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DSS field evaluation focussed on variety resistance in The Netherlands, 2002

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Summary

DSS's in the Netherlands for management of potato late blight are of a very good quality, but the possibilities to improve recommendations by including data regarding variety resistance can probably be exploited in a better way. This could lead to a more efficient control of blight and possibly in a further reduction of fungicide input. With this objective the 2002 trials in the Netherlands were conducted. With the DSS's PLANT-Plus, ProPhy and the research tool WUR-Blight five varieties were tested.

Prophy and PLANT-Plus did hardly differentiate between the varieties in the number of sprays and the dose rate of Shirlan.

Degree of tuber blight infection seemed to depend on degree of leaf blight at the end of the growing season and the input of Shirlan sprayed in this period

Key words: *Phytophthora infestans*, variety resistance, decision support systems, tuber blight, fluazinam

Introduction

In the years 1999 until 2001 yearly 3 trials were conducted in the Netherlands to compare and validate Dutch and foreign Decision Support Systems (DSS). In 2002 the field evaluation of DSS focussed on variety resistance. How to use and exploit moderate and high resistance for *Phytophthora infestans* is a challenge to further improve DSS's.

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In 2002 two trials were conducted. The trial situated at Valthermond is not discussed in this paper because of very low infection levels, although the disease pressure in the surrounding fields was very high.

Materials and methods

Trial site, experimental set-up and weather data

The trial was set up on a loamy soil at Lelystad, The Netherlands. In the trial the DSS's Prophy and PLANT-Plus and the DSS research tool WUR-Blight (Kessel *et al.*, 2003) were tested on the varieties (late blight resistance foliage/tuber): Bintje (3/4.5), Santé (4.5/7), Agria (5.5/8), Remarka (6.5/8.5) and Aziza (7.5/8). Plot size was 10.5 x 10 m gross and 4.5 x 8 m net. Potatoes were planted on ridges on a distance of 75 cm and 32 cm in the ridge on April 25. Eighty percent of the plants were emerged on June 4. The trial was desiccated on August 29 and harvested on September 23.

When the development of Phytophthora in a plot clearly exceeded the average level of infection in the other plots, the crop on this plot was desiccated. All experiments were set up as randomised block treatments with three replications. The log-transformed data of the calculated infection percentages and percentages tuber blight were statistically analysed using ANOVA of GENSTAT 5, release 6.1.

Tuber blight was only estimated on plots, which were not early desiccated.

Fertilisation, insecticides and herbicides were applied according to good agricultural practice.

Distance to the automatic weather station of DACOM was less than 1 km. The Opticrop weather station was situated in the trial. Hourly values of air temperature, precipitation, relative humidity, wind direction and wind speed at 150 cm height measured by DACOM stations were used for PLANT-Plus and WUR-Blight. Hourly data as mentioned before and on temperature and relative humidity in the crop measured by Opticrop stations were used for ProPhy. PLANT-Plus and ProPhy both used 3-hourly successively hourly regional weather forecasts for five consecutive days.

The fungicides used were Shirlan Flow (50 % a.i. fluazinam), Aviso DF (4.8 % a.i. cymoxanil, 57 % a.i. metiram) and Tattoo C (375 g/l a.i. chlorothalonil, 375 g/l a.i. propamocarb hydrochloride) in a variable dose for Shirlan, 2.5 kg/ha for Aviso DF and 2,7 l/ha for Tattoo C.

Observations

Disease observations were carried out weekly. The first disease observation was carried out on June 18, the last on August 29. The number of diseased leaflets, petioles and stems on four ridges of net length of the plots were counted (Wander and Spits, 2002). Yield was not assessed. A tuber sample of 18 m^2 out of the net plot was stored for some weeks at 15 °C. In this sample the number of potatoes with a lesion or lesions of Phytophthora were counted.

Use of the DSS's

The systems were consulted daily (before 9:30 A.M.) except on Sundays. The farm manager decided how to interpret the recommendations made by Prophy and PLANT-Plus.

Prophy

The 2002 version of Prophy (CROP 2002, version 2.8) was used. ProPhy gives full recommendation (recommended type of fungicide, interval, dose) for individual varieties. Fungicide and dose were used according to the recommendation, however in this trial the recommendation interval of the less resistant variety dictated the interval for all varieties.

PLANT-Plus

The Windows version 3.3 of PLANT-Plus was used. The spraying interval and recommended type of fungicide were calculated for each variety independently. A recommendation was only used when the threshold of 200 was exceeded.

WUR-Blight

The WUR-Blight version 1.0 was used. The program only calculated the date of spraying for a sensitive variety using the model SIMCAST (Kessel *et al.*, 2003). The fungicide used was always Shirlan, irrespective whether a recommendation could be followed immediately or had to be postponed due to weather circumstances. The dose of Shirlan used was based on the level of resistance: Bintje 0.4 l/ha, Santé 0.32, Agria 0.24, Remarka 0.16 and Aziza 0.08.

Results

Spraying schedule and infection percentage

Spraying schedules and infection percentages are shown in the figures 1, 2 and 3. ProPhy and

WUR-Blight both gave the first recommendation on June 6. PLANT-Plus gave the first recommendation 15 days later on June 21. The total number of sprayings per system was 9 for PLANT-Plus, 15 for ProPhy and 11 for WUR-Blight.
In table 1 the real infection percentages shown in figures 1, 2 and 3 are shown including significant differences. Desiccated plots are included in the average of a system / variety combination until the date of desiccation.
From the beginning of the season until mid August the infection level of PLANT-Plus / Bintje was higher than the infection level of the other varieties. From the beginning of August the infection percentage of PLANT-Plus / Remarka was higher than of Santé, Agria and Aziza.
The infection percentage of ProPhy / Remarka was significantly higher than on the other varieties on August 16. On August 29 the infection percentage of ProPhy / Bintje was significantly higher than on Santé and Agria.

Average dose Shirlan

The average dose of Shirlan sprayed according to the recommendation of ProPhy was 0.30 l/ha for Bintje, Santé and Agria, 0.28 l/ha for Remarka and 0.25 l/ha for Aziza. On Remarka, 4 out of 12 sprayings with Shirlan were with a reduced dose and on Aziza 7 out of 12.

Early desiccation

Table 2 shows the dates on which plots had to be desiccated because the level of infection clearly exceeded the average level of infection in the other plots. In this way a high spore pressure on the surrounding plots was prevented. On June 18 one of the plots of PLANT-Plus / Bintje had quite a severe infection. On this date only on one other plot of ProPhy / Santé a light infection was observed (table 1).
On July 26 one of the WUR-Blight / Remarka plots had to be desiccated. The two remaining plots still had a very low level in spite of the very low dose of Shirlan (0,16 l/ha).
After the desiccation on August 16 of one of the ProPhy / Remarka plots the two remaining plots of ProPhy / Remarka and the three plots of ProPhy / Aziza were desiccated by mistake on August 19 due to a wrong interpretation of the recommendation given by ProPhy.
For all systems none of the Santé and Aziza plots had to be desiccated.

Table 1. Calculated infection percentages and marks for significant differences based on log-transformed data.

System	Variety	18-6		25-6		3-7		11-7		18-7		25-7	
PLANT-Plus	Bintje	0.133	b[1]	0.187	b	0.472	b	0.430	b	0.842	c	0.469	ab
	Santé	0.000	a	0.005	a	0.000	a	0.003	a	0.005	a	0.015	a
	Agria	0.000	a	0.052	a	0.068	a	0.067	a	0.225	ab	0.259	ab
	Remarka	0.000	a	0.005	a	0.018	a	0.016	a	0.073	ab	0.231	ab
	Aziza	0.000	a	0.000	a	0.000	a	0.000	a	0.003	a	0.001	a
ProPhy	Bintje	0.000	a	0.000	a	0.000	a	0.000	a	0.009	a	0.055	a
	Santé	0.005	a	0.000	a	0.001	a	0.012	a	0.036	a	0.070	a
	Agria	0.000	a	0.000	a	0.000	a	0.004	a	0.037	a	0.099	a
	Remarka	0.000	a	0.000	a	0.000	a	0.001	a	0.013	a	0.095	a
	Aziza	0.000	a	0.000	a	0.000	a	0.003	a	0.005	a	0.020	a
WUR-Blight	Bintje	0.000	a	0.001	a	0.029	a	0.045	a	0.124	ab	0.149	ab
	Santé	0.000	a	0.000	a	0.000	a	0.001	a	0.001	a	0.010	a
	Agria	0.000	a	0.000	a	0.049	a	0.049	a	0.197	ab	0.355	ab
	Remarka	0.000	a	0.000	a	0.001	a	0.045	a	0.563	bc	13447.00	b
	Aziza	0.000	a	0.001	a	0.000	a	0.003	a	0.035	a	0.131	ab

Table 1 continued

System	Variety	2-8		9-8		16-8		22-8		29-8	
PLANT-Plus	Bintje	0.233	d	0.337	d	1.222	cd	0.478	a	2.000	abcd
	Santé	0.007	a	0.075	ab	0.319	abc	1.081	ab	1.763	ab
	Agria	0.115	abcd	0.269	cd	0.908	abcd	0.670	a	0.400	ab
	Remarka	0.147	bcd	0.268	cd	1.346	cd	8.000	c	8.500	bcd
	Aziza	0.000	a	0.001	a	0.019	a	0.154	a	0.197	a
ProPhy	Bintje	0.029	ab	0.100	abc	0.268	abc	0.820	ab	9.333	cd
	Santé	0.027	ab	0.100	abc	0.199	abc	0.503	ab	0.733	ab
	Agria	0.055	abc	0.070	ab	0.372	abc	1.063	ab	1.733	ab
	Remarka	0.041	abc	0.093	abc	1.933	d	-		-	
	Aziza	0.000	a	0.001	a	0.083	ab	-		-	
WUR-Blight	Bintje	0.086	abc	0.224	bcd	1.459	bcd	0.205	a	0.850	ab
	Santé	0.007	a	0.042	ab	0.146	abc	0.297	a	0.800	ab
	Agria	0.158	cd	0.286	d	1.116	cd	0.830	ab	2.500	abc
	Remarka	0.023	a	0.186	abcd	2.500	d	6.000	b	30.000	d
	Aziza	0.021	ab	0.045	ab	0.310	abc	0.685	ab	16.000	cd

[1] *Values in columns followed by the same letter are not significantly different (a= 0.05)*

Table 2. Dates of necessary early desiccation per plot.

	Bintje	Agria	Remarka
PLANT-Plus	18-6, 16-8	16-8	22-8
ProPhy			16-8
WUR-Blight	16-8	16-8	26-7, 16-8

First observation

In table 3 the dates are shown on which blight was first observed in a specific system / variety combination. In Bintje blight was observed first in PLANT-Plus and last in ProPhy. In Santé, blight was observed first in ProPhy and last in WUR-Blight. In Aziza, blight was observed first in WUR-Blight and last in PLANT-Plus.

Table 3. Dates of first observation of potato late blight.

	Bintje	Santé	Agria	Remarka	Aziza
PLANT-Plus	18-6	25-6	25-6	25-6	18-7
ProPhy	18-7	18-6	11-7	11-7	11-7
WUR-Blight	25-6	11-7	3-7	3-7	25-6

Tuber blight

Percentages tuber blight are shown in table 4. In PLANT-Plus and ProPhy, Bintje had significantly more tuber blight compared to the other varieties. In WUR-Blight Aziza showed the highest percentage.

Table 4. Percentage tuber blight per system and variety.

	variety	% tuber blight	
PLANT-Plus	Bintje	7.4	d[1]
	Santé	0.7	ab
	Agria	0.3	ab
	Remarka	0.1	a
	Aziza	1.0	ab
ProPhy	Bintje	2.8	cd
	Santé	0.6	ab
	Agria	0.5	ab
	Remarka	-	
	Aziza	-	
WUR-Blight	Bintje	0.9	abc
	Santé	0.2	ab
	Agria	0.1	a
	Remarka	0.4	ab
	Aziza	1.3	bc

[1] *Values in columns followed by the same letter are not significantly different (a= 0.05)*

Discussion

In the 2002 trial in Lelystad, PLANT-Plus gave the first recommendation 15 days later than ProPhy. This trend was also seen in other years cq trials. PLANT-Plus recommended the first spray 6 to 24 days (with a mean of 11 days) later than Prophy (Wander and Spits, 2002; Spits and Wander, 2001; Visser and Meier, 2000). Only in the 2002 trial at Valthermond no difference occurred. In the 1999, 2000 and 2001 trials the late first recommendation of PLANT-Plus did not cause problems with blight severity.

In the 2002 trial at Lelystad in 1 out of 3 PLANT-Plus plots with the variety Bintje blight was observed three days before the first recommendation cq spray. In this plot a calculated infection percentage of 0.14 occurred. There might be two reasons for the occurrence of this infection: (1) the model calculated a too low infection risk or (2) there was an unknown infection source. This second reason seems to be the most plausible. On the other hand several times before the infection was observed a high infection risk was calculated but the threshold of 200 was not exceeded. Using a lower threshold for the first recommendation can reduce the risk for an early infection. When the threshold of 50 is exceeded the program gives the recommendation to consider a spray. Before the first spray was recommended (at 200) this situation had occurred several times.

Directly after this first observation of blight, this information was imported in the program. Because of a low infection risk PLANT-Plus did not give a spraying recommendation until three days after the observation. Because of the high infection level and because the crop was still untreated, the infected plot was desiccated on the day of the first observation of blight. On the two replicate plots of PLANT-Plus / Bintje, blight was observed 4 days after the spray. Probably an infection had occurred on these two plots also before the first spray.

The infection level on the two remaining plots of PLANT-Plus / Bintje was on a relatively high level during the rest of the growing season. Because also several other plots in the trial were infected, it was decided not to desiccate these two plots. The infection level remained high probably by the fact that the second, third and fourth spraying recommendations had to be postponed with one or two days because of the weather circumstances. Also the long intervals between recommendations in the period mid July mid August might have contributed to remaining a high infection level. Mid August several other plots including a second plot of PLANT-Plus / Bintje were desiccated.

First observation of blight in ProPhy was June 18 in Santé, July 11 in Agria and July 18 in Bintje. The spraying schedule (recommendation, spraying date, dose and fungicide) was exactly the same for these three varieties except the erroneously postponed spray on June 24 on Santé. The late occurrence in Bintje is especially remarkable while this is the most susceptible variety.

The figures 1, 2 and 3 show a remarkable increase of the infection in all varieties and especially in Remarka after the observation on August 9. On all systems spray recommendations of August 3, 5 or 6 had to be postponed to August 7. So, in this period infections have occurred. The increase of the severity on Remarka (late blight resistance 6.5) and Agria (5.5) were about the same as on Bintje (3). Probably the ageing of the plants had a stronger effect on the decrease of the resistance on Remarka and Agria than on the other varieties.

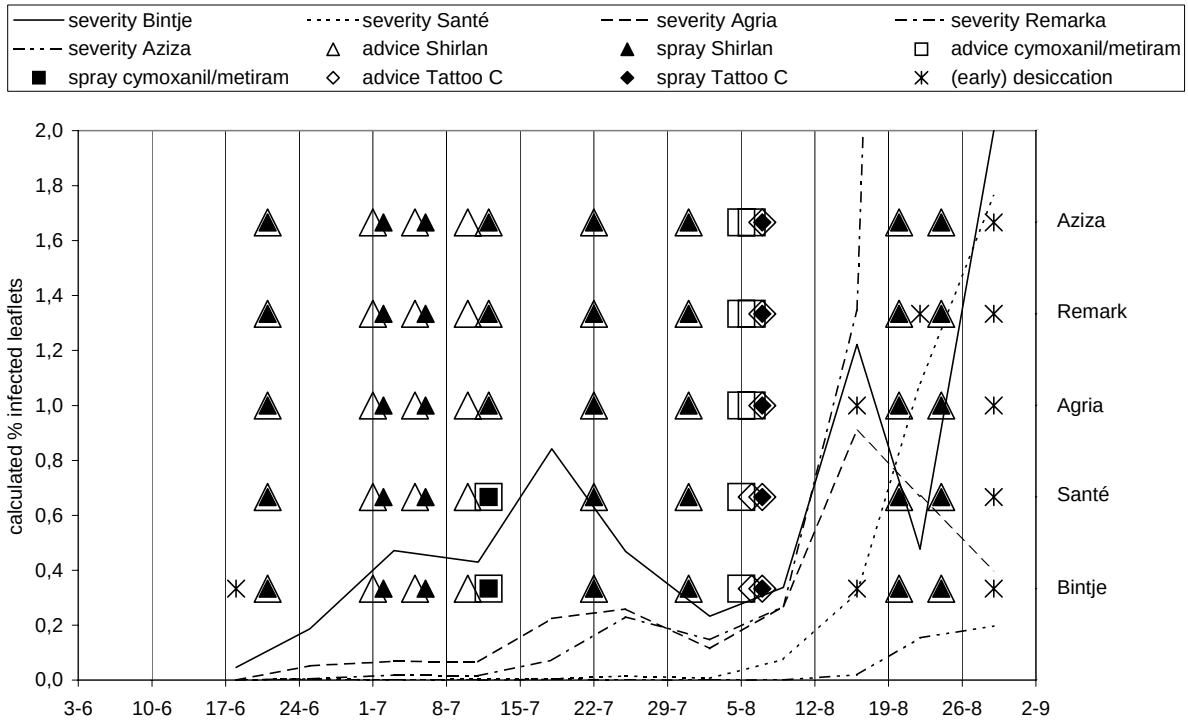

Figure 1. Advises, spraying schedule and calculated percentage infected leaflets for PLANT-Plus.

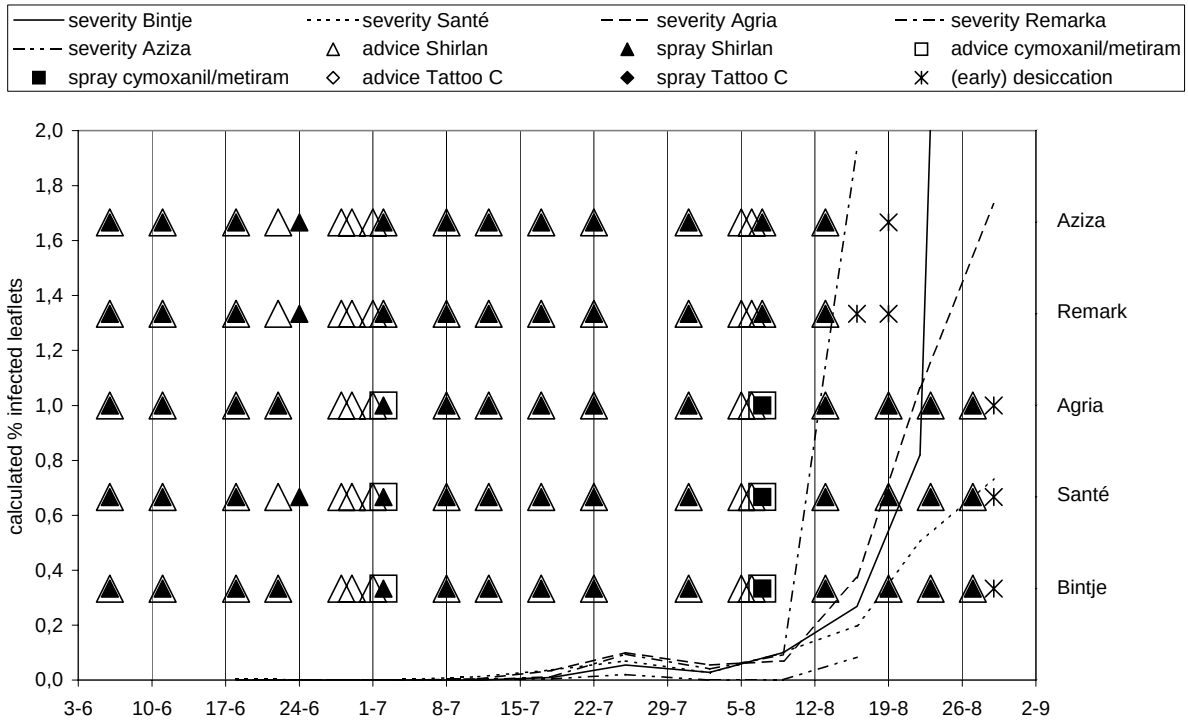

Figure 2. Advises, spraying schedule and calculated percentage infected leaflets for ProPhy.

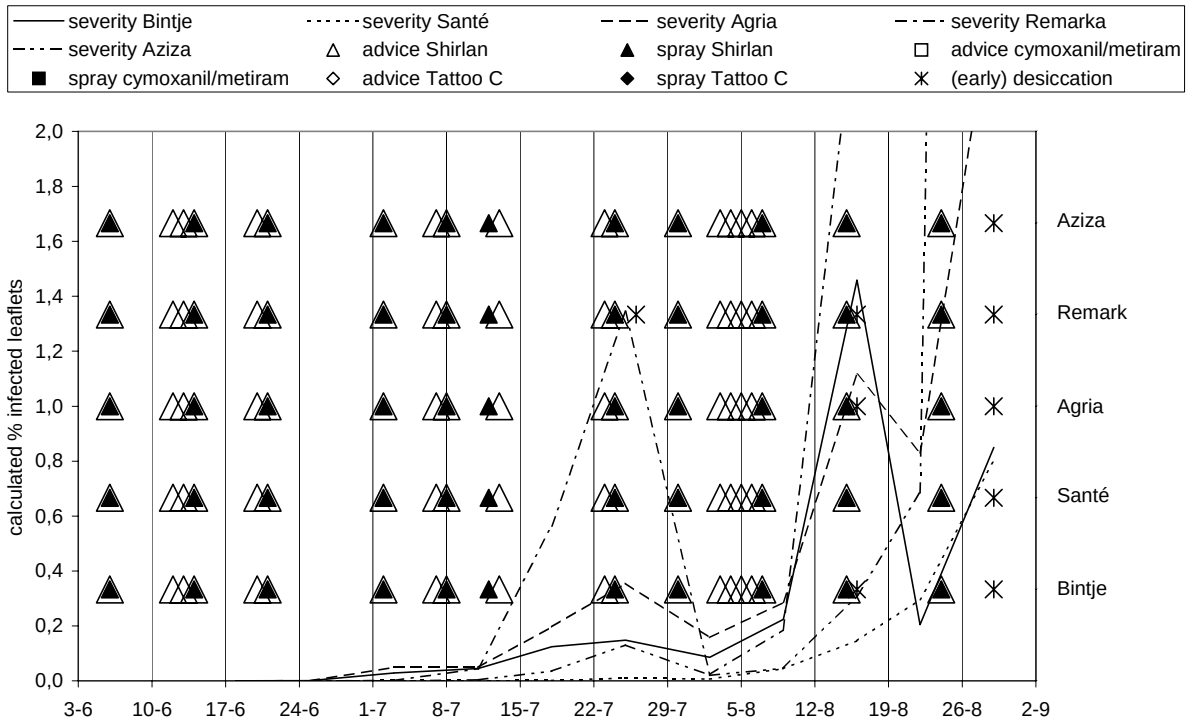

Figure 3. Advises, spraying schedule and calculated percentage infected leaflets for WUR-Blight.

ProPhy system recommendations led to an overall better performance (based on fungicide input, first appearance of blight, early desiccation and severity of leaf blight) of Aziza than of Bintje thanks to the lower fungicide input and lower severity. Bintje performed better than Santé due to the earlier first symptoms on Santé, although the severity on Bintje was higher. Bintje performed a little better than Agria thanks to the later first symptoms. Bintje performed better than Remarka thanks to the later first symptoms, no early desiccation and the lower severity although the fungicide input on Remarka was a little lower.

PLANT-Plus system recommendations led to an overall performance of all varieties better than Bintje due to mainly the early desiccation of Bintje and the earlier first symptoms. Also on Agria, Remarka and Aziza the fungicide input was lower than on Bintje. Severity was much less on Aziza, less on Santé and a little less on Agria compared with Bintje.

Over all three systems Santé performed better than should be expected based on the low potato late blight resistance (4.5). Nevertheless Gans (2003) showed that Santé could in some years act as a more susceptible variety and sometimes as a more resistant variety.

Tuber blight, leaf blight and dose of Shirlan

In WUR-Blight, Aziza showed the highest percentage tuber blight in spite of the high tuber resistance. A severe leaf infection at the end of the season in combination with the very low dose of Shirlan (0.08 l/ha) were probably more important than the tuber resistance.

Like last year (Wander and Spits, 2002) the percentage tuber blight was quite high. This provided again the possibility to look at the correlation between the input of Shirlan and the infection rate. For Bintje correlations between tuber blight and dose of Shirlan in the period from August 7, 13 or 19 to August 15, 20, 24 and 27 were compared. Of this 12 periods the period between August 7 and 20 gave the highest correlation. Apparently the strong increase of the epidemic shortly after August 7 played an important role. Precipitation in this period was only 25 mm. Nevertheless including 25 mm extra precipitation by prolonging the period until August 24 did not increase the correlation.

For the mentioned periods also the correlations between tuber blight and cumulative leaf blight were calculated. The period of August 7 until 20 showed the highest correlation.

In figure 4 the relationship between leaf blight for the period August 7 until 20, dose of

Shirlan in this period and tuber blight is shown. Regression analysis showed that the dose of Shirlan had a significant effect on tuber blight (F-prob. 0.049). Accumulated leaf blight did not have a significant effect.

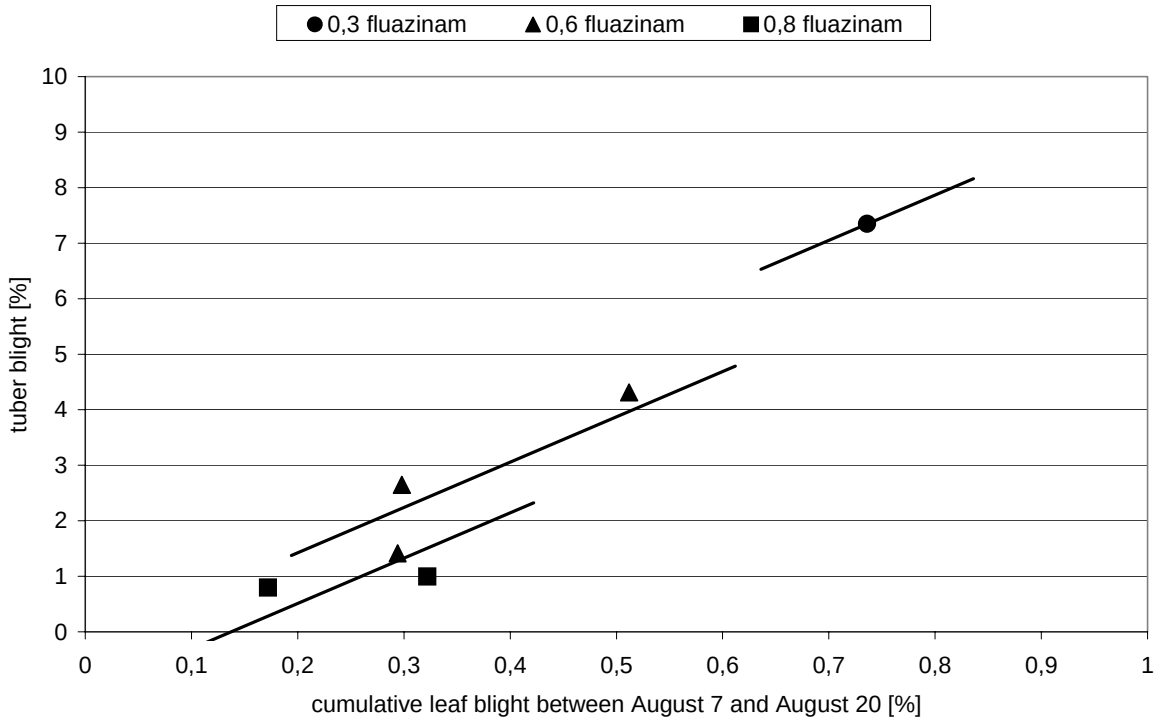

Figure 4. Effect on tuber blight by leaf blight on Bintje cumulated for the period of August 7 and 20 and the dose of Shirlan sprayed in this period (R^2 adj. = 89 %).

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