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

EuroBlight field experiment AGV7716

A. Evenhuis & H.T.A.M. Schepers | Wageningen Plant & Research |

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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
- No spreader rows are set-up in the experiment
- 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 2019 experiment at Lelystad (NL).
Because the results are confidential the treatments are not given in this report.

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: AGV7716

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			

On 12 June 2019, the potato plants were sprayed with the different treatments for the first time (**Error! Reference source not found.**). 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)
12-6-2019	11:00		17.7	73	1.3	O	1	7.8
19-6-2019	15:00		22.7	69	1.2	SSW	4	4.6
26-6-2019	9:00	51	19.3	91	3.4	NNW	245	0
3-7-2019	11:00	58	16.8	62	3.6	WSW	75	0
10-7-2019	11:00	65	15.8	63	2.0	SSW	1	4.4
17-7-2019	11:00	65	16.1	86	0.8	E	32	0
24-7-2019	12:00	65	32.0	40	2.5	ZE	168	0
1-8-2019	13:00	66	19.1	90	1.3	SSW	21	0
7-8-2019	9:00	72	17.8	85	2.1	SW	46	0
14-8-2019	14:00	72	19.5	59	3.2	SSW	4	1.6
21-8-2019	13:00	75	20.0	53	2.0	SSW	179	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*. No spreader rows were present in the field. Also, no sprinkler irrigation facilitated the potato late blight epidemic. Irrigation was carried out two times 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 harvested. Rotten tubers were sorted out, weighed and counted, before storage. After storage rotten tubers were sorted out weighed and counted. The rest of the potatoes were weighed and counted. Size distribution assessment was not carried out.

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

In general, the weather conditions in July and August were dry. Precipitation was 36 mm in July and 49 mm in August. Furthermore, two periods of exceptionally warm weather were observed. The first being from 23 to 30 June with temperatures well over 25°C. The second period of hot weather was measured from 22 to 30 July with temperatures up to 36.8°C.
Due to the dry and hot weather in June and July the late blight epidemic developed moderately. By the end of August the untreated reference reached a disease severity level of almost 100% and disease assessments were stopped.

3.1 Potato late blight severity

Until 16 July no significant differences of potato late blight severity between treatments were observed. Data are given in Appendix 3. Based on the StAUDPC treatments E, F and G significantly controlled potato late blight. Percentage control of treatments E, F and G was 23%, 47% and 67% respectively. The results are presented in Table 3, 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]	23-jul	30-jul	7-aug	15-aug	21-aug	28-aug	StAUDPC
A	4.0	6.0	4.5	11.3	70.0 cd	91.3	14.0 d
B	3.1	3.4	5.3	10.6	73.8 cd	93.0	14.0 d
C	2.5	4.4	5.3	9.4	63.8 bc	87.5	12.7 d
D	3.3	4.3	6.4	15.0	71.3 cd	91.3	14.4 d
E	2.0	3.3	2.9	5.1	52.5 b	87.5	10.8 c
F	1.1	1.4	3.1	3.1	28.8 a	75.0	7.5 b
G	0.7	0.8	2.2	2.2	17.5 a	57.5	5.2 a
H	0.5	1.2	3.1	10.6	77.5 d	94.8	13.7 d
Lsd	1.6	3.6	2.3	7.3	12.4	14.4	1.9
F pr.	<0.001	<0.10	<0.01	<0.05	<0.001	<0.001	<0.001

label[2]	23-jul	30-jul	7-aug	15-aug	21-aug	28-aug	StAUDPC
A	3.6 d[3]	4.6 c	4.2 bc	9.1 bc	70.4	91.7 cd	13.9
B	3.0 d	3.3 c	4.9 bc	9.6 bc	74.1	93.4 cd	14.1
C	2.3 cd	3.6 c	5.2 c	9.4 bc	64.1	88.1 c	12.8
D	3.1 d	4.0 c	5.3 c	13.4 c	71.4	91.7 cd	14.4
E	1.9 cd	2.6 bc	2.6 abc	3.7 ab	52.7	87.8 c	10.7
F	1.2 bc	1.5 ab	2.6 abc	2.6 a	27.3	75.8 b	7.3
G	0.7 ab	0.7 a	1.4 a	1.4 a	14.5	59.6 a	4.6
H	0.5 a	1.1 a	2.3 ab	8.2 bc	77.7	95.5 d	13.8
Lsd	-	-	-	-	-	-	-
F pr.	<0.001	<0.001	<0.05	<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).

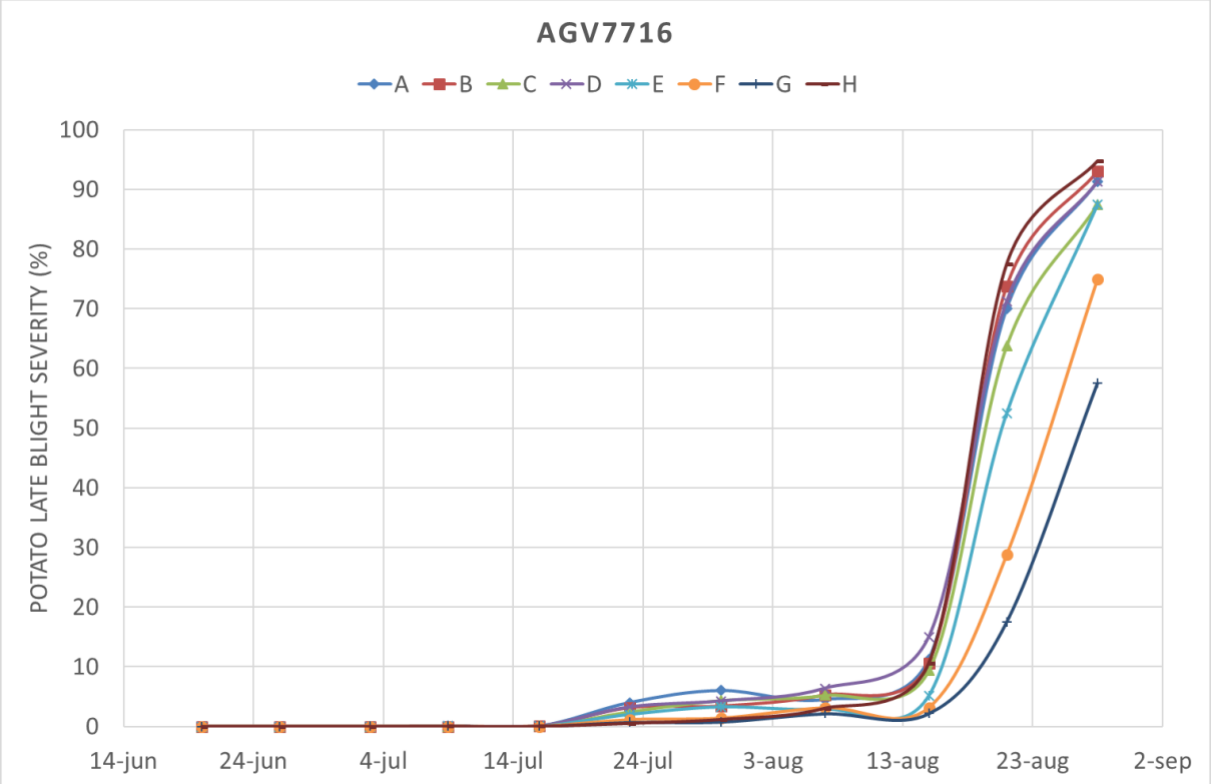


Figure 1 Potato late blight epidemic as a result of various spray schedules

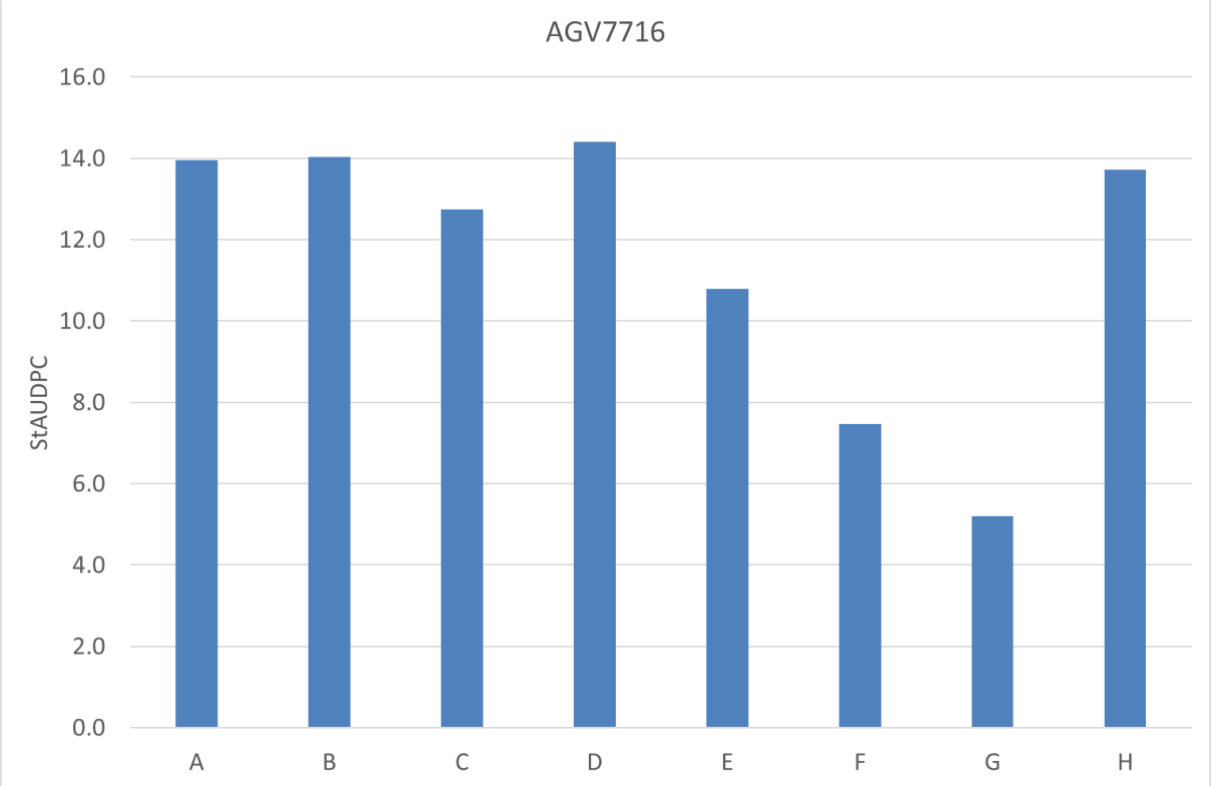


Figure 2 Potato late blight StAUDPC as a result of various spray schedules

3.2 Tuber blight and yield

Tuber blight incidence (%) in the untreated control was significantly higher than all other treatments based on number but not on weight due to high variance and low incidence (Figure 3).
Yield of the untreated control was significantly lower than treatment G and comparable to the other treatments (Figure 4).

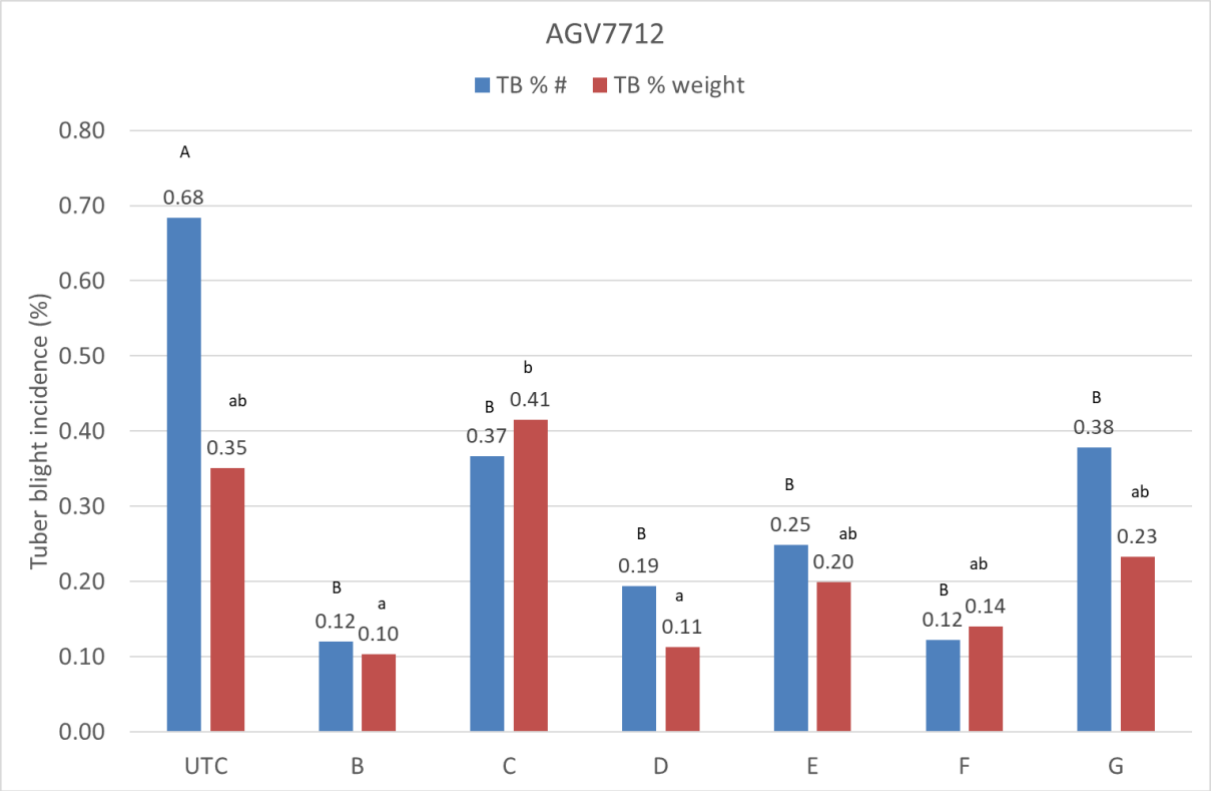


Figure 3 Tuber blight incidence (TB %) based on number (#) and weight as a result of various spray treatments. Values above columns followed by the same character are not significantly different (P=0.05).

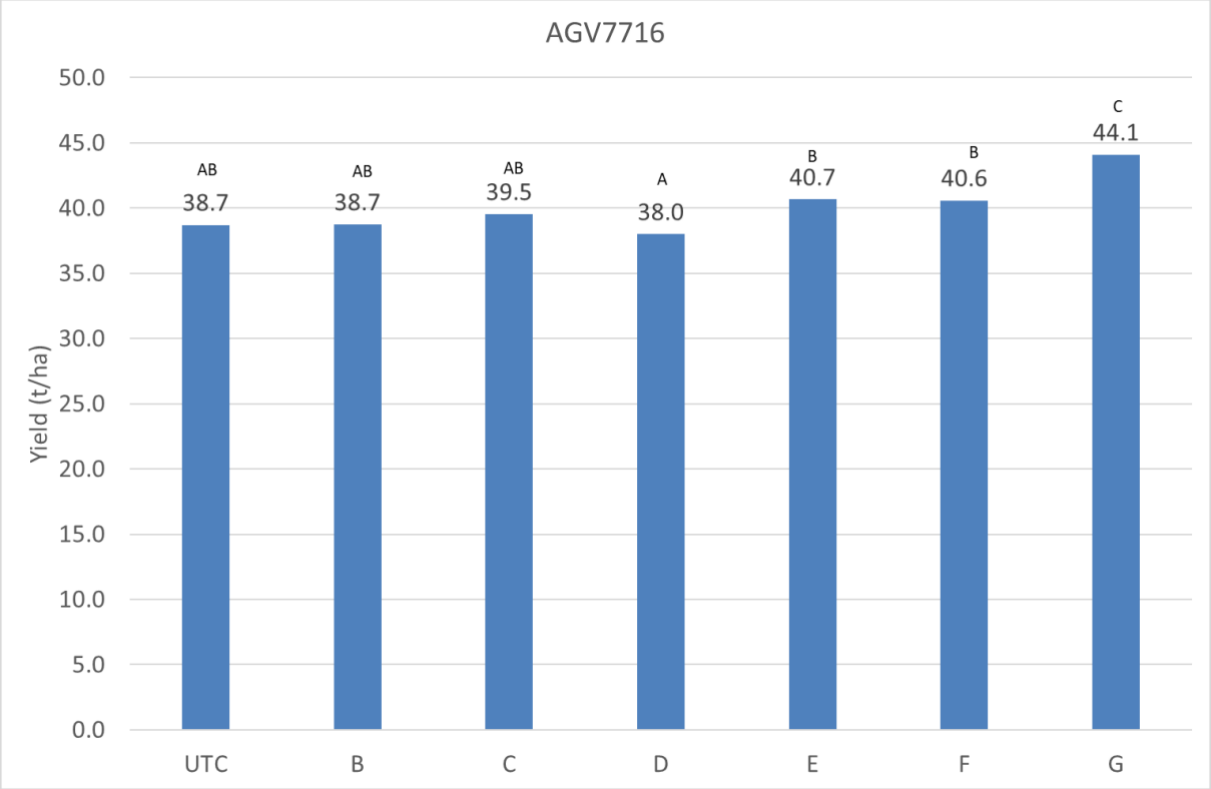


Figure 4 Yield (t/ha) as a result of the various spray treatments. Values above columns followed by the same character are not significantly different (P=0.05).

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 dry and warm weather. Potato late blight severity was very low until half August, including the untreated control. Disease pressure was not enhanced by misting of the crop and relied on natural weather circumstances. Also, no untreated spreader rows were present alongside the experiment. Furthermore no artificial inoculation was carried out. In the neighbourhood fields infected with *P. infestans* were present ensuring some disease pressure. Half August potato late blight was observed in the crop, after that the potato late blight epidemic developed strong. Basically, treatment B, C, D and H 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 E, F and G showed some efficacy to control potato late blight. Nevertheless, disease severity was between 60% and 88% at the last assessment on 28 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 was low and based on weighed none of the treatments were significantly different from the untreated control. Tuber blight incidence (weight) of treatments B and D were lower than treatment C. Based on numbers, tuber blight incidence of treatment B to G were significantly lower than the untreated control comparable top each other. Weather conditions were not conducive for tuber blight since rain was limited and foliar blight severity remained low until half August. After that foliar blight increased exponentially in the following two weeks. In that period precipitation was only measured on 17 August (7.8 mm). Therefore, the risk period for tuber blight was limited at the time the late blight epidemic developed.

4.3 Yield

Total yield was around 40 t/ha which was medium yield considering the dry season. Due to foliar blight severity increasing strong in the second half of August desiccation was carried out early September. Normally in September the crop could grow and a yield of around 60 t/ha would have been possible.
Yield was affected by foliar blight. Yield of treatment G was significantly higher than all other treatments. Treatments E and F gave a higher yield than treatment D and were comparable with the untreated control and treatments B and C.

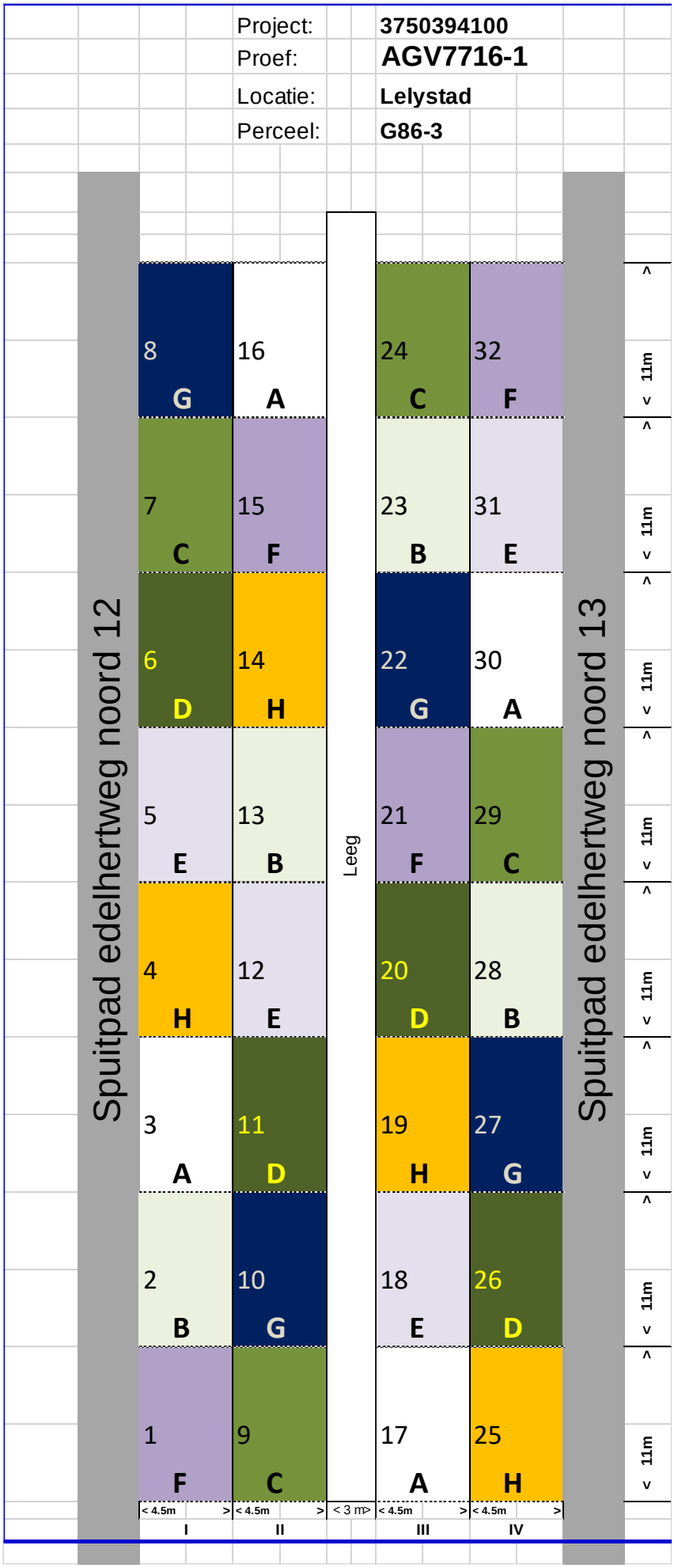
4.4 Conclusions

- No phytotoxicity was observed, the biological crop protection products used were crop safe.
- Based on the StAUDPC treatments B, C, D and H showed no efficacy to control potato late blight, disease severity was comparable to the untreated control.
- Based on the StAUDPC, treatments E, F and G showed a significant efficacy to control potato late blight, where treatment G performed the best, followed by treatment F and in turn followed by treatment E.
- Tuber blight incidence (%) based on number in the untreated control was significantly higher than all other treatments (B to G).
- Yield of treatment G was significantly higher than all other treatments.
- Treatments E and F gave a higher yield than treatment D and were comparable with the untreated control and treatments B and C.

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:	16 May 2019
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:	30 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


Project: 3750394100
Proef: AGV7716-1
Locatie: Lelystad
Perceel: G86-3
Spuitpad edelhertweg noord 12
Spuitpad edelhertweg noord 13
Leeg
8 G
16 A
24 C
32 F
7 C
15 F
23 B
31 E
6 D
14 H
22 G
30 A
5 E
13 B
21 F
29 C
4 H
12 E
20 D
28 B
3 A
11 D
19 H
27 G
2 B
10 G
18 E
26 D
1 F
9 C
17 A
25 H
< 4.5m
< 4.5m
< 3 m>
< 4.5m
< 4.5m
I
II
III
IV
< 11m

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

Assessor:			T	T	T	T	T	T	T	T	T	T	T	
Date:			20-6	26-6	3-7	9-7	16-7	23-7	30-7	6-8	15-8	21-8	28-8	
Crop stage (BBCH):				51	58	65	65	65	65	72	72	75	78	
Crop height (cm):				50	50	60	60	60	60	70	70	70	70	
ıny, half cloudy, cloudy):				Z	Z	Z	hb	z	z	b	b	HB	Z	
			P.	P.	P.	P.	P.	P.	P.	P.	P.	P.	P.	
ɛt (disease/pest/weed):			infestans	infestans	infestans	infestans	infestans	infestans	infestans	infestans	infestans	infestans	infestans	
t level(Field/Leaf/Stem):			Veld	Veld	Veld	Veld	Veld	Veld	Veld	Veld	Veld	Veld	Veld	
Assessment:			Loof	Loof	Loof	Loof	Loof	Loof	Loof	Loof	Loof	Loof	Loof	
Unit:			%	%	%	%	%	%	%	%	%	%	%	
lanner (estimate, count):			Schatten	Schatten	Schatten	Schatten	Tellen	Schatten	Schatten	Schatten	Schatten	Schatten	Schatten	
Field!	**Object!**	**Blok!**	**Phy2006**	**Phy2606**	**Phy0307**	**Phy0907**	**Phy1607**	**Phy2307**	**Phy3007**	**Phy0708**	**Phy1508**	**Phy2108**	**Phy2808**	**StAUDPC**
1	**F**	**1**	0	0	0.01	0	0.02	1	1.5	1.5	1.5	25	75	6.8
2	**B**	**1**	0.001	0.001	0.005	0.016	0.015	2	2.5	2.5	5	70	92	12.5
3	**A**	**1**	0	0.001	0.01	0.015	0.015	3.5	3.5	3.5	7.5	75	90	13.5
4	**H**	**1**	0	0.005	0.005	0.005	0.02	0.3	0.5	1.5	5	75	90	12.4
5	**E**	**1**	0	0.001	0.001	0.015	0.03	2	2	2	2	45	85	9.4
6	**D**	**1**	0	0.001	0.015	0.015	0.05	3	3.5	3.5	7.5	70	90	13.0
7	**C**	**1**	0	0	0	0	0.003	1.5	2	3.5	10	70	90	12.9
8	**G**	**1**	0	0.001	0.001	0.005	0.006	0.1	0.1	0.1	0.1	5	25	1.8
9	**C**	**2**	0.01	0	0.007	0.007	0.01	1.5	3.5	5	7.5	60	90	12.1
10	**G**	**2**	0	0	0.025	0.005	0.005	0.7	1	1.5	1.5	35	85	8.1
11	**D**	**2**	0	0.004	0.01	0.035	0.035	5	7.5	10	20	70	95	15.9
12	**E**	**2**	0	0.002	0.01	0.015	0.015	1.5	2.5	3.5	7.5	65	90	12.3
13	**B**	**2**	0	0	0.01	0.015	0.02	3.5	3.5	7.5	10	80	95	15.0
14	**H**	**2**	0	0.001	0.001	0.025	0.03	1	2	7.5	20	75	97	15.2
15	**F**	**2**	0	0	0	0.005	0.005	1.5	1.5	5	5	50	85	10.4
16	**A**	**2**	0	0.002	0.005	0.01	0.1	3.5	3.5	5	15	70	90	14.0
17	**A**	**3**	0	0.002	0.015	0.015	0.015	1.5	2	2	2.5	60	95	11.3
18	**E**	**3**	0	0.002	0.002	0.01	0.01	1	1	1	1	35	90	8.3
19	**H**	**3**	0	0	0.001	0.015	0.025	0.1	0.7	0.7	2.5	80	95	12.8
20	**D**	**3**	0	0.001	0.02	0.02	0.034	1.5	2.5	2	7.5	70	90	12.6
21	**F**	**3**	0	0.005	0.005	0.015	0.01	1	1.5	1	1	15	65	5.2
22	**G**	**3**	0	0.01	0.03	0.03	0.1	1	1	2	2	10	45	3.9
23	**B**	**3**	0	0.002	0.002	0.002	0.025	2	2.5	3.5	20	75	90	14.5
24	**C**	**3**	0	0.005	0.015	0.03	0.03	2	2	5	10	55	80	11.3
25	**H**	**4**	0	0.001	0.001	0.026	0.026	0.7	1.5	2.5	15	80	97	14.5
26	**D**	**4**	0	0.007	0.007	0.025	0.025	3.5	3.5	10	25	75	90	16.1
27	**G**	**4**	0	0.005	0.005	0.025	0.025	1	1	5	5	20	75	7.0
28	**B**	**4**	0	0.002	0.005	0.005	0.005	5	5	7.5	7.5	70	95	14.1
29	**C**	**4**	0	0.003	0.011	0.011	0.03	5	10	7.5	10	70	90	14.6
30	**A**	**4**	0.005	0.001	0.001	0.02	0.045	7.5	15	7.5	20	75	90	16.9
31	**E**	**4**	0	0	0	0.035	0.035	3.5	7.5	5	10	65	85	13.2
32	**F**	**4**	0	0.001	0.002	0.016	0.015	1	1	5	5	25	75	7.5

Annex 4 Yield and tuber blight

Datum:			24-9				10-10	
Oppervlakte:			11.1					
Maatsortering (cm):			veldgewas					
Opmerkingen:			object H is niet geoogst					
Doel:			P. infestans	P. infestans	P. infestans	P. infestans	gezond	gezond
Beoordeling niveau:			netto veld	netto veld	netto veld	netto veld	netto veld	netto veld
Beoordeling:			Knollen	Knollen	Knollen	Knollen	Knollen	Knollen
Eenheid			aant	kg	aantal	kg	aantal	kg
Manier:			Tellen	Wegen	Tellen	Wegen	Tellen	Wegen
28			**1e beoordeling: 24-9**		**2e beoordeling: 10-10**			
veldnr!	**Object!**	**Blok!**	**P. infestans aant**	**P. infestans kg**	**nfestans aant**	**P. infestans kg**	**healthy #**	**healthy kg**
1	**F**	**1**	0	0.00	0	0.00	395	47.4
2	**B**	**1**	1	0.09	0	0.00	447	44.3
3	**A**	**1**	3	0.19	0	0.00	428	45.4
5	**E**	**1**	0	0.00	1	0.12	393	48.3
6	**D**	**1**	0	0.00	0	0.00	407	45.9
7	**C**	**1**	0	0.00	1	0.24	384	45.5
8	**G**	**1**	1	0.12	0	0.00	390	50.5
9	**C**	**2**	1	0.04	0	0.00	415	43.9
10	**G**	**2**	1	0.05	0	0.00	423	48.0
11	**D**	**2**	1	0.08	0	0.00	434	42.7
12	**E**	**2**	0	0.00	0	0.00	435	45.4
13	**B**	**2**	0	0.00	0	0.00	387	41.9
15	**F**	**2**	1	0.16	0	0.00	424	45.9
16	**A**	**2**	1	0.06	0	0.00	388	40.8
17	**A**	**3**	2	0.09	1	0.06	398	47.1
18	**E**	**3**	0	0.00	0	0.00	409	45.9
20	**D**	**3**	1	0.06	0	0.00	357	39.4
21	**F**	**3**	0	0.00	0	0.00	396	44.8
22	**G**	**3**	0	0.00	0	0.00	476	50.2
23	**B**	**3**	0	0.00	0	0.00	402	44.8
24	**C**	**3**	0	0.00	1	0.03	427	44.9
26	**D**	**4**	1	0.05	0	0.00	374	40.7
27	**G**	**4**	3	0.16	1	0.12	387	47.0
28	**B**	**4**	1	0.08	0	0.00	388	41.0
29	**C**	**4**	0	0.00	3	0.41	406	41.1
30	**A**	**4**	4	0.20	0	0.00	383	38.6
31	**E**	**4**	3	0.22	0	0.00	403	40.9
32	**F**	**4**	1	0.09	0	0.00	397	42.0

Annex 5 Weather data Lelystad

Date	T-gem	T-max	T-min	rain	radiation	RV-min	wind direction	wind speed
01-05-19	9.2	10.8	7.4	0	0	73	WNW	0.7
02-05-19	9.5	12.5	6.2	0.2	0	77	NW	1.5
03-05-19	7.9	9.6	6.2	0.4	0	59	NW	1.9
04-05-19	7.1	9.3	5.6	0.8	0	53	N	3.1
05-05-19	7.4	10.1	4.7	0.2	0	57	WNW	2.4
06-05-19	7.5	10.3	5.7	2.4	0	56	NW	1.3
07-05-19	8.2	11.5	4.8	0	0	58	SE	0.7
08-05-19	9.1	12.8	5.2	0.6	0	59	SSE	0.9
09-05-19	11.3	15.6	7.5	0	0	63	W	1.2
10-05-19	9.8	12	7.9	6.8	0	66	NE	1
11-05-19	8.9	12.5	4.9	0	0	54	ESE	1.3
12-05-19	9.4	12	6.7	0	0	63	NNE	1.4
13-05-19	8.9	12.5	3.3	0	0	53	NNE	0.9
14-05-19	10.5	15.4	5.5	0	0	42	NNE	0.8
15-05-19	11.3	16.1	5.5	0	0	31	NE	0.6
16-05-19	11.1	16.5	6.4	0	0	38	NNE	0.8
17-05-19	12.1	14.2	10	0.8	0	62	NNE	0.6
18-05-19	13.9	19.1	9.9	0.2	0	57	NNW	0.7
19-05-19	13.7	17.3	10.9	4	0	87	NNW	1.2
20-05-19	12.7	14.4	12	0	0	99	NW	1
21-05-19	11.8	12.7	11.2	0	0	98	NW	1.7
22-05-19	12.7	16	10.4	0	0	64	N	0.8
23-05-19	14	19.8	7.9	0	0	45	NW	0.8
24-05-19	13.7	18.7	9.4	0	0	62	N	1.1
25-05-19	12.9	15.2	10.6	0	0	67	WNW	0.9
26-05-19	15	19.6	9.3	7.8	0	64	WSW	1.7
27-05-19	14.1	16.5	11.5	1.4	0	55	WNW	1.6
28-05-19	11.6	14.3	9	0	0	59	N	1.5
29-05-19	12.4	17.8	4.7	0	0	36	WSW	0.9
30-05-19	15.7	19.4	12.2	0	0	67	SSW	1.7
31-05-19	17.1	19.7	14.4	0	0	64	S	1.4
01-06-19	17.1	21.5	11.6	0	0	65	E	0.8
02-06-19	21.9	28.9	14.4	0	0	38	SW	1.1
03-06-19	17.3	19.5	15.1	0	0	53	NNW	0.9
04-06-19	18.2	23.3	12.3	22	0	39	SSE	0.8
05-06-19	16.6	18.5	14.6	0.8	0	74	SE	1.5
06-06-19	14.8	17.2	12.1	5.6	0	53	ENE	1.6
07-06-19	15.1	21.6	10.1	0.2	0	52	SSE	0.8
08-06-19	14	16.5	12.1	1.8	0	55	SSW	2.3
09-06-19	14.1	18.6	9.5	0	0	53	NNE	0.9
10-06-19	16.6	21.7	12.3	20.6	0	61	N	0.9
11-06-19	15.1	17.9	12.6	1.4	0	65	NNW	0.7

12-06-19	12.7	17.7	3.5	7.8	0	24	S	0.7
13-06-19	13	17	4.6	2.6	0	31	SSE	1.2
14-06-19	14.9	22	4.8	1.4	0	32	ESE	0.8
15-06-19	13.7	17.9	3.8	6.2	0	25	WSW	0.6
16-06-19	15.8	19.9	9	1	0	39	WSW	0.7
17-06-19	18.2	23.7	12.2	0	0	54	NNE	0.7
18-06-19	18.8	23.3	13.5	0	0	63	NNE	0.7
19-06-19	18.4	22.9	14.9	7.2	0	69	SSE	0.8
20-06-19	16.5	18.7	14.6	6.2	0	72	SW	0.9
21-06-19	15.2	18.7	11.7	0	0	61	NNW	1.1
22-06-19	15.8	20.4	9.4	0	0	59	NNE	0.9
23-06-19	20.8	28.2	13.6	0	0	42	E	0.8
24-06-19	24.5	30.4	18.2	0	0	46	ESE	1.9
25-06-19	25.8	32.1	20.1	0	0	47	WNW	1.4
26-06-19	19.1	22.7	15.3	0	0	76	N	3.5
27-06-19	15.1	17.7	12.3	0	0	71	N	2.8
28-06-19	16.9	22.7	13.2	0	0	56	NE	1.2
29-06-19	21.8	30.8	12.1	0	0	34	SSE	0.9
30-06-19	20.2	22.7	16.8	0	0	63	SSW	1.2
01-07-19	17.4	19.6	14.8	0	0	59	WSW	1.8
02-07-19	16.6	19	14	0	0	57	NNW	3.3
03-07-19	15.1	17.7	11.9	0	0	58	N	3.1
04-07-19	15.4	20.2	9.7	0	0	58	SSW	1.6
05-07-19	17.8	21	14.4	0	0	55	NW	2.3
06-07-19	15.6	19.2	13.5	3.4	0	73	NW	2.5
07-07-19	14.2	16.6	12.7	0.2	0	60	NW	3.3
08-07-19	13.6	15.2	12.3	0.4	0	69	SW	3.7
09-07-19	14.4	17.1	12	0.4	0	59	NE	2.8
10-07-19	13.3	15.8	10.2	4.6	0	63	SSE	1.6
11-07-19	16.9	20.5	14	3.6	1.273	79	WNW	1.6
12-07-19	16.3	20.3	13.7	4.6	3.104	84	NNW	1.7
13-07-19	16.2	18.4	14.7	0.2	4.6	73	NW	3.5
14-07-19	14.8	17	13.3	0.6	4.993	72	NNE	3.4
15-07-19	14.4	16.4	13.1	0	3.779	73	NNW	2.7
16-07-19	14.9	17.1	12.6	0	3.264	73	N	1.6
17-07-19	15.8	22	10.3	0	7.143	55	N	1
18-07-19	18.2	22.8	14.1	0.8	5.26	52	SW	2.3
19-07-19	18.5	22.8	13.6	0	5.422	50	ESE	1.2
20-07-19	18.9	22.4	16.5	4.2	3.838	71	SW	2.7
21-07-19	18.4	21.5	15.2	0	7.45	47	NW	2.2
22-07-19	19.5	25.5	13.7	0	6.315	58	SW	1.8
23-07-19	22.3	28.3	14.9	0	8.15	50	NNE	1.3
24-07-19	25.7	35.2	17.4	0	7.681	27	NNW	1.1
25-07-19	27	36.8	17	0	7.281	34	NE	1.2
26-07-19	29	35.1	23.8	0	7.43	28	NNW	1.9
27-07-19	24.7	30.9	19.8	0	6.703	33	WNW	1.4
28-07-19	20.7	26.1	18.2	0	5.047	58	SW	1.1
29-07-19	19.8	24	16	0	7.436	46	NNE	1.2
30-07-19	21.7	28.1	15.9	0	7.1	35	N	1.5

31-07-19	17.7	20.6	15.9	13	3.542	64	S	1.4
01-08-19	17.4	20.8	14.3	1.4	4.401	73	SW	1.2
02-08-19	17.4	19.8	15.7	5.2	3.14	83	ESE	1.3
03-08-19	17.5	19.5	15.5	0	2.754	72	NNW	1.1
04-08-19	18.1	22.9	13.2	0	5.611	58	ENE	0.8
05-08-19	19.6	23.1	16.7	0	5.365	59	SW	1.5
06-08-19	18.8	22	14.9	0	5.814	57	SE	1.1
07-08-19	18.8	22	15.6	0	6.683	57	SSW	1.4
08-08-19	18.5	22.5	14.8	0	5.916	54	NW	1.4
09-08-19	17.4	21.7	12.5	4.8	1.987	90	SSW	1
10-08-19	19.8	22.1	17.8	0	4.878	53	SSW	3
11-08-19	17.7	20.9	14.4	0	4.448	55	SSW	2.1
12-08-19	15.6	18.9	13.5	2	3.715	76	WNW	1.3
13-08-19	14.4	17.4	11.5	5	4.9	65	SW	1.1
14-08-19	15.1	20.6	9.9	5.6	5.747	51	SSE	2
15-08-19	16.6	19.4	14.4	15	3.695	79	W	2.3
16-08-19	16.7	20.5	11.6	0	4.502	63	S	1.5
17-08-19	17.2	19.3	15.6	7.8	2.801	85	SSW	2.2
18-08-19	16.3	19.2	14.8	0.2	3.017	70	SSW	1.7
19-08-19	16.4	20.3	13.1	0	6.038	52	WSW	2.5
20-08-19	15.9	19.9	12.2	0.2	5.291	58	S	1.9
21-08-19	15.7	20.9	10.5	0	5.412	48	NNW	1.1
22-08-19	16.8	22.6	11	0	6.723	50	SSE	1.3
23-08-19	17.6	23.5	11.5	0	6.545	50	NE	0.9
24-08-19	21	28.8	13.9	0	6.723	31	ENE	0.9
25-08-19	21.2	29.1	13.8	0	6.426	34	ENE	0.7
26-08-19	22.4	29.2	15.6	0	6.014	44	NNE	1.1
27-08-19	24.3	31.6	16.6	0	5.431	40	S	1
28-08-19	22.1	26.4	18.3	0	4.308	57	WSW	1.6
29-08-19	19.1	22.1	15.2	1.8	4.647	64	S	1.7
30-08-19	16.8	21.8	12.1	0	5.782	57	ESE	1.4
31-08-19	19.5	26.5	12.9	0	5.597	43	WNW	1

To explore the potential of nature to improve the quality of life

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