Eighth Workshop of an European Network for development of an
Integrated Control Strategy of potato late blight
Jersey, England/France, 31st of March – 4th of April 2004

DSS development focussed on variety resistance in The Netherlands, 2003

H.G. SPITS[1], J.G.N. WANDER[1] AND G.J.T. KESSEL[2]

[1] Applied Plant Research (PPO), P.O. Box 430, 8200 AK Lelystad, The Netherlands

[2] Plant Research International, P.O. Box 16, 6700 AA Wageningen, The Netherlands

Summary

In the Netherlands, potato late blight DSS's are important tools for future reductions of the chemical input. Possibilities to adapt recommendations to an increasing public and governmental environmental awareness include exploration of possibilities to incorporate variety resistance in a better way. Thus, the current potato late blight control efficiency could be maintained while at the same time the chemical input is reduced. With this objective the 2003 trials in the Netherlands were conducted.

Standard and experimental versions of the commercially available DSS's PLANT-Plus and ProPhy were incorporated in two field experiments together with a WUR-experimental system using infection efficiency to determine the dose rate and PLANT-Plus to determine the timing of applications. Four potato varieties, differing in resistance to potato late blight, were incorporated in the experiment.

Standard versions of ProPhy and PLANT-Plus hardly differentiated between varieties regarding the number of sprays and the dose rate of Shirlan. PLANT-Plus experimental reduced the number of sprays on more resistant varieties. ProPhy experimental reduced the number of sprays as well as the average Shirlan dose rate on more resistant varieties.

Keywords: *Phytophthora infestans*, variety resistance, decision support systems, potato late blight, fluazinam

PPO-Special Report no. 10 (2004), 215-222

Introduction

During the period 1999 - 2001 each year, 3 trials were conducted in the Netherlands to compare and validate European Decision Support Systems (DSS). In 2002 and 2003 this field evaluation continued focussing on possibilities to incorporate variety resistance into DSS systems. The aim was to exploit moderate and high variety resistance to *Phytophthora infestans* to reduce fungicide dose rates.

Materials and methods

In 2003 two trials were conducted. Both trials were set up as randomised block experiments including three replications, four potato cultivars and five different DSS's per experiment. Fertilisation, insecticides and herbicides were applied according to good agricultural practice. The weather during these trials was hot and dry. As a result, disease pressure and disease severity in the trials was low.

Trial one was located on a loamy soil in Lelystad, The Netherlands. Trial two was located on a peaty soil in Valthermond, The Netherlands. Commercial and experimental versions of ProPhy and PLANT-Plus and the WUR experimental system were included in both trials. In Lelystad potato cultivars Bintje (3/4.5), Santé (4.5/7), Agria (5.5/8) and Aziza (7.5/8) were included. In Valthermond potato cultivars Bintje (3/4.5), Starga (5.5/4.5), Seresta (7/8) and Karnico (8/6.5) were included. Ratings between brackets represent foliar and tuber resistance to potato late blight respectively. Plot sizes were 10.5 x 10 m gross and 4.5 x 8 m net in Lelystad and 12 x 9 m gross and 10 x 4.5 m net in Valthermond. Seed tubers were planted on ridges at 75 cm between ridges and 32 cm within the ridge. Eighty percent emergence was reached on 30 May in Lelystad and on 26 May in Valthermond. Trials were desiccated on 2 and 3 September in Lelystad and Valthermond respectively. Both trials were not harvested because hardly any late blight was observed.

Fungicides used in the experiments were: Shirlan Flow (50 % a.i. fluazinam), Tanos (25 % a.i. cymoxanil, 25 % a.i. famoxadone) and Curzate M (4.5% a.i. cymoxanil, 68% a.i. mancozeb). Shirlan was applied at variable dose rates, Tanos at 0.6 kg/ha and Cuzate M at 2.5 kg/ha.

Application of the DSS's

The systems were consulted daily (before 9:30 A.M.) except on Sundays. Experimental versions of ProPhy and PLANT-Plus were built by Opticrop and Dacom. Aim of all

experimental systems (including the WUR experimental system) was to minimise the fungicide input on resistant varieties.

A Dacom automated weather station was situated within 1 km of both trials. Opticrop automated weather stations were situated in the trial at Lelystad and at a distance of about 2 km in Valthermond. Hourly measurements of air temperature, precipitation, relative humidity, wind direction and wind speed at 150 cm height measured by Dacom weather stations were used for PLANT-Plus. For ProPhy, these measurements were provided by the Opticrop weather stations and supplemented by in crop measurements on temperature and relative humidity. PLANT-Plus and ProPhy both used 3-hourly, five-day regional weather forecasts.

ProPhy

The 2003 version of ProPhy (CROP 2003, version 3.1) was used. ProPhy recommends the type of fungicide, spray interval and dose rate for individual varieties. Fungicide and dose rates were used according to recommendation. Timing of the spray application in this trial was dictated by the interval recommended for the least resistant variety. Thus all varieties were sprayed at the same moment with potentially different dose rates.

ProPhy-experimental

ProPhy experimental provides the same functionality as the ProPhy standard version with the following differences:

1) possibility to postpone the first spray,
2) resistant varieties are protected longer (until flowering),
3) a lower dose rate has no effect on the protection period,
4) overruling from the calculated disease pressure is reduced and
5) the minimum dose rate recommended on resistant cultivars is lower.

PLANT-Plus

The Windows version 4.01 of PLANT-Plus was used. Spray interval and recommended fungicide were calculated independently for the individual varieties. A recommendation was followed when the threshold of 200 was exceeded. The first spray was carried out when the advice "consider first spray" (threshold 50 points) was given.

PLANT-Plus-experimental

PLANT-Plus-experimental provides the same functionality as the PLANT-Plus standard version with the following differences:

1) A recommendation was only followed when "carry out a spray today" was advised.

2) The threshold triggering a spray recommendation was higher on more resistant varieties.

WUR experimental system

Spray intervals were calculated by PLANT-Plus-experimental. Shirlan was always used, irrespective whether a spray recommendation could be followed immediately or had to be postponed (except for Bintje). The Shirlan dose rate was based on the level of resistance: Bintje 0.4 l/ha, Agria and Starga 0.32 l/ha, Santé 0.24 l/ha, Seresta 0.16 l/ha and Aziza and Karnico 0.08 l/ha.

Results

Sprays

With ProPhy all varieties were sprayed on the same day. In Lelystad the average dose rate recommended for Aziza was lower than the average dose rate for Bintje (Table 2). In Valthermond the average dose rate for Bintje and Starga was the same. Average dose rates were also the same for Seresta and Karnico. However, the average dose rate for Seresta and Karnico was lower than for Bintje and Starga. On both locations ProPhy-experimental resulted in a reduction of the number of sprays as well as a lower average dose rate on varieties with a higher level of resistance.

Table 2. Average dose of Shirlan (l/ha) on ProPhy and ProPhy-experimental and the total number of sprays (between brackets) in Lelystad and in Valthermond.

Trial site	Lelystad			Valthermond	
Variety ↓	ProPhy	ProPhy exp.	variety ↓	ProPhy	ProPhy exp.
Bintje	0.40 (9)	0.36 (9)	Bintje	0.40 (8)	0.35 (7)
Santé	0.40 (9)	0.30 (8)	Starga	0.40 (8)	0.33 (7)
Agria	0.39 (9)	0.26 (8)	Seresta	0.33 (8)	0.29 (6)
Aziza	0.31 (9)	0.21 (7)	Karnico	0.33 (8)	0.22 (6)

The average dose rate and the number of recommended sprays for PLANT-Plus is given in Table 3. In Lelystad differences in the number of spray applications was small. In Valthermond the number of recommended sprays for Bintje and Starga (10) was the same. The number of recommended sprays for Seresta and Karnico (9) was the same for both varieties and 1 spray less than recommended for Bintje and Starga.
On both locations the use of PLANT-Plus-experimental resulted in a decrease of the number of applications on varieties with a higher level of resistance.

The timing of spray applications for the WUR-experimental system was based on PLANT-Plus-experimental (cv. Bintje). The more resistance varieties were sprayed with a fixed and reduced dose rate (Table 4).

Table 3. Average dose of Shirlan (l/ha) on PLANT-Plus and PLANT-Plus-experimental and the total number of sprays (between brackets) in Lelystad and in Valthermond

Trial site	Lelystad		Valthermond		
Variety ↓	PLANT-Plus	PLANT-Plus exp.	variety ↓	PLANT-Plus	PLANT-Plus-exp.
Bintje	0.40 (7)	0.40 (7)	Bintje	0.40 (10)	0.40 (8)
Santé	0.40 (8)	0.40 (6)	Starga	0.40 (10)	0.40 (8)
Agria	0.40 (8)	0.40 (6)	Seresta	0.40 (9)	0.40 (5)
Aziza	0.40 (8)	0.40 (5)	Karnico	0.40 (9)	0.40 (6)

Table 4. Average dose of Shirlan (l/ha) on WUR-experimental system and the total number of sprays (between brackets) in Lelystad and in Valthermond.

Variety ↓	Lelystad	Variety ↓	Valthermond
Bintje	0.40 (7)	Bintje	0.40 (8)
Santé	0.24 (7)	Starga	0.32 (8)
Agria	0.32 (7)	Seresta	0.16 (8)
Aziza	0.08 (7)	Karnico	0.08 (8)

Late blight

Due to the hot and dry weather, conditions for disease development were unfavourable (Table 5). The number of lesions per plot was calculated based on the number of lesions counted in four rows per plot. In Lelystad hardly any infection was found. In Valthermond some infection was found but severity levels generally remained very low.

Table 5. Calculated number of infected leaflets per DSS in Lelystad and Valthermond at 28 august 2003.

Lelystad	Variety:	Bintje	Santé	Agria	Aziza
DSS:	ProPhy	0.3	0.0	0.0	0.0
	ProPhy-experimental	0.0	5.1	0.0	0.0
	PLANT-Plus	0.0	0.0	0.0	0.0
	PLANT-Plus-experimental	0.0	0.0	0.0	0.0
	WUR-experimental	0.0	3.7	0.0	0.3

Valthermond	Variety:	Bintje	Starga	Seresta	Karnico
DSS:	ProPhy	0.0	0.0	0.0	0.3
	ProPhy-experimental	7.0	23.6	0.0	11.6
	PLANT-Plus	0.0	0.0	1.3	0.0
	PLANT-Plus-experimental	0.0	1.7	8.0	38.6
	WUR-experimental	0.0	0.0	0.0	0.3

Discussion

Experimental DSS's were developed to explore options to incorporate variety resistance into warning systems such that the chemical input can be reduced on more resistant varieties. Field trials were carried out in which three experimental systems were compared to two, Dutch, commercially available DSS's. The WUR-experimental system used infection efficiency (IE) to adapt the Shirlan dose rate for each of the potato cultivars. Both commercial DSS's modified their basic principles underlying the systems to allow incorporation of cultivar resistance.

Experimental plots did not have to remain blight free throughout the season, thus stimulating the experimental systems to pursuit a maximum reduction of the fungicide input and explore the limits to this approach at the same time.

WUR experimental system: Assuming that IE is the most important parameter regarding cultivar resistance when using a preventive control strategy, laboratory estimates of this quantitative trait should provide some insight into the possibilities to decrease the dose rate of protectant fungicides. IE estimates as determined by W. Flier (PRI, The Netherlands, pers. comm.) in a laboratory assay are given in Table 6. The low late blight resistance for Bintje (3) corresponds with a high IE. The relatively low resistance rating of Santé (4.5) however does not correspond very well with the relatively low IE found in the laboratory experiment. Also the high resistance rating of Seresta (7) does not correspond with the relative high IE. These

differences accentuate the difference between resistance ratings based on poly-cyclic and mono-cyclic infection events.

Apart from the cultivar, the foliar fungicide concentration, the micro-climate and the disease pressure also affect the infection risk at any time during the growing season. In this context, it makes sense to determine the "effective IE" on cultivars sprayed with different dose rates and determine the time course of this effective IE as influenced by climate and disease pressure. The effective IE for any cultivar should always be equal or remain below the effective IE for a susceptible cultivar sprayed with a protectant at its recommended dose rate near the end of the protection period.

Table 6. Infection efficiency (IE) of *P. infestans* on different cultivars (W.G. Flier, PRI, Netherlands).

Cultivar	IE (prob.)	Foliar resistance
Aziza	0,014	7,5
Karnico	0,017	8
Starga	0,020	7
Agria	0,022	5,5
Sante	0,023	4,5
Seresta	0,029	7
Bintje	0,037	3

PLANT-Plus: Remarkably, the number of sprays on the susceptible variety Bintje at PLANT-Plus in Lelystad was less than for the more resistant varieties (Table 2). In retrospect, this can be explained by a more optimal placement of spray applications over the whole growing season on Bintje than on any of the other cultivars: During a high risk period, Bintje was sprayed more recently than any of the other cultivars and did not exceed its critical threshold. Whereas a spray recommendation was triggered on the other cultivars. The next spray recommendation for Bintje coincided with a recommendation on the other cultivars.

In Valthermond PLANT-plus-experimental recommended one spray more recommended for the most resistant variety (Karnico) than for the less resistant variety (Seresta). The explanation for this is that in the plots of Karnico some attack by late blight was observed. This attack was incorporate in the system and led to an extra spraying advice.

ProPhy: With ProPhy, all varieties were sprayed at the same moment with potentially

different dose rates. In Lelystad differences in dose rate between the varieties Bintje, Santé and Agria were not observed. Most likely the biological demolition of the fungicide is more important in the recommendation than the variety resistance under a low disease pressure. Which result in almost de same recommendations (Table 1).
In Valthermond, spraying Starga according to ProPhy-experimental resulted in more infected leaflets than in the susceptible variety Bintje, while timing and dose rate of the recommended sprays were the same. The explanation for this was that only in one of the Starga plots a small focus of infection was found. The other plots of Starga were free of infection.

Due to the hot and dry weather conditions during the 2003 growing season the number of spray applications was generally low. At the end of the growing season this led to a large spray interval of 31 days for PLANT-Plus-experimental in Lelystad. In both trials the final level of late blight severity was also low. In Valthermond most infected leaflets were found in plots sprayed according to the experimental DSS's. As compared with the standard versions the stretched spraying intervals (in combination with a lower dose rate for ProPhy) on the resistant varieties most likely exceeded the safety limits at least in some instances. The lowered Shirlan dose rates did probably not contribute too much to this level of infection since there was no infection found in the plots sprayed according the WUR-research tool.

Both trials showed that it is possible to reduce the chemical input in more resistance varieties. More detailed knowledge on the effective IE and its time course following a spray application as influenced by weather and disease pressure will enable more specific recommendations and explanation of the current results. More field research has to be done to determine whether these results are consistent under a wider range of disease pressure.