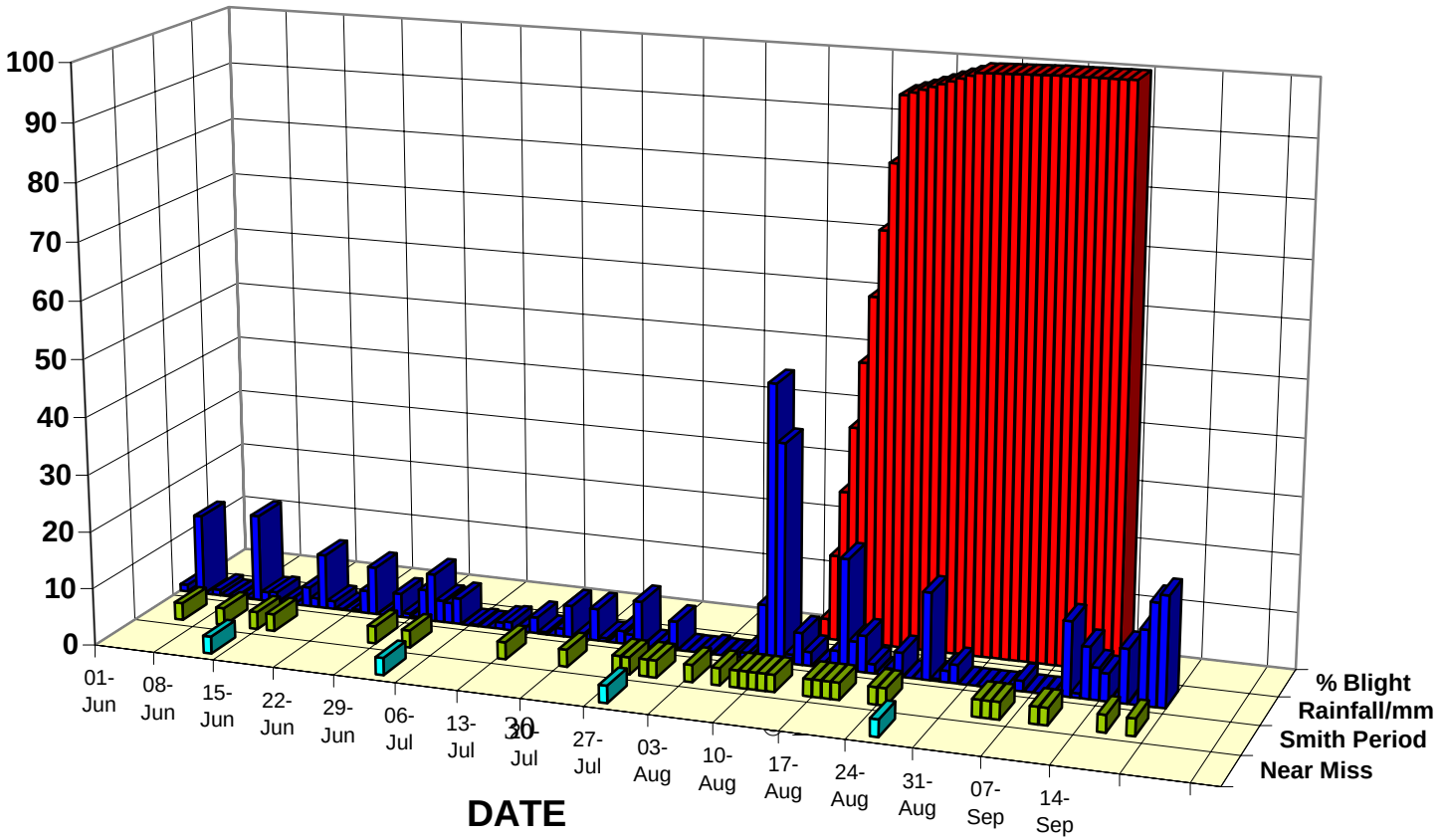


Figure 2. Daily Rainfall and Smith periods recorded at SAC Auchincruive and Blight Progress in untreated plots 2004



Evaluation of early season fungicide applications (protocol 1)

Control of foliar blight

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 the Rosemaund site are given in Table 5 and Auchincruive in Table 6. At both sites, comparisons were made between four applications of Dithane DF NT, Shirlan, Tanos, Sonata & Invader.

Rosemaund

At Rosemaund, the spray programmes started at approximately 100% emergence on 19 June. Subsequent applications were made on 25 June (approx. rosette stage), on 5 July (approx. haulm meeting along the rows) and on 12 July (approaching full ground cover). These treatments were followed by weekly oversprays with Dithane DF NT until desiccation.

The unsprayed guard areas surrounding the experiment were inoculated with a mixture of isolates of *P. infestans* on 25 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 20 July after the fifth spray had been applied i.e. just after the first Dithane DF NT overspray. Foliar blight was generally at low levels in this experiment but was highest in the 'control plots' where the first four sprays had been omitted. The 'control plot' values were not included in the Analysis of Variance and there were no significant differences in the severity of foliar blight between the various treatments. This remained the case throughout the duration of the experiment.

N.B. Although not part of the protocol, applications of Dithane oversprays continued until desiccation. It was noticed on one of the later applications that there was uneven application across the plots. This has not been seen on other experiments at the site in either 2003 or 2004. Investigations have shown that the problem may have been associated with sedimentation of the Dithane in the sprayer cannister. This occurred when canisters were completely full with no headage space making routine shaking ineffective.

Auchincruive

Blight pressure was low when the first four sprays were applied but was high when the blanket sprays of Mancozeb were applied. As a result foliar blight was severe in all treatments. As expected, foliar blight was worst where plots were untreated for the first four sprays (Table 13). Sonata gave the best control of foliar blight, consistently significantly better than Tanos and Shirlan from 24 August. Sonata also gave significantly better control than Dithane NT on 24 August and Invader on 8 September. None of the first four fungicide application timings in 2004 allowed curative activity. The application on 16 June would have been curative but the trial was not inoculated until after this first application of fungicide.

There were no significant differences in the control of tuber blight when assessed shortly after harvest (Table 14). The blight-free yields for the five fungicide programmes were similar. The yield for the 'control' was considerably lower (Table 14).

TABLE 12. EARLY FUNGICIDE APPLICATIONS - FOLIAR BLIGHT ASSESSMENTS - ADAS ROSEMAUND, 2004

Mean Percentage Leaf Area Destroyed by Blight – MAFF Key 2.1.1					
Spray Programme	**20-Jul**	**27-Jul**	**4-Aug**	**9-Aug**	**12-Aug**
Untreated/ Dithane DF NT*	0.1	0.6	4.4	16.3	16.7
Dithane NT DF	0.0	0.08	0.08	0.08	0.10
Shirlan/ Dithane DF NT	0.0	0.05	0.08	0.10	0.10
Tanos/ Dithane NT DF	0.0	0.08	0.12	0.12	0.12
Sonata/ Dithane NT DF	0.0	0.05	0.08	0.10	0.12
Invader/ Dithane NT DF	0.0	0.07	0.07	0.08	0.08
F pr		NS	NS	NS	NS

Treatment 1 excluded from the analysis
*First application of Dithane NT DF for treatment 1 applied the same time as 5th treatment in T2-6

TABLE 13. EARLY FUNGICIDE APPLICATIONS - FOLIAR BLIGHT ASSESSMENTS – SAC AUCHINCRUIVE, 2004

Mean Percentage Leaf Area Destroyed by Blight - MAFF Key 2.1.1					
Spray Programme	**9 Aug**	**16 Aug**	**24 Aug**	**1 Sep**	**8 Sep**
Untreated/ Dithane DF NT*	0.2	1.8	38.8	80.0	92.5
Dithane NT DF	0.0	0.38	23.8	72.5	90.4
Shirlan/ Dithane DF NT	0.0	0.33	23.3	80.8	93.3
Tanos/ Dithane NT DF	0.0	0.57	24.6	81.2	92.9
Sonata/ Dithane NT DF	0.0	0.35	14.6	64.6	82.1
Invader/ Dithane NT DF	0.0	0.38	20.8	73.3	92.1
F pr (20 DF)		0.002	<0.001	<0.001	<0.001
LSD (5% level)		0.145	7.97	14.68	9.77

Treatment 1 excluded from the analysis

*First application of Dithane NT DF for treatment 1 applied the same time as 5th treatment in T2-6

TABLE 14. EARLY FUNGICIDE APPLICATIONS - INCIDENCE (%) PRE-STORAGE TUBER BLIGHT AND YIELD AT AUCHINCRUIVE, 2004

	Tuber blight				Yield (t/ha)	
Spray Programme	**% by weight**	**% Weight (1)**	**% by number**	**%Number (1)**	**Total Yield**	**Blight-free (marketable) yield (>35 mm)**
Untreated/ Dithane DF NT	11.40	18.40	13.90	20.60	50.9	45.1
Dithane NT DF	9.90	17.50	12.10	19.60	60.5	54.5
Shirlan/ Dithane DF NT	10.70	17.60	12.40	19.30	61.1	55.0
Tanos/ Dithane NT DF	7.90	14.60	9.90	16.30	59.8	55.1
Sonata/ Dithane NT DF	12.00	18.50	14.20	20.50	61.2	54.0
Invader/ Dithane NT DF	10.80	17.90	11.00	18.20	61.7	55.0
F pr	0.02	0.001	0.008	<0.001	0.002	<0.001
LSD (5% level)	6.290	7.350	6.720	7.480	10.83	11.22

(1) Angular transformation.

Evaluation of fungicides & fungicide programmes (protocol 2)

Control of foliar & tuber blight & yield measurements

The application dates for the fungicides at the Rosemaund site are given in Table 7 and for Auchincruive in Table 8. Comparisons were made between applications of Shirlan, Curzate M68, Invader, Ranman TP, Electis & Sonata as canopy stable treatments following three initial applications of Tattoo. The Tattoo treatments started as the haulm began to meet along the rows. Also in the experiment comparisons were made between commercial spray programmes sponsored by Agrochemical manufacturers.

Details of the foliar blight progress for each of the treatments 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 5 August. Smith Periods/Near Misses were recorded in early/mid August and disease development was further encouraged by overhead misting. Foliar blight reached complete haulm destruction in the unsprayed plots by 1 September indicating that there was a considerable 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 10% foliage infected until the last assessment on 10 September. Prior to that date, there were no significant differences in the severity of foliar blight between the canopy stable (core) treatments and manufacturer sponsored spray programmes ($P>0.05$).

At the last foliar assessment on 10 September there were no significant differences between any of the canopy stable (core) treatments and the manufacturers programmes with the exception of Sipcam 2 and DuPont 2. The Sipcam 2 programme had the highest level of foliar blight (11.3%) and was significantly higher than all the other treatments ($P<0.05$). In view of the low level of foliar blight in this experiment, these data should be treated with caution.

Tuber blight

The incidence of tuber blight measured after a period of ambient storage is expressed as both the percentage by weight & percentage by number of infected tubers and is shown in 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.

There was a high incidence of tuber blight at this site with a mean of 26.8% of tubers infected in the untreated control plots. Canopy stable (core) treatments with Ranman TP, Electis & Shirlan significantly reduced the incidence of tuber blight compared with the unsprayed control ($P<0.05$), although there were no significant differences between these three treatments ($P>0.05$). Curzate M & Invader did not reduce the incidence of tuber blight compared with the unsprayed control.

There were significant differences between the manufacturer sponsored spray programmes in the incidence in tuber blight ($P<0.05$). The most effective spray programmes were BASF1, Sipcam1, DuPont 2, and the Syngenta and Belchim programmes. These spray programmes contained Shirlan, Electis, RanmanTP or combinations thereof.

Yield

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 not included in the statistical analysis. There were no significant differences in yield between the canopy stable fungicide comparisons or between manufacturers' spray programmes ($P>0.05$).

Auchincruive

Foliar blight

The 2004 growing season was low blight risk until near the end of July (Fig. 2). From this time onwards there were many prolonged periods of high risk.

The core treatments could be grouped into one of three categories for the control of foliar blight. The most effective was Ranman TP. The second most effective group comprised Shirlan and Electis with Invader, Sonata and Curzate M in the third group (Table 16). There were significant differences between the manufacturer sponsored spray programmes. The best control for the 10-7 day programmes was obtained with Syngenta 1 and Sipcam 1. For the 7-day programmes the Belchim/Dow and Du Pont 2 programmes gave the best control.

Tuber blight

There were many significant differences between programmes in the pre-storage and total incidences of tuber blight. Only the total incidence data are referred to here. Total tuber blight incidence was closely related to the severity of foliar blight on 5 September (r=0.91, F pr.=0.018) and 13 September (r=0.94, F pr=0.005). Consequently, the best core treatments were Ranman and Shirlan, the best 10-7 day programme was Syngenta and the best 7 day programmes were Belchim/Dow and Du Pont 2 (Table 20).

There was a significant correlation between the incidence of tuber blight recorded in the Rosemaund trial and the total tuber blight incidence at Auchincruive (r=0.90, F pr.=0.019) (Table 21).

Yield

There were many significant differences in yield between fungicide programmes. The same programmes that had performed best for foliar and tuber blight control gave the highest blight-free yields, i.e. Ranman and Shirlan (core), Syngenta (10-7 day programmes) and Belchim/Dow and Du Pont 2 (7 day programmes) (Table 19). Blight-free yield was closely related to the severity of foliar blight at the final assessment in mid-September (r=0.94, F pr.<0.001).

TABLE 15. COMPARISON OF FUNGICIDE PROGRAMMES - FOLIAR BLIGHT ASSESSMENTS ADAS ROSEMAUND, 2004

	Mean Percentage Leaf Area Destroyed by Blight - MAFF Key 2.1.1			
Spray programme*	**5-Aug**	**11-Aug**	**17-Aug**	**23-Aug**
Untreated control	0.08	0.38	37.7	82.0
Core Programmes				
Tattoo(x3), Shirlan	0.0	0.0	0.1	0.4
Tattoo(x3), Curzate M68	0.0	0.0	0.1	0.4
Tattoo(x3), Invader	0.0	0.0	0.1	0.4
Tattoo(x3), Ranman TP	0.0	0.0	0.1	0.6
Tattoo(x3), Electis	0.0	0.0	0.1	0.3
Tattoo(x3) Sonata	0.0	0.0	0.1	0.2
10-7 day interval programmes				
BASF1 (Invader fb Shirlan)	0.0	0.0	0.1	0.3
BASF2 (Invader alt Shirlan)	0.0	0.0	0.1	0.2
Sipcam 1 (Tattoo +/- C50 fb Electis +/- C50)	0.0	0.0	0.1	0.2
Sipcam 2 (Tairel +/- C50 fb Sonata alt Globe)	0.0	0.0	0.1	0.2
Syngenta 1 (Fubol Gold fb Shirlan)	0.0	0.0	0.08	0.1
Syngenta 2 (Fubol Gold fb Ranman TP then Shirlan+ Cymoxanil , Shirlan)	0.0	0.0	0.1	0.1
7 day interval programmes				
Bayer 1 (Consento fb Curzate M then Sonata)	0.0	0.0	0.1	0.2
Bayer 2 (Consento fb Curzate alt with Sonata)	0.0	0.0	0.08	0.2
DuPont 1 (Curzate M68 fb Shirlan alt Curzate M68 Then Shirlan)	0.0	0.0	0.08	0.2
DuPont 2 (Tanos fb Curzate M68 alt Ranman TP, then Ranman TP)	0.0	0.0	0.1	0.4
Belchim (Epok fb Electis alt Ranman TP)	0.0	0.0	0.08	0.2
F pr (51 df)			NS	0.017
LSD (5% level)(NB Untreated excluded from the analyses)				

***See Table 3 for full details. NB The core and 10-7 day interval programmes had the same spray dates throughout and therefore are directly comparable.**

TABLE 15 (CONT.) COMPARISON OF FUNGICIDE PROGRAMMES - FOLIAR BLIGHT ASSESSMENTS ADAS ROSEMAUND, 2004

	Mean Percentage Leaf Area Destroyed by Blight - MAFF Key 2.1.1			
Spray programme*	**27-Aug**	**1-Sep**	**6-Sep**	**10-Sep**
Untreated control	94.3	99.5	99.8	100
Core programmes				
Tattoo(x3), Shirlan	0.8	0.9	2.8	4.3
Tattoo(x3), Curzate M68	0.5	0.6	2.5	3.4
Tattoo(x3), Invader	0.6	0.7	3.4	5.3
Tattoo(x3), Ranman TP	1.1	1.4	3.9	4.9
Tattoo(x3), Electis	0.7	1.0	3.3	4.8
Tattoo(x3) Sonata	0.6	0.9	2.7	3.9
10-7 day interval programmes				
BASF1 (Invader fb Shirlan)	0.5	0.8	2.3	2.5
BASF2 (Invader alt Shirlan)	0.5	0.6	3.0	3.8
Sipcam 1 (Tattoo +/- C50 fb Electis +/- C50)	0.5	0.6	1.1	1.7
Sipcam 2 (Tairel +/- C50 fb Sonata alt Globe)	0.8	1.5	6.9	11.3
Syngenta 1 (Fubol Gold fb Shirlan)	0.2	0.3	1.1	1.8
Syngenta 2 (Fubol Gold fb Ranman TP then Shirlan+ Cymoxanil, Shirlan)	0.5	0.6	1.8	2.4
7 day interval programmes				
Bayer 1 (Consento fb Curzate M then Sonata)	0.5	0.5	2.4	2.7
Bayer 2 (Consento fb Curzate alt with Sonata)	0.5	0.6	2.8	3.7
DuPont 1 (Curzate M68 fb Shirlan alt Curzate M68 then Shirlan)	0.4	0.5	2.3	2.6
DuPont 2 (Tanos fb Curzate M68 alt Ranman TP, then Ranman TP)	0.7	1.3	6.2	6.6
Belchim (Epok fb Electis alt Ranman TP)	0.3	0.4	1.8	2.3
F pr (51 df)	NS	NS	NS	0.008
LSD (5% level)(NB Untreated excluded from the analyses)				4.164

***See Table 3 for full details. NB The core and 10-7 day interval programmes had the same spray dates throughout and therefore are directly comparable.**

TABLE 16. COMPARISON OF FUNGICIDE PROGRAMMES - FOLIAR BLIGHT ASSESSMENTS SAC AUCHINCRUIVE, 2004.

Spray programmes ranked by foliar blight on 13 September

	Mean Percentage Leaf Area Destroyed by Blight - MAFF Key 2.1.1				
Spray programme*	**12-Aug**	**20-Aug**	**28-Aug**	**5-Sep**	**13-Sep**
Untreated control	3.5	94.8	99.3	99.7	99.8
Core programmes					
Tattoo(x3), Ranman TP	0.0	0.7	10.0	21.9	36.9
Tattoo(x3), Shirlan	0.0	0.8	29.4	46.3	64.4
Tattoo(x3), Electis	0.0	0.6	23.1	46.9	70.6
Tattoo(x3), Invader	0.0	0.7	42.5	70.0	85.0
Tattoo(x3) Sonata	0.0	0.7	55.0	80.0	90.6
Tattoo(x3), Curzate M68	0.0	0.7	38.1	78.1	92.5
10-7 day interval programmes					
Syngenta 1 (Fubol Gold fb Shirlan)	0.0	0.5	16.9	33.8	55.0
Sipcam 1 (Tattoo +/- C50 fb Electis +/- C50)	0.0	0.6	20.0	51.3	75.0
BASF1 (Invader fb Shirlan)	0.0	0.8	35.0	74.4	89.4
BASF2 (Invader alt Shirlan)	0.0	0.6	61.2	86.2	95.0
Sipcam 2 (Tairel +/- C50 fb Sonata alt Globe)	0.0	1.0	73.8	86.9	95.6
7 day interval programmes					
Belchim (Epok fb Electis alt Ranman TP)	0.0	0.5	1.3	7.5	10.6
DuPont 2 (Tanos fb Curzate M68 alt Ranman TP, then Ranman TP)	0.0	0.6	6.9	13.8	28.8
DuPont 1 (Curzate M68 fb Shirlan alt Curzate M68 then Shirlan)	0.0	0.6	25.0	44.4	72.5
Bayer 1 (Consento fb Curzate M then Sonata)	0.0	0.7	38.8	65.6	83.1
Bayer 2 (Consento fb Curzate alt with Sonata)	0.0	0.7	45.0	71.9	86.2
F pr (48 df)	-	0.18	<0.001	<0.001	<0.001
LSD (5% level) (NB Untreated excluded from the analyses)	-	0.286	15.06	17.07	13.59

***See Table 3 for full details. NB The core and 10-7 day interval programmes had the same spray dates throughout and therefore are directly comparable**

TABLE 17. COMPARISON OF FUNGICIDE PROGRAMMES - TUBER BLIGHT & YIELD ASSESSMENTS AT ADAS ROSEMAUND, 2004

Spray Programme	**Tuber Blight**		**Total yield >35 mm) (t/ha)**
	% affected tubers by weight	**% affected tubers by number**	
Untreated control	25.0	26.8	39.2
Core programmes			
Tattoo(x3), Shirlan	12.4	13.0	59.2
Tattoo(x3), Curzate M68	24.8	25.0	52.4
Tattoo(x3), Invader	27.2	27.2	53.8
Tattoo(x3), Ranman TP	6.8	5.0	51.5
Tattoo(x3), Electis	11.9	10.2	53.2
Tattoo(x3) Sonata	16.1	17.3	51.2
10-7 day programmes			
BASF1 (Invader fb Shirlan)	8.9	9.2	55.0
BASF2 (Invader alt Shirlan)	26.6	25.5	51.1
Sipcam 1 (Tattoo +/- C50 fb Electis +/- C50)	14.7	13.8	52.8
Sipcam 2 (Tairel +/- C50 fb Sonata alt Globe)	22.3	20.8	50.0
Syngenta 1 (Fubol Gold fb Shirlan)	8.3	8.8	57.9
Syngenta 2 (Fubol Gold fb Ranman TP then Shirlan+ Cymoxanil, Shirlan)	4.2	3.0	56.6
7 day programmes			
Bayer 1 (Consento fb Curzate M then Sonata)	30.3	26.8	50.5
Bayer 2 (Consento fb Curzate alt with Sonata)	20.8	21.2	50.7
DuPont 1 (Curzate M68 fb Shirlan alt Curzate M68 then Shirlan)	17.9	17.8	53.6
DuPont 2 (Tanos fb Curzate M68 alt Ranman TP, then Ranman TP)	12.3	13.8	55.2
Belchim (Epok fb Electis alt Ranman TP)	3.4	2.5	55.5
F pr (51 df)	<0.001	<0.001	0.058
LSD (5% level)	13.37	12.47	9.11

*See Table 3 for full details. NB The core and 10-7 day interval programmes had the same spray dates throughout and therefore are directly comparable

TABLE 18. COMPARISON OF FUNGICIDE PROGRAMMES - TUBER BLIGHT (PRE-STORAGE) AT SAC AUCHINCRUIVE, 2004

Spray Programme*	Tuber Blight		Tuber Blight**	
	% affected tubers by weight	% affected tubers by number	% affected tubers by weight	% affected tubers by number
Untreated control	13.0	12.4	20.1	19.7
Core programmes				
Tattoo(x3), Ranman TP	1.1	2.0	4.7	6.3
Tattoo(x3), Shirlan	2.9	3.6	8.8	10.0
Tattoo(x3), Electis	3.8	4.8	9.9	11.2
Tattoo(x3) Sonata	4.9	5.7	12.2	13.3
Tattoo(x3), Curzate M68	5.4	7.5	13.1	15.4
Tattoo(x3), Invader	5.5	6.9	13.4	14.9
10-7 day interval programmes				
Syngenta 1 (Fubol Gold fb Shirlan)	0.7	1.0	2.5	2.8
Sipcam 2 (Tairel +/- C50 fb Sonata alt Globe)	3.1	3.7	8.2	8.8
Sipcam 1 (Tattoo +/- C50 fb Electis +/- C50)	3.3	3.7	9.5	10.0
BASF1 (Invader fb Shirlan)	3.9	4.2	10.0	10.6
BASF2 (Invader alt Shirlan)	4.1	4.6	10.3	10.9
7 day interval programmes				
Belchim (Epok fb Electis alt Ranman TP)	0.7	0.5	2.3	2.0
DuPont 2 (Tanos fb Curzate M68 alt Ranman TP, Then Ranman TP)	1.3	1.3	4.5	4.5
Bayer 2 (Consento fb Curzate alt with Sonata)	3.1	4.3	9.2	10.9
Bayer 1 (Consento fb Curzate M then Sonata)	4.5	5.3	10.9	12.0
DuPont 1 (Curzate M68 fb Shirlan alt Curzate M68 then Shirlan)	5.8	6.5	13.7	14.5
F pr (48 df)	0.001	<0.001	<0.001	<0.001
LSD (5% level)	2.66	5.10	3.20	5.59

*** See Table 3 for full details; ** Angular transformation**

NB The core and 10-7 day interval programmes had the same spray dates throughout and therefore are directly comparable

TABLE 19. COMPARISON OF FUNGICIDE PROGRAMMES – YIELD ASSESSMENTS AT SAC, AUCHINCRUIVE, 2004. SPRAY PROGRAMMES RANKED BY BLIGHT-FREE YIELD.

Spray Programme*	Yield (t/ha) Total	Blight free (marketable)
Untreated control	32.63	28.43
Core programmes		
Tattoo(x3), Ranman TP	50.05	49.45
Tattoo(x3), Electis	50.00	48.04
Tattoo(x3), Shirlan	48.33	46.86
Tattoo(x3), Curzate M68	43.62	41.37
Tattoo(x3) Sonata	43.55	41.36
Tattoo(x3), Invader	43.11	40.74
10-7 day programmes		
Syngenta 1 (Fubol Gold fb Shirlan)	52.55	52.13
Sipcam 1 (Tattoo +/- C50 fb Electis +/- C50)	47.83	46.42
BASF1 (Invader fb Shirlan)	46.12	44.35
BASF2 (Invader alt Shirlan)	43.39	41.73
Sipcam 2 (Tairel +/- C50 fb Sonata alt Globe)	41.54	40.20
7 day programmes		
Belchim (Epok fb Electis alt Ranman TP)	51.78	51.48
DuPont 2 (Tanos fb Curzate M68 alt Ranman TP, then Ranman TP)	51.04	50.39
DuPont 1 (Curzate M68 fb Shirlan alt Curzate M68 then Shirlan)	48.50	45.85
Bayer 1 (Consento fb Curzate M then Sonata)	44.20	42.21
Bayer 2 (Consento fb Curzate alt with Sonata)	42.40	41.11
F pr (48 df)	<0.001	<0.001
LSD (5% level)	4.335	4.41

*** See Table 3 for full details**

NB. The core and 10-7 day interval programmes had the same spray dates throughout and therefore are directly comparable

TABLE 20. COMPARISON OF FUNGICIDE PROGRAMMES - TOTAL TUBER BLIGHT (PRE-STORAGE PLUS POST-STORAGE) AT SAC AUCHINCRUIVE, 2004

Spray Programme*	Tuber Blight		Tuber Blight**	
	% affected tubers by weight	% affected tubers by number	% affected tubers by weight	% affected tubers by number
Untreated control	20.9	20.5	26.3	26.3
Core programmes				
Tattoo(x3), Ranman TP	5.0	5.5	11.7	12.2
Tattoo(x3), Shirlan	7.5	7.6	14.7	15.0
Tattoo(x3), Invader	9.5	10.9	17.7	18.9
Tattoo(x3), Electis	11.4	12.0	18.5	19.2
Tattoo(x3) Sonata	12.6	13.0	19.4	19.9
Tattoo(x3), Curzate M68	13.7	15.4	20.9	22.5
10-7 day programmes				
Syngenta 1 (Fubol Gold fb Shirlan)	1.0	1.3	2.9	3.1
BASF1 (Invader fb Shirlan)	5.5	5.7	13.0	13.3
Sipcam 2 (Tairel +/- C50 fb Sonata alt Globe)	6.0	6.4	13.6	14.0
BASF2 (Invader alt Shirlan)	11.0	11.5	18.4	18.7
Sipcam 1 (Tattoo +/- C50 fb Electis +/- C50)	13.3	12.7	20.6	20.1
7 day programmes				
Belchim (Epok fb Electis alt Ranman TP)	2.1	1.8	6.3	5.9
DuPont 2 (Tanos fb Curzate M68 alt Ranman TP, then Ranman TP)	3.3	3.6	8.8	9.2
Bayer 1 (Consento fb Curzate M then Sonata)	9.0	9.8	17.2	17.9
Bayer 2 (Consento fb Curzate alt with Sonata)	10.1	11.1	16.9	18.0
DuPont 1 (Curzate M68 fb Shirlan alt Curzate M68 then Shirlan)	12.7	12.6	20.2	20.4
F pr (48 df)	<0.001	<0.001	<0.001	<0.001
LSD (5% level)	5.56	5.53	5.91	5.74

*** See Table 3 for full details; ** Angular transformation**

NB The core and 10-7 day interval programmes had the same spray dates throughout and therefore are directly comparable

TABLE 21. COMPARISON OF FUNGICIDE PROGRAMMES - TUBER BLIGHT AT ADAS ROSEMAUND AND SAC AUCHINCRUIVE, 2004

Spray Programme*	Tuber Blight	
	% affected tubers by weight Rosemaund	% affected tubers by weight Auchincruive
Core programmes		
Tattoo(x3), Ranman TP	6.8	5.0
Tattoo(x3), Electis	11.9	11.4
Tattoo(x3), Shirlan	12.4	7.5
Tattoo(x3) Sonata	16.1	12.6
Tattoo(x3), Curzate M68	24.8	13.7
Tattoo(x3), Invader	27.2	9.5
10-7 day programmes		
Syngenta 1 (Fubol Gold fb Shirlan)	8.3	1.0
BASF1 (Invader fb Shirlan)	8.9	5.5
Sipcam 1 (Tattoo +/- C50 fb Electis +/- C50)	14.7	13.3
Sipcam 2 (Tairel +/- C50 fb Sonata alt Globe)	22.3	6.0
BASF2 (Invader alt Shirlan)	26.6	11.0
7 day programmes		
Belchim (Epok fb Electis alt Ranman TP)	3.4	2.1
DuPont 2 (Tanos fb Curzate M68 alt Ranman TP, then Ranman TP)	12.3	3.3
DuPont 1 (Curzate M68 fb Shirlan alt Curzate M68 then Shirlan)	17.9	12.7
Bayer 2 (Consento fb Curzate alt with Sonata)	20.8	10.1
Bayer 1 (Consento fb Curzate M then Sonata)	30.3	9.0

Discussion

Early season fungicide use

The choice of fungicide for the first few sprays in a programme is often difficult for growers. It is difficult 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 & Auchincruive in 2003 clearly demonstrated that early fungicide treatments in the presence of blight inoculum can have an impact on the subsequent development of an epidemic. Similar results were recorded in 2004 confirming earlier findings. The effects of these fungicide treatments at both sites were again seen much later in the season. However, at Rosemaund, the differences between fungicide chemistry were not evident as in 2003.

The efficacy of Sonata in the Auchincruive trial matched the good control of foliar blight demonstrated in the same trial at Rosemaund in 2003. At Auchincruive there were no significant differences in the control of tuber blight. This contrasts with the 2003 trial at the same site in which early sprays of Shirlan and Sonata gave better control of tuber blight than some of the other fungicides. The difference between the 2003 and 2004 results is not related to the period of tuber protection required. In 2004 the interval between the fourth application of fungicide and tuber blight being detected was 33 days whereas in 2003 this interval was 64 days. The explanation for the lack of differences between fungicides in 2004 is probably that the very high number of zoospores washed down into the soil during the 2004 growing season overwhelmed the fungicides. In 2004, compared with 2003, there was much more foliar blight, a larger number of Smith Periods and considerably more rain.

Evaluation of fungicides & fungicide programmes.

In these trials the number of fungicide treatments applied throughout the canopy stable period (core treatments) through to senescence 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**.

The manufacturers' fungicide programmes were far too robust for the low disease pressure recorded at Rosemaund and despite a strong disease challenge as demonstrated by the epidemic in the untreated plots, differences between the core treatments and the manufacturer's programmes were minimal. Treatment effects at such low levels of foliar blight should be treated with caution.

Despite the low levels of foliar blight at Rosemaund and the 'slow blight epidemic', there was an extremely high incidence of tuber infection. This presents an extremely good example of the relationship between inoculum levels, exposure period and high tuber infection. This in itself is a strong knowledge transfer message to the GB industry and is a reminder of the need to maintain fungicide programmes up to and after the haulm desiccation stage.

Canopy stable (core) treatments with Ranman TP, Electis & Shirlan significantly reduced the incidence of tuber blight compared with the unsprayed control at Rosemaund ($P<0.05$) although there were no significant differences between these three treatments ($P>0.05$). Curzate M & Invader did not reduce the incidence of tuber blight compared with the unsprayed control.

There were also some significant differences between the manufacturer sponsored spray programmes in the incidence in tuber blight ($P<0.05$). The most effective spray programmes were BASF1, Sipcam1, DuPont 2, and the Syngenta and Belchim programmes. These spray programmes contained Shirlan, Electis, RanmanTP or combinations thereof.

The foliar blight results from the Auchincruive trial are from one trial in one growing season. It is important to stress that the relative efficacies of the different fungicides in controlling blight may be different under different circumstances.

Fungicides with limited curative activity, e.g. Curzate M and Invader, were expected to give very good foliar blight control because the high number of Smith Periods would provide opportunities for curative action. This result has been observed previously. However, the timing of their application in the 2004 trial (on 2, 11, 20 and 28 August and 6 and 14 September) was such that curative activity was limited. Three of the sprays, S1, S4 and S6, were applied when there was no opportunity for curative activity. The other three sprays, S2, S3 and S5, could only be applied 2, 3 and 2 days after Smith Periods, respectively.

If the curative properties of the fungicides weren't tested then what properties were? The most critical spray was that applied on the 11th of August, i.e. only the second of the test fungicides. The spray interval between the first and second applications of the test fungicides was extended to 9 days because of the weather conditions (Table 22). There was exceptionally high rainfall at an unfortunate time, i.e. 7 and 8 days after the first application of the test fungicides. This considerably reduced the fungicide protection of the plants. In addition there was an extended Smith Period between the 8th and 12th of August. These conditions suggest that the ability of the fungicides to persist on the haulm and also to resist wash off were the key properties being tested.

TABLE 22. CIRCUMSTANCES OF THE CRITICAL SECOND SPRAY OF THE DIFFERENT FUNGICIDES

Date	8th	9th	10th	11th	12th
Smith conditions	P	P	P	P	P
Rainfall (mm)	9.8	48.2	38.2	1.6	5.6
Days after previous spray	6	7	8	9/0	1

The grouping of the core treatments in terms of foliar blight control quite closely reflected the relative rainfastness of the fungicides attributed by the fungicide sub-group of EU.NET.ICP (Bradshaw, 2004).

There are two important knowledge transfer messages from the 2004 results. Firstly, it is important for growers to appreciate that different fungicide products have different strengths and weaknesses, and these need to be known in order to use the most appropriate fungicide(s) for the circumstances. Secondly, fungicides with curative activity can only be curative if applied sufficiently soon after high-risk conditions. Timely information on local high-risk periods is vital to their successful use.

The close relationship between the severity of foliar blight in September and the total incidence of tuber blight demonstrated that the effect of fungicides on tuber blight control can be indirect in addition to being direct. Also the strong correlation between tuber blight results for both sites was surprising because the indirect effect of the fungicide programmes on tuber blight was being evaluated in the Auchincruive trial whereas in the Rosemaund trial it was essentially the direct effect that was being tested, because of the similar severities of foliar blight for most treatments.

Future work should continue with greater flexibility in spray intervals of the fungicide programmes to allow differences between fungicides to be demonstrated. There is a strong case to evaluate fungicides at both high and low blight risk intervals i.e. at both 7 & 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

- As shown in 2003, there was a clear benefit in 2004 from the early use of fungicides for the control of foliar blight even when disease pressure was not severe.

- The benefit from early fungicide use remained evident for a period of time and treatment effects were recorded well after they had been applied. This suggests that fungicides were suppressing blight inoculum before visible symptoms became evident.

- There were no differences in the effectiveness between any of the fungicides tested.

Auchincruive

- Where disease pressure was low during the period that the fungicides were applied but high afterwards, there was a clear benefit from the early use of fungicides for the control of foliar blight but no benefit for tuber blight control.

- Sonata gave prolonged good control of foliar blight compared with the other fungicides. This confirmed a similar result with Sonata at Rosemaund in 2003.

- Unlike 2003 in the Auchincruive trial, the different fungicide treatments had no effect on the incidence of tuber blight.

These results do not change the current advice to UK 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 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 & fungicide programmes (protocol 2)

Rosemaund

- Under low blight risk conditions almost 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 Ranman TP, Electis, Shirlan and combinations of these fungicides in the manufacturers spray programmes.

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

Auchincruive

- There were many, often large, differences between fungicide programmes in the control of foliar and tuber blight.

- The results obtained in the trial may not be typical for the fungicide products. The weather pattern in 2004 was unusual, and the trial tested the persistence of products and their ability to withstand removal from the plant by exceptionally high rainfall. There were no opportunities for kick back activity.

- The effectiveness of the core treatments in terms of foliar blight control quite closely reflected the relative rainfastness of the fungicides.

- Fungicides with curative activity can only be curative if applied sufficiently soon after high-risk conditions.

- There was a close relationship between the severity of foliar blight in September and the total incidence of tuber blight.

- There was a strong correlation between the tuber blight results for the fungicide treatments at Rosemaund and Auchincruive.

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ACHIEVEMENT OF MILESTONES

The following milestones were achieved

Evaluation of early season application of fungicides for the control of potato blight 2004

a) May/ June - mark out plots in a previously established crop of potatoes.

b) June-July - apply spray treatments according to the protocol and assess the progress of the foliar blight epidemic.

Evaluation of fungicides and fungicide programmes for the control of potato blight 2004

a) May / June - mark out plots in a previously established crop of potatoes.

b) June-September - apply spray treatments according to the protocol and assess the progress of the foliar blight epidemic.

c) September/October - harvest the experiment and measure total ware yield (>35 mm).

d) Assess stored ware tubers for tuber blight

SUMMARY OF TECHNOLOGY TRANSFER AND PROJECT DELIVERABLES

Nick Bradshaw "Fight against Blight Campaign – are we getting it right?" Participative workshop at BPC Seed Industry Conference, 11-12 November, Crieff.

Ruairidh Bain "Blight R & D update" SAC Potato Crop Study Group meeting, 7 December 2004, Bush Estate, Penicuik, Midlothian.

Nick Bradshaw & Ruairidh Bain "Blight fungicides" EUCABLIGHT UK Forum, 19 January 2005, CSL York.

Ruairidh Bain "Horses for courses". Potato Newsletter, March 2005.

Results are also available on www.potato.org.uk

APPENDIX I

Plot layout of the early season fungicide trial at ADAS Rosemaund 2003

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

Plot layout of the early season fungicide trial at SAC Auchincruive 2003

Orientation: ↑ Met. Office station

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

Appendix I (Cont'd)

Plot layout of the fungicide programme evaluation trial at ADAS Rosemaund, 2003

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

Plot layout of the fungicide programme evaluation trial at SAC, Auchincruive, 2003

Orientation: ↑ Met. Office station

20	1	2	5	12	20	7	4
5	13	9	15	10	14	9	16
15	18	8	18	7	9	12	1
12	11	19	3	6	19	5	20
8	3	1	11	8	17	10	11
19	14	4	17	2	5	3	2
6	17	16	20	16	3	19	13
10	4	6	7	18	13	17	18
9	16	12	14	11	15	14	15
2	7	10	13	4	1	6	8