Efficacy to control potato late blight by applying biological crop protection products

EuroBlight field experiment AGV7837

A. Evenhuis

This study was carried out by the Wageningen Research Foundation (WR) business unit Field Crops and was commissioned and financed by EuroBlight participants.

WR is part of Wageningen University & Research, the collaboration of Wageningen University and Wageningen Research Foundation.

Wageningen, September 2020

WPR-OT 938

WAGENINGEN
UNIVERSITY & RESEARCH

A. Evenhuis, 2020. *Efficacy to control potato late blight by applying biological crop protection products* Wageningen Research

© 2020 Wageningen, Stichting Wageningen Research, Wageningen Plant Research, Business Unit Field Crops P.O. Box 430, 8200 AK Lelystad, The Netherlands; T +31 (0)320 29 11 11; www.wur.eu/plant-research

This report can be downloaded for free at https://doi.org/10.18174/570734

Chamber of Commerce no. 09098104 at Arnhem
VAT NL no. 8065.11.618.B01

Stichting Wageningen Research. All rights reserved. No part of this publication may be reproduced, stored in an automated database, or transmitted, in any form or by any means, whether electronically, mechanically, through photocopying, recording or otherwise, without the prior written consent of the Stichting Wageningen Research.

Stichting Wageningen Research is not liable for any adverse consequences resulting from the use of data from this publication.

Contents

1 Introduction

1.1 EuroBlight Table

Late blight caused by *Phytophthora infestans* is the most important foliar disease in the cultivation of potatoes. The crop needs to be protected from *P. infestans* by spraying fungicides regularly during the growing season. It is important to use fungicides that effectively protect leaves against this disease. A whole range of fungicides was or became registered in the last years. Each fungicide has its own mode of action and efficacies and therefore has specific characteristics. To evaluate each characteristic a EuroBlight table was set up to get an overview of the value of each characteristic. Up until the Bologna meeting in 2007, the ratings are based upon expert judgement, from both agrochemical companies and independent researchers. To evaluate the effectiveness of fungicides harmonised protocols were discussed at Tallinn. It was proposed that ratings of fungicides for the EU-table are calculated when field experiments are carried out over 2 years in 3 European countries. Each year from 2006 to 2019 at least three experiments were carried out. In fact 43 field experiments were set up to compare the effectiveness against leaf late blight by measuring the protection of leaves from application of a fungicide in a standard 7-day spray schedule (this standard spray schedule is not necessarily related to the label recommendations). This protection originates from the protectant and/or curative properties of the active ingredients and in the rapid growth phase of the crop also protection of new growth can contribute to the effectiveness of the fungicide for leaf blight control. Dose rates were the highest preventative doses registered in Europe. The results of the trials were used to re-evaluate the effectiveness of fungicides to control potato late blight.

1.2 EuroBlight table set-up for low risk products

Nowadays a growing public concern on using synthetic crop protection products has led to the search for new and biological crop protection products (BCPP) with low risk to the environment. In literature products from bacterial origin, plant extracts, salts etc are described and claim to control *P. infestans*. Within the EuroBlight network, an initiative was taken to set up an experiment to rate the biological crop protection products similarly to the EuroBlight table for fungicides. Since it is expected that these products will be less effective than synthetic fungicides the set-up of the experiment was adjusted. Major adjustments in comparison to the EuroBlight experiment are:

- The cultivar is medium susceptible to potato late blight
- The potato crop is not inoculated. Infection relies on natural sources
- Spreader rows are set-up in the experiment in case potato late blight does not occur naturally
- No sprinkler irrigation to facilitate the late blight epidemic is used. Irrigation for the purpose of supplying water in case of drought is allowed.
- The untreated control is allotted randomly to the block design

This report describes the efficacy of biological plant protection products to control potato late blight during the whole season of the 2020 experiment at Lelystad (NL).

2 Methods and materials

2.1 Experimental set up.

The cultivated potato plants (cv. Agria) were grown at Wageningen University and Research location Lelystad. The experiment was treated conform local good agricultural practice, only the fungicide sprayings against *P. infestans* were carried out as mentioned in Table 1. A plot consisted of 3 meters (4 rows) of 11 meters. The trial was carried out in four replications. The experiment was carried out in accordance with GEP (NVWA-recognition; Appendix 2; details Appendix 1).

Conducted Under GLP: No Official Trial ID: -
Conducted Under GEP: Yes Other Trial ID: AGV7837

No.	Guideline	Description
1.	PP 1/135(4)	phytotoxicity assessment
2.	PP 1/152(4)	Design and analysis of efficacy evaluation trials
3.	PP 1/181(4)	Conduct and reporting of efficacy evaluation trials including GEP
4.	PP 1/2(4)	Phytophthora infestans on potato

2.2 Treatments

In Table 1 the biological crop protection products used, and dose rates are presented. Applications were carried out using a CHD-sprayer with Airmix XR110.04 nozzles approximately 50 cm above the foliage. Sprayings were carried out with 300 l/ha and 2.5 bar.

Table 1 Treatments and biological crop protection products applied in a 7 day spray interval

Code	Treatment	Active ingredient	Dose rate l or kg per ha
A	Untreated control	-	-
B			
C			
D			
E			
F			
G			
H			
J			
K			
L			
M			
N			

On 10 June 2020, the potato plants were sprayed with the different treatments for the first time (Table 2). Spray interval was approximately 7 days. Weather conditions at the time of spraying are given in Table 2.

Table 2 Weather conditions during spray applications

Date	Time	BBCH	Temp.	RH	wind speed	wind direction	hours dry[1]	Precipitation [6][2]
			(°C)	(%)	(m/s)		(h)	(mm)
10-6-2020	16:00		17.0	68	1.9	E	16	0
17-6-2020	11:00		19.3	80	0.5	NNE	9	0
24-6-2020	11:00	51	25.3	47	1.9	ESE	60	0
1-7-2020	11:00	61	18.9	89	3.2	SW	76	0
8-7-2020	18:00	67	14.3	99	1.1	ENE	9	0
13-7-2020	9:00	67	17.2	75	0.7	SSW	25	0
20-7-2020	9:00	68	14.7	83	3.0	NNW	24	0
27-7-2020	9:00	69	15.0	88	3.1	S	4	2.0
3-8-2020	9:00	72	17.0	77	2.3	S	6	0
10-8-2020	9:00	72	24.7	63	2.4	NE	89	0
17-8-2020	11:00	72	20.5	88	1.0	S	5	1.6
24-8-2020	11:00	72	18.4	71	3.2	WSW	26	0

[1]: Number of hours without precipitation after the spray application

[2]: Cumulative precipitation (mm) in the first six hours after the spray application.

2.3 Inoculation *P. infestans*

The experiment was not inoculated with *Phytophthora infestans*. Spreader rows were present in the field alongside the plots. No sprinkler irrigation facilitated the potato late blight epidemic. Irrigation was carried out once due to the continuous dry weather.

2.4 Disease observations and Yield

Disease observations were carried out once a week. The number of infected leaves was counted, and percentage infected foliage was calculated or percentage necrotic foliage per plot was estimated.
The Standard Area under Disease Progress Curve (StAUDPC) was calculated (indication for disease development during the growing season).
The crop was not harvested.

2.5 Statistics

Analysis of variance on the parameters was made using GENSTAT 19th Edition. The experiment was carried out with four replications in a randomised block design. Each replication consisted of a plot. Transformation of data was carried out when necessary.

3 Results

At the first half of July weather conditions were conducive for potato late blight. The weather conditions in the second half of July and the first half of August were dry. The first part of August was characterised by warm weather on which on several days temperatures were higher than 30°C. In the night of 13 on 14 August about 115 mm water fell in one night followed by approximately another 35 mm in the next four days, which led to a total amount of about 150 mm. The weather station was located approximately 2 km from the field, therefore the actual amount on 14 August at the location of the experiment may have been less.

3.1 Potato late blight severity

Until 28 July no significant differences of potato late blight severity between treatments were observed. Data are given in Appendix 3. Based on the StAUDPC treatments J, K, L and N significantly controlled potato late blight. Percentage control of treatments J, K, L and N was 80%, 75%, 80% and 17% respectively. The results are presented in Table 4, Figure 1 and Figure 2.

Table 3 Arithmetical means of potato late blight severity (%) and back transformed logit means for the different treatments.

label[1]	14-jul	22-jul	28-jul	30-jul	3-aug	6-aug	12-aug	18-aug	25-aug	StAUDPC
A	0.00075 ab[3]	2.0	57.5	70.0	76.3	83.8 bc	89.3 b	89.3 b	91.3	51.7 c
B	0 a	3.3	32.5	48.8	60.0	75.0 b	82.0 b	82.3 b	91.0	44.7 bc
C	0.00025 a	0.8	37.5	52.5	71.3	78.8 bc	83.8 b	86.3 b	93.0	47.1 bc
D	0 a	0.9	40.0	53.8	67.5	78.8 bc	82.5 b	83.8 b	90.5	46.4 bc
E	0 a	0.8	36.3	50.0	67.5	77.5 bc	81.3 b	81.3 b	85.0	44.9 bc
F	0 a	1.0	36.9	46.3	65.0	80.0 bc	83.8 b	86.3 b	93.3	46.3 bc
G	0.0025 b	3.9	48.8	62.5	76.3	86.8 c	87.5 b	88.3 b	93.0	50.8 c
H	0 a	1.1	43.8	52.5	65.0	80.0 bc	87.5 b	88.8 b	91.3	47.9 bc
J	0 a	0.0	1.0	1.5	2.8	7.8 a	20.6 a	23.8 a	53.8	10.6 a
K	0.00025 a	0.0	1.1	1.5	4.4	12.0 a	28.8 a	30.0 a	56.3	13.1 a
L	0 a	0.0	0.8	1.4	3.4	5.3 a	20.6 a	27.5 a	48.8	10.5 a
M	0 a	4.3	35.0	51.3	68.8	80.0 bc	83.3 b	86.5 b	92.3	47.1 bc
N	0 a	1.3	35.0	47.5	60.0	72.5 b	78.0 b	79.3 b	83.0	42.9 b
Lsd	0.00203	3.5	18.7	18.4	15.4	11.5	11.8	12.7	8.4	7.5
F pr.	n.s.	n.s.	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

label[2]	14-jul	22-jul	28-jul	30-jul	3-aug	6-aug	12-aug	18-aug	25-aug	StAUDPC
A	0.001	1.90 bc	57.8 c	70.1 c	76.4 b	84.0	89.6	89.6	91.7 bcd	51.8
B	0	1.92 bc	30.3 b	49.3 bc	62.0 b	79.0	86.8	88.9	93.8 cd	44.8
C	0	0.80 ab	37.0 bc	52.7 bc	71.5 b	79.2	84.3	86.9	93.4 bcd	47.1
D	0	0.92 ab	39.8 bc	54.0 bc	67.9 b	79.2	84.1	84.9	91.2 bcd	46.5
E	0	0.76 ab	34.7 bc	49.9 bc	67.7 b	77.7	81.5	81.5	85.5 b	45.0
F	0	0.89 ab	32.7 bc	44.5 b	66.2 b	81.2	85.2	88.7	94.4 cd	46.3
G	0.002	2.94 c	48.3 bc	63.5 bc	77.7 b	88.8	91.0	92.0	95.9 d	50.9
H	0	1.08 bc	43.3 bc	52.7 bc	65.5 b	80.3	87.8	89.0	91.7 bcd	48.0
J	0	0.00 a	0.9 a	1.4 a	2.8 a	6.3	19.1	22.4	53.9 a	10.3
K	0	0.01 a	1.1 a	1.3 a	3.0 a	7.1	23.6	24.7	56.7 a	11.4
L	0	0.01 a	0.7 a	1.2 a	2.8 a	4.1	18.6	24.5	48.8 a	9.9
M	0	1.90 bc	33.2 bc	51.4 bc	71.8 b	83.1	88.9	92.0	94.8 cd	47.1
N	0	1.09 bc	32.1 bc	45.7 b	60.9 b	76.0	81.0	84.7	89.1 bc	42.5
F pr.	n.s.	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

[1]) The upper table gives the arithmetical means, when followed by a character the values are normally distributed allowing ANOVA without transformation

[2]) The lower table gives the back-transformed logit values to meet the requirements for a normal distribution.

[3]) Values in columns followed by the same character are not significantly different (P=0.05).

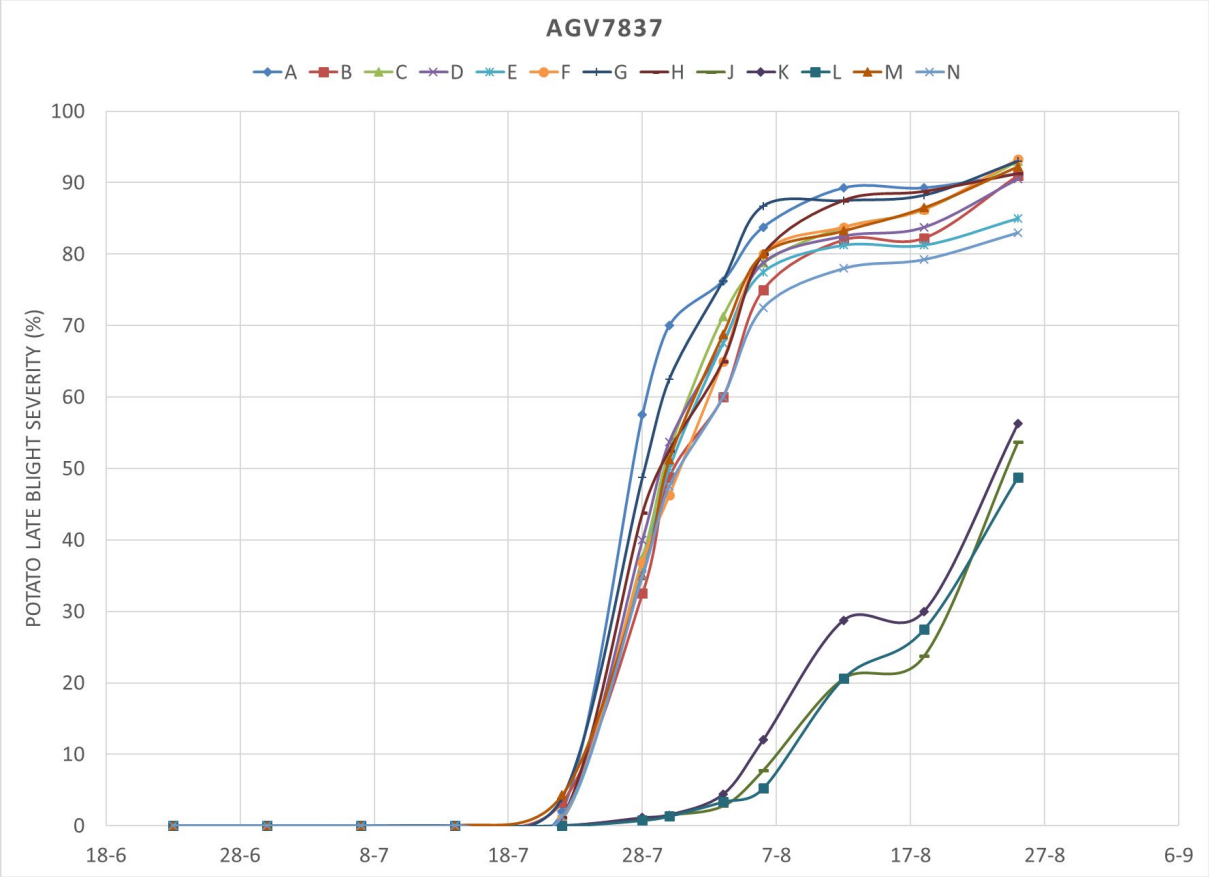


Figure 1 Potato late blight epidemic as a result of various spray schedules

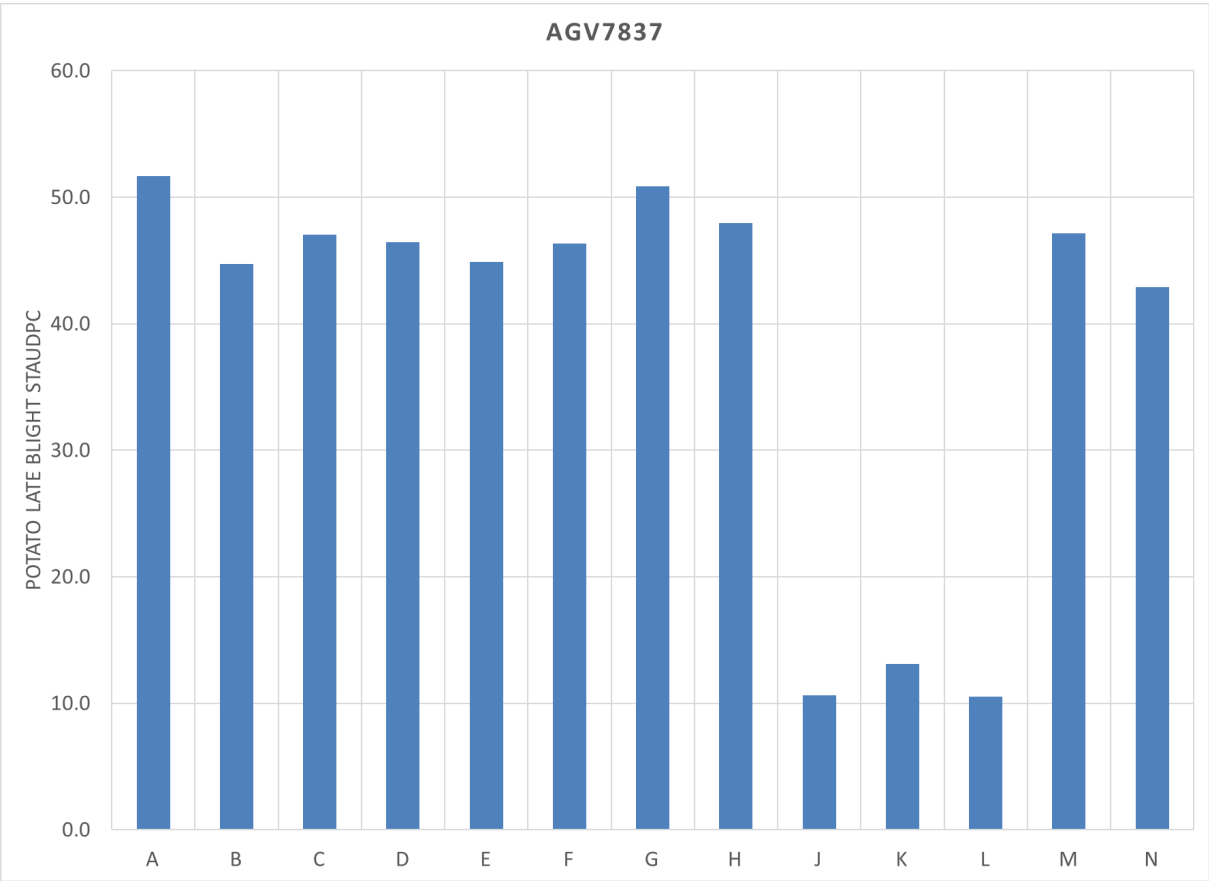


Figure 2 Potato late blight StAUDPC as a result of various spray schedules

3.2 Tuber blight and yield

No tuber blight data (Figure 3).
No yield data available (Figure 4).

Figure 3 Tuber blight incidence (TB %) based on number (#) and weight as a result of various spray treatments. Values above columns followed by the same character are not significantly different (P=0.05).

Figure 4 Yield (t/ha) as a result of the various spray treatments. Values above columns followed by the same character are not significantly different (P=0.05).

4 Discussion and conclusions

The experiment aimed at showing the efficacy of biological crop protection products to control potato late blight.

4.1 Potato late blight

The season was characterised by infection periods in the first half of July. Followed by dry and warm weather until half August. Potato late blight severity was very low until half July, including the untreated control. Disease pressure was not enhanced by misting of the crop and relied on natural weather circumstances. Furthermore no artificial inoculation was carried out. In the neighbourhood fields infected with *P. infestans* were present ensuring some disease pressure. Nevertheless half Ju;y potato late blight was observed in the crop, after that the potato late blight epidemic developed strong in most treatments. Basically, treatments B, C, D, E, F, G, H and M were not able to control *P. infestans*. In this experiment the products were sprayed in a weekly scheme not taking into account periods of infection risk. Pin point application of the biological crop protection products might have improved the efficacy, but it remains the question if this would be sufficient.
Treatments J, K , L and N showed some efficacy to control potato late blight. Nevertheless, disease severity was between 49% and 83% at the last assessment on 25 August. This indicates that the products might postpone the epidemic but are generally not comparable to synthetic fungicide with respect to efficacy. In organic potato production these products might prove beneficial.

4.2 Tuber blight

Tuber blight incidence not available.

4.3 Yield

Yield not available.
.

4.4 Conclusions

- No phytotoxicity was observed in treatments B, C, D, E, F, G, H, M and N, the biological crop protection products used were crop safe.
- Based on the StAUDPC treatments B, C, D, E, F, G, H and M showed no efficacy to control potato late blight, disease severity was comparable to the untreated control (A).
- Based on the StAUDPC, treatments J, K, L and N showed a significant efficacy to control potato late blight, where treatment J, K and L performed the comparable and significantly better treatment N.
- Tuber blight incidence (%) not available
- Yield not available

Annex 1 Trial lay-out

Site	Lelystad, The Netherlands 52.53 N; 5.56 E

Soil texture:	Clay sandy loam
Previous crop:	sugar beet
Tillage:	Conventional till
Fertilization:	
Variety:	Agria
Planting date:	4 May 2020
Seed Rate:	2.500 kg/ha
Herbicide treatment:	according to good agricultural practice
Fungicide application:	see paragraph 2.2
Alternaria treatments:	Narita 0.5 l/ha 3 times, 14 day schedule
Crop desiccation:	27 August & 3 September
Harvest:	-
Tuber assessments:	-
Gross plot dimensions:	Six rows (0.75 m) of 11 m length
Net plot dimensions:	Two rows (0.75) of 11 m length
Demo design:	Four replications in a randomized block design

Ververs kleuren

Splits in banen

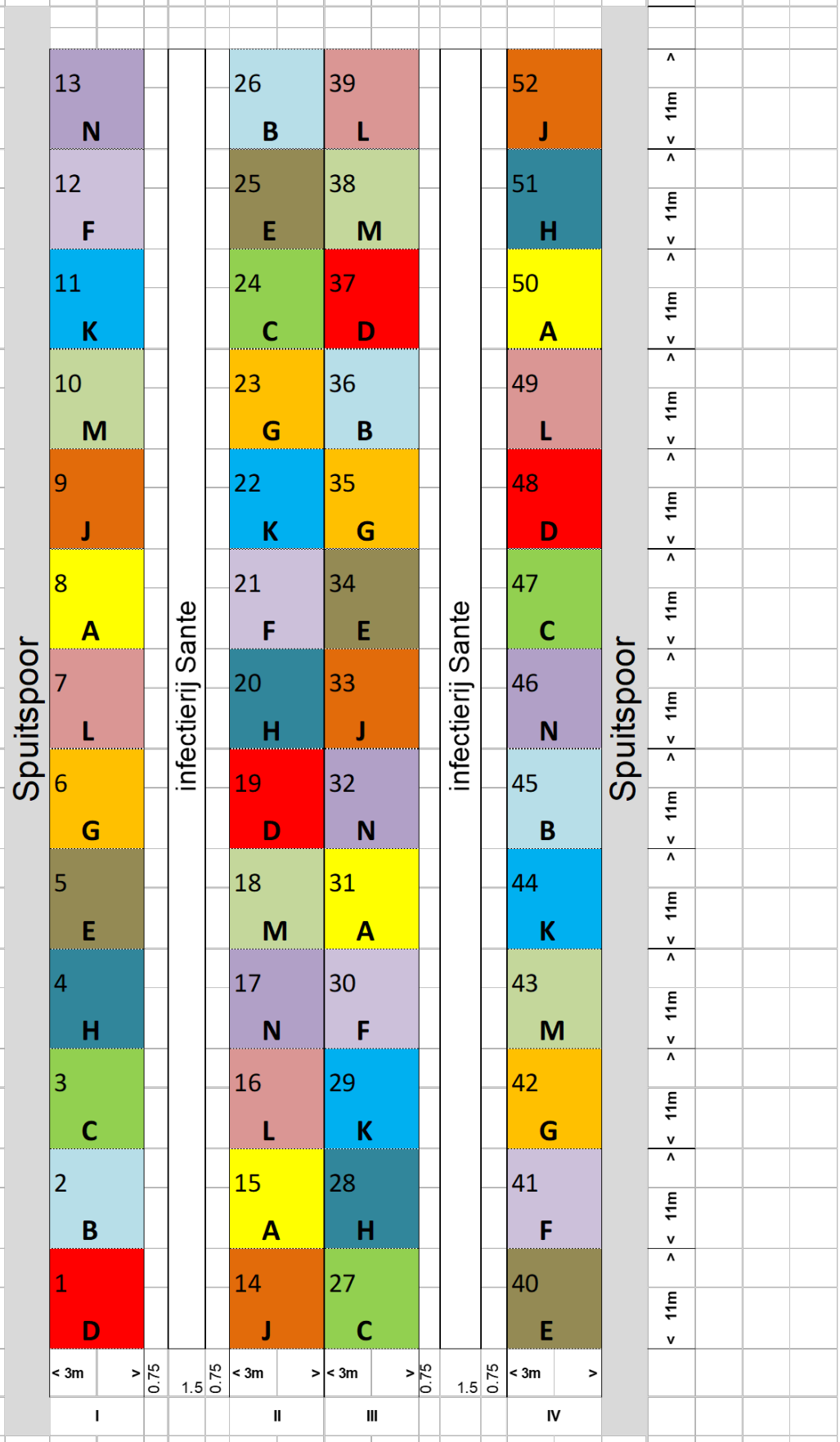
Project: 3750421900

Proef: AGV7837

Locatie: Lelystad

Perceel: G87

Euro Blight Biol



Annex 2 NVWA certificate

Netherlands Food and Consumer
Product Safety Authority
Ministry of Economic Affairs

Certificate

of Official Recognition of Efficacy Testing Organisations in the Netherlands
This certifies that, in conformity with the request of March 9, 2017

STICHTING WAGENINGEN RESEARCH
BUSINESS UNIT PRAKTIJKONDERZOEK AGV

Residing: Edelhertweg 1 Lelystad, the Netherlands

has officially been recognised as an organisation for efficacy testing in the Netherlands.

As has been laid down in the 'Regeling gewasbeschermingsmiddelen en biociden' (Regulation Crop Protection Products and Biocides) of September 26, 2007 (Staatscourant 2007, 386).

This recognition commences on: March 1, 2017
and expires on: February 12, 2022

The above organisation is competent to carry out efficacy trials/tests in the categories mentioned in the annex of this certificate.

Utrecht, March 14, 2017

For the Minister of Economic Affairs,

Ir. W.J.H. van der Sande
Deputy Director
Netherlands Plant Protection Organization

CERTIFICATE NUMBER: NL_GEP_13160822

Page 1 of 2

Annex 3 Disease observations PLB

Date:			23-6	30-6	7-7	14-7	22-7	28-7	30-7	3-8	6-8	12-8	18-8	25-aug	
Crop stage (BBCH):			51	61	67	bloei	68	69	69	72	72	72	72	72	
Crop height (cm):			50--55	55-60	65	65	65	65	65	65	65	65	65	65	
Weather (sunny, half cloudy, cloudy):			z	z	b	b	hb	Z	Z	Z	Z	Z	Z	B	
Target (disease/pest/weed):			P. infestans	P. infestans	P. infestans	P. infestans	P. infestans	P. infestans	P. infestans	P. infestans	P. infestans	P. infestans	P. infestans	P. infestans	
Assessment level(Field/Leaf/Stem):			Veld	Veld	Veld	Veld	Veld	Veld	Veld	Veld	Veld	Veld	Veld	Veld	
Assessment:			Loof	Loof	Loof	Loof	Loof	Loof	Loof	Loof	Loof	Loof	Loof	Loof	
Unit:			%	%	%	%	%	%	%	%	%	%	%	%	
Manner (estimate, count):			Schatten	Schatten	Schatten	Schatten	Schatten	Schatten	Schatten	Schatten	Schatten	Schatten	Schatten	Schatten	
					0	7	15	21	23	27	30	36	42	49	
			PHYTIN%230	HYTIN%300	HYTIN%070	HYTIN%140	HYTIN%220	HYTIN%280	HYTIN%300	HYTIN%030	HYTIN%060	HYTIN%120	HYTIN%180	HYTIN%2508	
Field!	**Treatment!**	**Repl!**	**Phy2306**	**Phy3006**	**Phy0707**	**Phy1407**	**Phy2207**	**Phy2807**	**Phy3007**	**Phy0308**	**Phy0608**	**Phy1208**	**Phy1808**	**Phy2508**	**StAUDPC**
1	**D**	**1**	0	0	0	0	1	35	55	65	75	80	80	85	44.4
2	**B**	**1**	0	0	0	0	2	20	35	45	65	75	80	85	39.1
3	**C**	**1**	0	0	0	0	1	25	40	65	75	80	80	90	43.0
4	**H**	**1**	0	0	0	0	1.5	45	50	65	75	85	85	90	46.6
5	**E**	**1**	0	0	0	0	1	35	50	65	75	80	80	80	43.7
6	**G**	**1**	0	0	0	0	1.5	25	35	60	75	75	75	85	40.8
7	**L**	**1**	0	0	0	0	0.01	0.5	0.7	2	2	7.5	10	45	5.9
8	**A**	**1**	0	0	0	0.002	1.5	45	70	75	80	85	85	90	49.0
9	**J**	**1**	0	0	0	0	0	1	1.5	2.5	3.5	7.5	10	45	6.1
10	**M**	**1**	0	0	0	0	1	30	55	75	80	85	85	90	46.8
11	**K**	**1**	0	0	0	0	0	0.5	0.5	0.5	1.5	5	5	40	4.4
12	**F**	**1**	0	0	0	0	0.03	7.5	15	40	65	70	70	90	34.6
13	**N**	**1**	0	0	0	0	0.02	10	15	25	45	55	55	55	25.6
14	**J**	**2**	0	0	0	0	0.01	1.5	2	2.5	10	25	30	55	12.3
15	**A**	**2**	0	0	0	0.001	1.5	65	70	80	85	92	92	95	53.6
16	**L**	**2**	0	0	0	0	0.005	1	2.5	4	7.5	30	45	55	14.8
17	**N**	**2**	0	0	0	0	1.5	40	55	70	85	85	85	95	48.1
18	**M**	**2**	0	0	0	0	1	30	50	65	80	90	92	95	47.7
19	**D**	**2**	0	0	0	0	1	50	65	75	85	90	90	95	51.1
20	**H**	**2**	0	0	0	0	1	45	50	65	80	90	90	95	48.6
21	**F**	**2**	0	0	0	0	1	45	45	70	85	90	90	98	49.3
22	**K**	**2**	0	0	0	0.001	0.001	1	1	3.5	5	25	25	65	11.9
23	**G**	**2**	0	0	0	0.01	2.5	55	75	85	92	92	95	98	54.8
24	**C**	**2**	0	0	0	0	1	30	55	75	85	90	90	95	48.9
25	**E**	**2**	0	0	0	0	0.2	15	30	65	75	80	80	85	41.1
26	**B**	**2**	0	0	0	0	0.1	15	40	50	70	80	70	90	39.2
27	**C**	**3**	0	0	0	0	1	55	65	70	75	80	85	95	48.4
28	**H**	**3**	0	0	0	0	1.5	60	65	75	85	85	90	90	51.0
29	**K**	**3**	0	0	0	0	0.02	1	1.5	3.5	6.5	25	30	50	11.6
30	**F**	**3**	0	0	0	0	1.5	50	65	80	85	85	90	90	50.6
31	**A**	**3**	0	0	0	0	3.5	65	70	75	85	90	90	90	52.6
32	**N**	**3**	0	0	0	0	2	35	55	65	70	80	80	85	44.1
33	**J**	**3**	0	0	0	0	0.001	1.5	2	3.5	15	25	30	55	12.8
34	**E**	**3**	0	0	0	0	1	50	60	70	80	80	80	85	46.7
35	**G**	**3**	0	0	0	0	1.5	55	65	75	85	85	85	90	50.0
36	**B**	**3**	0	0	0	0	1	30	45	60	70	75	80	90	42.3
37	**D**	**3**	0	0	0	0	0.7	30	45	60	75	70	75	90	41.4
38	**M**	**3**	0	0	0	0	0.1	15	25	45	65	60	70	85	34.7
39	**L**	**3**	0	0	0	0	0.006	0.1	0.3	1	1.5	15	15	45	7.3
40	**E**	**4**	0	0	0	0	1	45	60	70	80	85	85	90	47.9
41	**F**	**4**	0	0	0	0	1.5	45	60	70	85	90	95	95	50.8
42	**G**	**4**	0	0	0	0	10	60	75	85	95	98	98	99	57.8
43	**M**	**4**	0	0	0	0	15	65	75	90	95	98	99	99	59.4
44	**K**	**4**	0	0	0	0	0.02	2	3	10	35	60	60	70	24.6
45	**B**	**4**	0	0	0	0	10	65	75	85	95	98	99	99	58.3
46	**N**	**4**	0	0	0	0	1.5	55	65	80	90	92	97	97	53.7
47	**C**	**4**	0	0	0	0.001	0.3	40	50	75	80	85	90	92	48.0
48	**D**	**4**	0	0	0	0	1	45	50	70	80	90	90	92	48.8
49	**L**	**4**	0	0	0	0	0.02	1.5	2	6.5	10	30	40	50	14.2
50	**A**	**4**	0	0	0	0	1.5	55	70	75	85	90	90	90	51.5
51	**H**	**4**	0	0	0	0	0.5	25	45	55	80	90	90	90	45.5
52	**J**	**4**	0	0	0	0	0.001	0.1	0.5	2.5	2.5	25	25	60	11.1

Annex 4 Yield and tuber blight

Annex 5 Weather data Lelystad

date	T-average	T-max	T-min	precipitation	radiation	RH-min	Wind direction	Wind speed
01-05-20	9.5	12.4	7.9	8.2	3.658	76	WSW	4.5
02-05-20	9.8	12.4	8.1	3.8	3.788	82	WSW	3.8
03-05-20	10.4	14.2	6.5	0	2.343	68	NE	1.6
04-05-20	10.3	14.3	7.1	0	4.483	59	NNE	3.1
05-05-20	8.9	13.1	3.6	0	3.655	44	NNE	2.5
06-05-20	10	15	4.2	0	4.914	43	NNE	1.7
07-05-20	10.5	16	3.8	0	4.316	40	ENE	1.3
08-05-20	13.7	19.2	6.6	0	4.732	40	NNE	1.3
09-05-20	16.5	21.4	9.2	0	7.771	40	NE	2.1
10-05-20	12.6	19.9	7.3	0	4.161	61	E	4.4
11-05-20	8	10.9	5.8	0	5.914	40	ENE	7.1
12-05-20	8.7	12	5.9	0	5.385	46	WNW	3.7
13-05-20	7.5	10.2	3.2	2	4.911	53	NE	3.7
14-05-20	7.5	10.9	3.6	0	6.688	51	NNE	3.4
15-05-20	8.9	12.9	3.6	0	5.486	60	WNW	1.9
16-05-20	11.3	14.8	7.6	0	5.687	54	WNW	3.6
17-05-20	12.7	16.8	6.3	0	6.64	47	S	2.8
18-05-20	14.1	18.7	9.3	0	6.965	55	W	3.2
19-05-20	15.1	19.5	11.3	0	7.125	59	NW	2.3
20-05-20	15.9	19.4	12.4	0	4.408	62	ENE	2
21-05-20	18.6	25.3	11.4	0	5.413	39	ESE	1.4
22-05-20	18.9	23.3	15.3	0	3.208	31	WSW	3.7
23-05-20	15.1	17.3	13.3	0	4.023	48	SW	5.3
24-05-20	13.2	14.6	11.7	4.2	2.064	70	WNW	4.5
25-05-20	14.4	16.9	12.4	0	8.119	63	NNE	3.1
26-05-20	15.3	21.2	9	0	6.221	46	N	1.4
27-05-20	15.4	18	12.8	0	6.363	60	N	2.9
28-05-20	14.3	20	7.5	0	0	43	WSW	1.7
29-05-20	14.4	21.9	6.2	0	0.903	44	ENE	2
30-05-20	16.8	22.5	8.5	0	6.204	32	ENE	2.3
31-05-20	16.6	22.1	9.6	0	4.905	38	NNE	2.4
01-06-20	17.5	23.3	11.8	0	5.416	39	NNW	2.2
02-06-20	19.9	26.6	10.7	0	5.447	33	W	1.7
03-06-20	16.8	19.6	12.4	0	6.284	72	NNW	2.7
04-06-20	12.8	14.6	9.1	7.6	1.877	82	W	3.7
05-06-20	9.8	11.3	8.1	6.4	1.717	73	SW	3.7
06-06-20	10.6	13.8	7.6	0	4.616	52	SSW	5.2
07-06-20	11.6	13.8	9.6	7	1.855	74	WSW	3.9
08-06-20	13.2	16	10.9	2.8	3.782	72	N	2.8
09-06-20	12.3	14.9	9.8	0	5.973	66	N	2.6
10-06-20	13.3	18.1	8.1	0	2.467	65	NNE	1.4
11-06-20	15	18.1	12.8	4.6	3.167	76	NE	1.8
12-06-20	19.5	25.5	14.5	0	6.939	48	NE	1.9

13-06-20	18.8	22.2	15.2	10.6	7.272	74	NW	1.9
14-06-20	18.4	21.5	16.3	1	5.933	89	WNW	1.7
15-06-20	18.2	21.3	15.2	0	6.356	59	N	1.9
16-06-20	17.9	19.8	16.5	1	3.725	71	N	0.5
17-06-20	18	22.2	14.6	3.2	7.195	63	NE	1.3
18-06-20	17.5	20.8	15.8	4.8	5.019	70	NNW	1.7
19-06-20	17.5	20.5	14	15.6	6.887	70	WSW	1.7
20-06-20	16.9	20.2	12.6	0	7.444	61	NNW	2.1
21-06-20	18.2	23.7	13.2	0	6.133	54	WSW	2.2
22-06-20	17.7	20.6	14.8	0	8.564	49	N	2.1
23-06-20	18.6	23.2	12.6	0	8.664	52	ENE	1.5
24-06-20	22	27.7	14.5	0	8.839	40	ENE	1.7
25-06-20	22.9	28.6	16.4	0	8.611	43	ENE	1.8
26-06-20	24.5	29.5	18.3	0	8.305	35	SW	1.9
27-06-20	20.5	23.7	18.1	7.6	4.348	70	SW	2.6
28-06-20	17.6	19.6	15.5	0	6.85	50	SSW	3.8
29-06-20	15.3	17	12.8	0	4.302	60	SW	4.4
30-06-20	14.8	17.8	13.1	14.2	2.868	66	WSW	3.8
01-07-20	17.1	18.9	15.4	0.6	4.88	69	SW	2.9
02-07-20	16.5	19.2	14.3	0	5.288	66	WSW	3
03-07-20	16.7	19.7	13.7	0	5.942	58	SW	3.5
04-07-20	16	16.9	13.7	3.4	1.894	74	SW	4.6
05-07-20	17.5	20.3	16.1	0	4.738	67	SW	4.9
06-07-20	14.7	16.2	13.3	3	5.666	69	WNW	4.4
07-07-20	13.7	17	10.4	6.2	5.356	64	WNW	2.5
08-07-20	13.3	14.5	11.5	3.2	1.896	99	E	1.3
09-07-20	15.4	16.5	13.6	17.4	1.766	99	SSW	2.4
10-07-20	14.4	15.9	12.4	3.8	3.252	72	NNW	3
11-07-20	14.3	18	10.1	0	7.316	68	NW	1.2
12-07-20	15.1	18.3	11	0	8.49	52	NNE	1.4
13-07-20	16.7	21.2	11	0	8.688	52	SE	1.3
14-07-20	15.4	17.7	12.8	17.4	2.231	79	NW	1.3
15-07-20	15.2	18.8	11.4	4.6	7.018	65	SSE	1.7
16-07-20	15.6	17.9	13.7	1.6	3.554	84	NNW	1.6
17-07-20	17.8	20.7	14.7	0	4.893	68	ENE	1.1
18-07-20	19	24.4	14.3	0	6.207	54	NW	1.2
19-07-20	17.9	22.4	14.5	3	5.949	65	NNE	1.9
20-07-20	15.7	18.1	13.3	0.4	6.908	63	NW	2.4
21-07-20	2.9	20.2	-40	1.2	7.496	29	NNW	2.4
22-07-20	14.4	19.8	7.8	0	7.104	42	SSE	2
23-07-20	16.7	23.9	9.4	0	5.053	47	S	2.5
24-07-20	17.9	21.9	14.6	1.6	4.788	60	S	2.6
25-07-20	17.2	20.7	14.9	19.8	2.982	77	SW	3
26-07-20	17.9	21.2	14.2	9.2	6.719	57	SW	4
27-07-20	16.5	22.6	12.7	2.2	3.431	69	SSW	2.8
28-07-20	17.8	19.5	16.2	1.6	6.956	55	WSW	3.4
29-07-20	16.7	19.2	13.5	0	6.999	53	S	3.1
30-07-20	18.1	24.2	11	0	9.148	46	E	1.4
31-07-20	23.9	32.6	14.3	0	9.764	34	ESE	1.3
01-08-20	21.7	24.1	17.5	0	6.097	62	SSE	2.2
02-08-20	18.2	21.4	15	0	8.273	52	SW	2.3
03-08-20	16.5	20.9	12.5	0.2	5.463	58	NNW	1.7

04-08-20	17.9	21.4	14.4	0	8.684	43	SSE	1.9
05-08-20	20.8	28.7	14.4	0	9.377	35	SE	2.2
06-08-20	22.5	28.1	15.3	0	9.044	45	NE	1.5
07-08-20	26.1	33.6	16.3	0	9.132	29	N	1.1
08-08-20	26.4	34.6	18.2	0	8.22	30	NE	1.2
09-08-20	26	31.6	20.9	0	7.88	42	ENE	1.9
10-08-20	26.4	33.8	19.1	0	8.479	36	NE	1.7
11-08-20	26.9	34.5	21.1	0	7.412	38	SSE	1.9
12-08-20	27.4	31.9	22.1	0	7.869	42	NNE	1.5
13-08-20	25.8	32.6	19.7	0	7.349	44	SSW	1.5
14-08-20	22.3	27.4	18.1	115.4	5.795	66	N	1.8
15-08-20	22.3	26.3	18.8	0	5.787	69	NNE	1.3
16-08-20	23.9	30.4	18.3	8.8	6.424	48	SSE	1.4
17-08-20	19.1	25	16.4	28.8	3.824	69	S	1.4
18-08-20	19.3	22.7	16	0.2	6.5	61	SSW	2.1
19-08-20	21.2	27.2	14.9	0	7.108	47	S	1.6
20-08-20	23	27.9	19.6	0	4.62	56	SSE	2.3
21-08-20	24.3	27.8	20.1	0	7.366	48	SW	3.4
22-08-20	19.3	21.5	17.2	1	5.396	63	SSW	3.7
23-08-20	17.5	19.8	15.6	5.4	5.246	67	SSW	3.4
24-08-20	17.1	20.1	14.3	8.4	4.854	62	S	2.9
25-08-20	16.2	19.3	13.1	2.8	2.399	74	SW	3.1
26-08-20	16.6	18.1	15.5	15.4	2.571	59	WNW	6.2
27-08-20	16.5	20	12.3	0.2	4.331	65	SE	1.6
28-08-20	16.1	19.8	13.8	6.2	3.992	66	SSW	3
29-08-20	15.3	18.2	12.7	1	4.992	74	SW	2.9
30-08-20	16.5	18.5	14.3	2.6	3.498	75	NNE	3.8
31-08-20	15.9	17.4	13.8	0	5.451	60	NNE	2.7

Corresponding address for this report:

P.O. 430

8200 AK Lelystad

The Netherlands

T +31 (0)320 291111

www.wur.eu/plant-research

The mission of Wageningen University and Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 5,000 employees and 10,000 students, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.