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Development of spray strategies to control late blight, 2003-2006.

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Introduction

Late blight is the most devastating disease of potato in The Netherlands. The new and more aggressive *P. infestans* population requires even more alertness than in the past. The potato crop is usually sprayed between 8 and 14 times. Timing and choice of fungicide are key factors to control late blight successfully. An adverse effect of spraying is the environmental burden by emission of the fungicides to the environment. Experiments were set up to compose strategies to improve late blight control. Besides the main objective of effectiveness, the environmental effects of the sprayings, the risk and the costs were evaluated. The possibility to reduce the dose rate of Shirlan on more resistant cultivars was especially implemented in 2006. Spray strategies were tested by Applied Plant Research at different locations throughout the Netherlands, during four years. The locations were chosen considering the climatic conditions, purpose of potato cultivation, disease pressure and type of soil. During and after the experiments farmers were informed at the internet site www.kennisakker.nl.

Materials & Methods

To compose a spraying strategy the characteristics of the fungicides have to be adjusted to the growing stage of the potatoes and external circumstances as weather conditions and disease pressure. Therefore the season was divided into two growing stages presented in Figure 1.

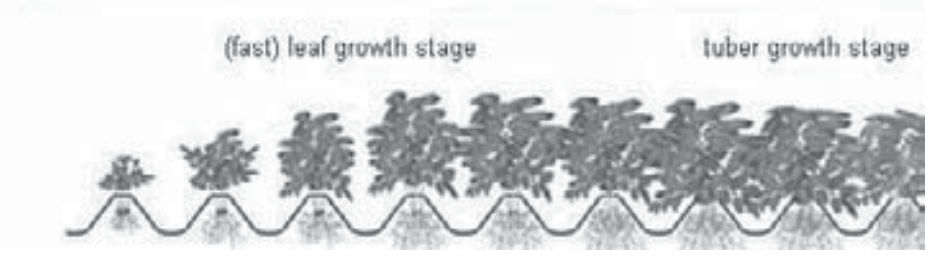

Figure 1. The growing season split up in two growing stages; the (fast) leaf growth stage and the tuber growth stage.

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Fungicides, which have the capacity to protect newly grown leaves, were used in the early stage of the growing season. Fungicides with tuber protecting characteristics were used in the second part of the growing season. The experiments were carried out at 5 locations (Table 1), during 2003 - 2005.

Table 1. Design of the experiments carried out from 2003 until 2005.

location	cultivar	leaf resistance	tuber resistance	purpose	Soil type
Lelystad (Flevoland)	Agria	5.5	7.5	Ware	clay
Valthermond (Drenthe)	Karakter	6.0	5.0	Starch	peat
Kollumerwaard (Friesland)	Asterix	5.0	8.5	Ware	clay
Westmaas (Zuid-Holland)	Agria	5.5	7.5	Ware	clay
Wijnandsrade (Limburg)	Lady Olympia	3.0	4.5	Ware	peaty soil

The spraying strategies were carried out as presented in Tables 2 and 3. Dose rates used were usually the recommended dose rates.

Table 2. Spraying strategies carried out at Lelystad, Kollumerwaard, Wijnandsrade and Westmaas; 2003 - 2005.

strategy	(fast) leaf growth			Tuber filling	
A	According to good agricultural practise				
B	Spraying with Shirlan				
C	Shirlan	Tanos (3x)	Ranman (3x)	Shirlan	Ranman (3x)
D	Shirlan	Fubol Gold (2x)	Curzate M	Shirlan	Ranman (3x)

Table 3. Spraying strategies carried out at Valthermond; 2003 - 2005.

strategy	(fast) leaf growth			Tuber filling	
A	According to good agricultural practise				
B	Spraying with Shirlan				
C	Curzate M	Curzate M	Curzate M	Curzate M	Curzate M
D	Dithane NT	Dithane NT	Dithane NT	Dithane NT	Dithane NT

Spray strategies were linked to cultivar resistance in 2006. Results of experiments lowering the dose rate according to the degree of cultivar resistance were used. The dose rate of Shirlan used was lower when highly resistant cultivars were grown. The experiments were carried out at Lelystad, Valthermond and Westmaas. Spraying strategies using local cultivars were carried out as presented in Tables 4 and 5.

Table 4. Spraying strategies carried out at Lelystad and Westmaas; 2006.

strategy	Cultivar	(fast) leaf growth	Tuber filling	
A	Bintje	0.4 l/ha Shirlan	0.4 l/ha Shirlan	
B	Agria	0.3 l/ha Shirlan	0.4 l/ha Shirlan	
C	Innovator	0.2 l/ha Shirlan	0.3 l/ha Shirlan	
D	Agria	Curzate M	0.4 l/ha Shirlan	
E	Agria	Valbon	Sereno	Ranman 3x

Table 5. Spraying strategies carried out at Valthermond; 2006.

strategy	Cultivar	(fast) leaf growth	Tuber filling
A	Seresta	As practise	
B	Karakter	0.4 l/ha Shirlan	0.4 l/ha Shirlan
C	Seresta	0.2 l/ha Shirlan	0.3 l/ha Shirlan
D	Festien	0.1 l/ha Shirlan	0.2 l/ha Shirlan
E	Seresta	Dithane NT	Dithane NT
F	Seresta	Curzate M	Curzate M

The number of spray applications, the number of spraying points, the amount of active ingredients used and the effect of fungicide sprays on the environment was established. Spraying points were calculated by multiplying the number of spray applications with the average relative dose rate compared to the full dose rate as permitted under Dutch legislation. Fungicides are rated for their effect on the environment (air, soil water, surface water and soil). Environmental effect of each strategy was established by adding up the effect of each separate spray application on each of the different aspects of the environment. Disease development was assessed weekly. Yield and tuber blight were established at the end of the season.
Data were analyzed using Genstat 9th edition.

Results

2003
The summer of 2003 was very warm and dry. Late blight was not found. Under these circumstances all strategies were very effective.

2004 and 2005
In both summers of 2004 and 2005 the weather conditions were favourable for the development of late blight. In these years there were no differences in effectiveness on leaf blight between the strategies applied. Tuber blight occurred in 2004 only. Table 6 shows the percentage tuber blight found after applying different late blight control strategies. Tuber blight incidence was not significantly different between the different spray strategies except for Valthermond.

Table 6. Effect op spray strategies on tuber blight incidence in 2004.

Spray strategy	% tuber blight at different sites				
	Lelystad	Kollumerwaard	Westmaas	Wijnandsrade	Valthermond
A	1.5	0	< 0.1	0	3.9 a
B	< 0.1	0	< 0.1	0	1.9 ab
C	0	0	0	0	0 b
D	< 0.1	0	< 0.1	0	2.4 ab

2006
The summer of 2006 (July) was very warm and dry and August was very wet. The wet August resulted in a high disease pressure during almost the whole of the month August. Infection was limited to several leaves per plot only, despite the high disease pressure in August 2006. This indicates that the strategies to control late blight were effective. When cultivars with a certain level of resistance were grown, the dose rate of Shirlan could be lowered accordingly.

Experiments showed that when in the foliage late blight lesions were observed and there is regularly rainfall, tuber protecting fungicides had to be sprayed.

The effect of spray applications in 2006 on the environment are presented in Table 7. The requirement to water organisms was not met in any of the strategies.

Table 7. The spraying strategies and their environmental impact in the experiment in 2006 at Lelystad.

strategy	number of sprayings	dose rate of the sprayings	spraying points	kg/ha active ingredient	exposure to the air	exposure to water organuisms
quality objective					0.7	0
Strategy A Bintje	14	14*1	14	2.8	0.89	100
Strategy B Agria	14	4*0.75 / 10*1	13	2.6	0.84	100
Strategy C Innovator	14	4*0.5 / 10*0.75	9.5	1.9	0.62	100
Strategy D Agria	16	16*1	16	9	0.78	62
Strategy E Agria	14	14*1	14	9.3	0.25	71

Discussion and conclusions

Spray strategies had no effect on yield. Probably because no difference in late blight control was found between the control strategies applied. Yield differences were found in 2006. However differences in yield were associated with the cultivar used and did not depend on the spray strategy (data not shown).

The past 4 years in which the experiments were carried out showed that the timing of the spraying moment is very important. The spraying moment depends primarily on the weather conditions, the disease pressure and the time since the last spray was carried out. On the whole all strategies gave an acceptable control of late blight under circumstances found in the agricultural practice. Some singinificant tuber blight was found only at Valthermond in 2004.

Dose rate reduction based on the resistance level of the cultivar proved to be possible. Timing of the fungicide application however is crucial. Lowering of the dose rate saves the farmer money.

Depending upon the growth stage a suitable fungicide has to be sprayed. For instance when it is supposed that the disease pressure originates from latently infected tubers which are expressed by stem infection, cymoxanil containing fungicides or Fubol Gold are advised to spray. The type of fungicide is also crucial when leaf blight is observed and (heavy and/or long lasting) rainfall is predicted. In that case it is necessary to spray the crop with tuber protecting fungicides. An example of that was shown in 2004 at Valthermond (Table 6).

Due to yearly adjustments of the spray strategies the environmental burden decreased during the research period. This was partly caused by exploiting the possibility of dose rate reduction in resistant cultivars. Also the effect of mancozeb on the environment was re-evaluated. The effect on air, soil water and soil was less when strategies based on fluazinam were used compared to the other strategies. Fluazinam has some effect on life in the surface water however.

In 2007 experiments will continue and will be carried out comparable to the 2006 experiment at 7 locations. The aim is to show farmers the possibilities of exploiting cultivar resistance by lowering the dose rate of the fungicide applied. Also the effect of spray strategies on early blight will be investigated.