Biological efficacy of experimental products to control potato late blight

Pot experiment KAS 1075 November 2021

A. Evenhuis & C.G. Topper

This study was carried out by the Wageningen Research Foundation (WR) business unit Field Crops and was commissioned and financed by PPS AF 16002 MIP.

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

Wageningen, November 2021

WPR-OT 937

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Contents

1 Introduction

Late blight, caused by *Phytophthora infestans*, is the most important disease in potato production because of its capacity to destroy foliage very rapidly and its ability to infect tubers. To avoid infection of the foliage, fungicides are used frequently. In the Netherlands, in some years up to 15 sprays are necessary to prevent the crop from infection by the pathogen.

Efficient use of crop protection agents is desirable. Improvement of the efficacy of active ingredients is a possibility to reduce environmental burden and at the same time achieve better results to control late blight in the field. To reduce the environmental burden choosing crop protection products with no or low environmental impact is also an option. Obviously these must be effective to be included in a controls strategy in practise.

The efficacy of fungicides to control late blight depends on their characteristics, dose rate and the time between the spray application and the infection of *P. infestans*.

In this experiment the efficacy of experimental products to control *P. infestans* was tested in a pot experiment in comparison with a copper reference. The experiment aimed to resemble agricultural practise as close as possible within an experimental set-up. The experiment was carried as part of research project AF 16002 MIP.

2 Methods and materials

2.1 Experimental set up

The cultivated tomato plants (cv. HANAMI-cherry tomato, susceptible to *P. infestans*) were grown in pots. The experiment was carried out in accordance with GEP (NVWA-recognition; Appendix 1) The experiment was artificially inoculated.

Conducted Under GLP: No Official Trial ID: -
Conducted Under GEP: Yes Other Trial ID: KAS1075

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 fungicides used, dose rates and the spray timing are presented. The fungicide sprayings were carried out when the tomato plants reached a height of 25-30 cm. The tomato plants were sprayed in a spraying cabin developed by Wageningen University & Research business unit Applied Arable and Vegetable Research (Field Crops). The fungicides were sprayed using a spray boom with three spray nozzles Airmix 110 05 at 2.5 bar, placed 50 cm apart, which was moving with a speed of 5 km/h, approximately 40 cm over the top of the tomato plants. Spray volume was 500 l/ha. Spray application was carried out on 10 (T1) & 16 (T2) November 2021.

Table 1 Treatments and fungicides applied 7 (T1) and 1 (T2) day before inoculation

Code	Fungicide	Dose rate l or kg per ha	Active ingredient	Spray applications
A	UTC	-	-	-
B	Nordox 45 WG	0.5	Cu 450 g/kg	T2
C		0.75		T1 & T2
D		2		T1 & T2
E		2		T2
F		1		T2
G		12.5		T1 & T2
H		12.5		T2
J		6.25		T2
K		2		T2
L		5		T1 & T2
M	UTC not inoculated	-		-

2.3 Inoculation *P. infestans*

The inoculation procedure was carried out according to a standard protocol that is used for all late blight experiments. A *P. infestans* isolate belonging to the EU-13-A2 clonal lineage was used. This isolate was chosen because it belongs to the most important genetic group of *P. infestans* in Europe. The isolate was stored in liquid nitrogen at Wageningen University & Research business unit BioInteractions & Plant Health. From the isolate a plate culture was made. The inoculum suspension was made by rinsing a one week old culture of *P. infestans* with water. The inoculum density was set at approximately 5.000 spores/ml. Inoculation was carried out by spraying tomato plants over head with approximately 10 ml of inoculum per plant. Inoculation was carried out on air dry plants. The experiment was inoculated on 17 November 2021.

2.4 Disease observations

Disease observations were carried out three times. The percentage necrotic foliage of four leaf layers per plant was estimated visually. Average disease severity was calculated per assessment date and over the three assessment dates.

2.5 Statistics

Analysis of variance on the parameters was made using GENSTAT 19th Edition. The experiment was carried out with four replications. Each replication consisted of a potted tomato plant. Transformation of data was carried out when necessary. Treatment M (untreated & not inoculated) was omitted from the analysis.

3 Results

No phytotoxicity on the tomato plants after spray application of the fungicides was observed. The results are presented in Table 2, Figure 1 and Figure 2. In Appendix 2 the detailed data are presented.

Based on the StAUDPC, the disease severity of treatments B, D, E and F were significantly lower than the untreated control, showing efficacy to control potato late blight.

Table 2 Tomato late blight severity (%) at 6, 7 and 9 days after inoculation (dpi) and the standard area under the disease progress curve (StAUDPC).

Code	6 dpi[1]	7 dpi	9 dpi	StAUDPC
A	42.8 d[2]	67.2 cd	95.9 d	72.7 de
B	1.8 ab	21.1 a	47.8 b	26.8 b
C	44.0 d	73.1 d	95.4 d	75.8 e
D	1.2 a	16.6 a	31.3 a	18.9 a
E	2.6 b	25.5 a	48.8 b	29.4 b
F	5.7 c	38.1 b	73.8 c	44.8 c
G	36.2 d	65.3 cd	93.9 d	70.1 de
H	40.2 d	64.1 cd	90.4 d	69.0 d
J	37.9 d	64.1 cd	94.3 d	70.2 de
K	35.6 d	66.3 cd	93.6 d	70.7 de
L	42.7 d	61.6 c	94.6 d	69.5 de
Lsd	-	9.2	7.1	6.6
F pr.	<0.001	<0.001	<0.001	<0.001

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

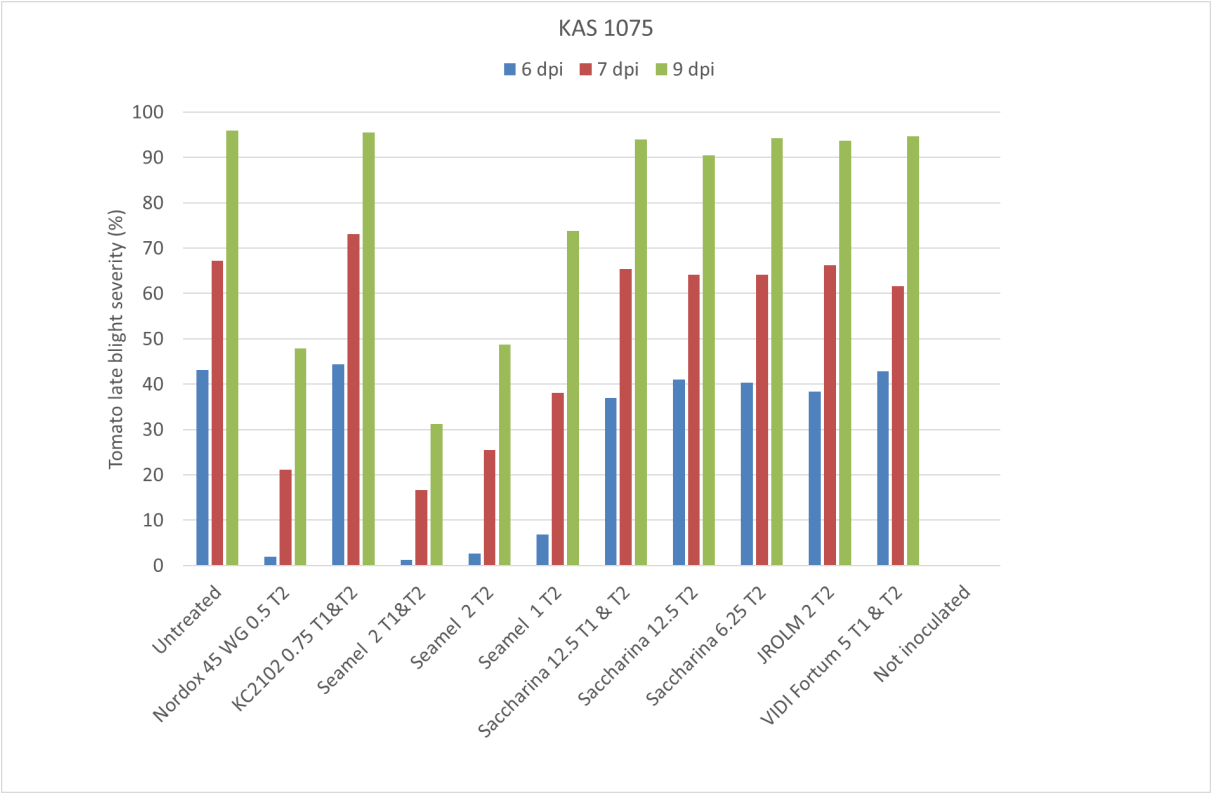

Figure 1 Late blight severity 6, 7 and 9 days after inoculation on the whole plant.

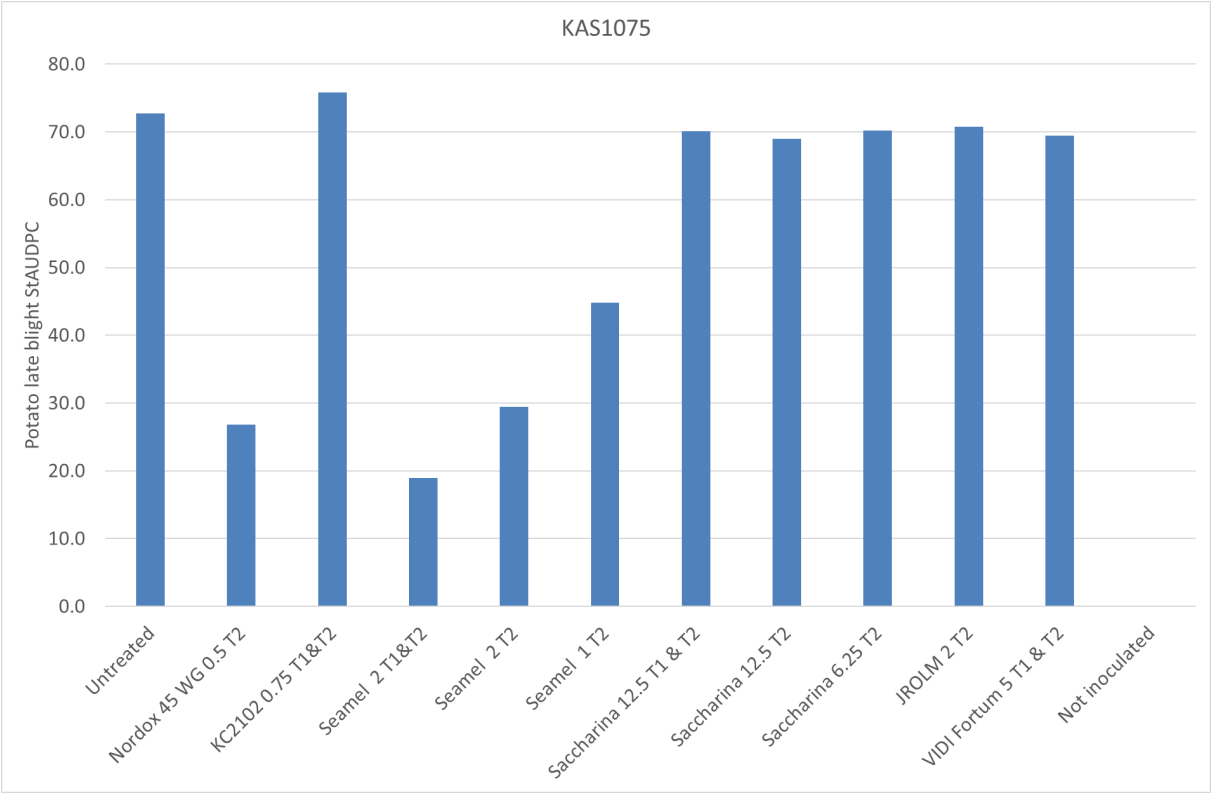

Figure 2 Average, expressed as StAUDPC, potato late blight severity (average of 3 assessments) after inoculation on whole tomato plants.

Figure 3 Tomato plants 9 days after inoculation with *P. infestans*, treatments A, B, C, D, E, F, G, H and J.

Figure 4 Tomato plants 9 days after inoculation with *P. infestans*, treatments K, L and M.

4 Discussion and conclusion

4.1 Discussion

The untreated control (UTC) was readily infected by *P. infestans* indicating that the artificial inoculation was successful. The experiment was inoculated with an isolate belonging to the clonal lineage EU-13-A2. In North west Europe EU-13-A2 is a regularly found genotype of the *P. infestans* population. EU-13-A2 is generally accepted as an aggressive *P. infestans* type on potato. The strain also readily infects tomato.
The efficacy of Copper to control potato late blight was 63% in this experiment, which indicates that a fairly effective control was possible. The efficacy of Seamel 2.0 l/ha sprayed at T1 and T2 to control potato late blight under greenhouse conditions was about 74%, when sprayed twice. It dropped to 60% when sprayed only at T2. A significant dose response effect of Seamel was found.
Other test products (treatments C, G, H, J , K and L) showed no efficacy to control potato late blight. In the greenhouse only one infection period occurs at the time of inoculation. This is different from the field situation where multiple infection periods occur under suitable weather. This might indicate that products usually perform better under greenhouse conditions than in the field.

4.2 Conclusions

- No phytotoxicity was observed in this experiment, the products sprayed were crop safe.
- The products sprayed behaved according to rating 1: the products were easily dissolved and no issue occurred at spray application.
- Based on the StAUDPC, the disease severity of treatments B, D, E and F were significantly lower than the untreated control.
- The efficacy to control potato late blight of treatment D was significantly better than all other treatments.
- The efficacy to control potato late blight of treatments B and E were comparable and significantly better than treatments A, C, F to L.
- The efficacy to control potato late blight of treatment F was significantly better than treatments A, C, G to L.

Annex 1 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 2 Disease observations

Projectnummer: 3750365100
Proef nummer: KAS1076
Locatie: LS

WAGENINGEN
UNIVERSITY & RESEARCH

Gewas: Tomato
Onderzoeker: Evenhuis
Uitvoerders:
Datum: T 23-11 (0) | T 24-11 (1)

Opmerkingen:

Doel:			Phytophthora infestans	Phytophthora infestans	Phytophthora infestans	Phytophthora infestans		Phytophthora infestans	Phytophthora infestans	Phytophthora infestans	Phytophthora infestans	
Beoordeling niveau:			Samengeseld bl	Samengeseld bl	Samengeseld bl	Samengeseld blad 4		Samengeseld b	Samengeseld b	Samengeseld b	Samengeseld blad 4	
Beoordeling:			Blad	Blad	Blad	Blad		Blad	Blad	Blad	Blad	
Eenheid:			%	%	%	%		%	%	%	%	
Manier:			Schatten	Schatten	Schatten	Schatten		Schatten	Schatten	Schatten	Schatten	
Potnr	**Code**	**Blok**					**PHYTIN AVG**					**PHYTIN AVG**
Potnr	**Object!**	**Blok!**	**Blad12311**	**Blad22311**	**Blad32311**	**Blad42311**	**Phy6dpi**	**Blad12411**	**Blad22411**	**Blad32411**	**Blad42411**	**Phy7dpi**
1	**L**	**H1**	50	30	35	40	38.75	45	45	55	55	50
2	**K**	**H1**	50	30	60	40	45	65	65	45	65	60
3	**F**	**H1**	15	12	8	20	13.75	55	60	30	60	51.25
4	**C**	**H1**	35	35	60	65	48.75	65	60	70	80	68.75
5	**A**	**H1**	20	45	55	65	46.25	65	65	70	75	68.75
6	**G**	**H1**	10	10	35	60	28.75	65	65	70	70	67.5
7	**H**	**H1**	5	45	60	55	41.25	55	55	65	60	58.75
8	**M**	**H1**	0	0	0	0	0	0	0	0	0	0
9	**J**	**H1**	5	20	25	30	20	60	55	60	65	60
10	**E**	**H1**	3	3	3	4	3.25	25	15	18	20	19.5
11	**B**	**H1**	2.5	2	3	4	2.875	25	25	35	35	30
12	**D**	**H1**	1	3	2	1	1.75	20	20	10	12	15.5
13	**D**	**H2**	0.5	0.5	1	1	0.75	18	15	12	12	14.25
14	**F**	**H2**	0	2.5	5	8	3.875	25	40	45	45	38.75
15	**H**	**H2**	30	60	55	65	52.5	65	70	65	70	67.5
16	**L**	**H2**	30	35	55	60	45	70	75	55	70	67.5
17	**M**	**H2**	0	0	0	0	0	0	0	0	0	0
18	**J**	**H2**	55	35	65	65	55	80	65	70	75	72.5
19	**G**	**H2**	45	25	30	50	37.5	75	65	65	75	70
20	**A**	**H2**	40	60	45	55	50	65	65	65	75	67.5
21	**C**	**H2**	15	55	55	55	45	70	80	75	70	73.75
22	**E**	**H2**	2	3	3	5	3.25	30	35	35	30	32.5
23	**B**	**H2**	0	2	2	4	2	9	6	20	18	13.25
24	**K**	**H2**	65	60	40	60	56.25	80	70	65	75	72.5
25	**B**	**H3**	0.5	1	1	1	0.875	15	25	30	35	26.25
26	**C**	**H3**	30	30	40	40	35	80	75	75	75	76.25
27	**M**	**H3**	0	0	0	0.5	0.125	0	0	0	1	0.25
28	**J**	**H3**	30	60	40	40	42.5	60	70	75	65	67.5
29	**H**	**H3**	25	35	45	55	40	60	60	65	75	65
30	**F**	**H3**	3	3	12	12	7.5	35	35	35	40	36.25
31	**D**	**H3**	0.5	0.5	0.5	1.5	0.75	30	18	25	30	25.75
32	**K**	**H3**	12	35	7	20	18.5	70	65	50	60	61.25
33	**G**	**H3**	35	20	40	35	32.5	75	55	55	65	62.5
34	**E**	**H3**	1	3	1	4	2.25	25	15	20	35	23.75
35	**A**	**H3**	10	35	60	40	36.25	70	60	85	70	71.25
36	**L**	**H3**	35	40	40	65	45	70	55	60	65	62.5
37	**F**	**H4**	1	3	1	4	2.25	15	30	25	35	26.25
38	**G**	**H4**	50	40	45	60	48.75	50	65	65	65	61.25
39	**K**	**H4**	30	15	40	50	33.75	80	60	70	75	71.25
40	**M**	**H4**	0	0	0	0	0	0	0	0	0	0
41	**H**	**H4**	15	30	60	15	30	60	55	65	80	65
42	**E**	**H4**	0	2	1	4	1.75	20	25	25	35	26.25
43	**D**	**H4**	1	2	2.5	1.5	1.75	18	7	9	10	11
44	**B**	**H4**	1.5	3	1	1.5	1.75	10	25	15	10	15
45	**J**	**H4**	35	40	55	45	43.75	55	60	55	55	56.25
46	**C**	**H4**	40	55	60	40	48.75	75	70	75	75	73.75
47	**A**	**H4**	30	30	55	45	40	55	55	65	70	61.25
48	**L**	**H4**	30	40	40	60	42.5	65	65	70	65	66.25

Projectnummer: 3750365100
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WAGENINGEN
UNIVERSITY & RESEARCH

Gewas: Tomato
Onderzoeker: Evenhuis
Uitvoerders: T
Datum: 24-11
3

Opmerkingen:

Doel:	Phytophthora infestans	Phytophthora infestans	Phytophthora infestans	Phytophthora infestans		
Beoordeling niveau:	Samengeseld b	Samengeseld b	Samengeseld b	Samengeseld blad 4		
Beoordeling:	Blad	Blad	Blad	Blad		
Eenheid:	%	%	%	%		
Manier:	Schatten	Schatten	Schatten	Schatten		

Potnr Potnr	Code Object!	Blok Blok!	Blad12611	Blad22611	Blad32611	Blad42611	Phy9dpi	StAUDPC
1	L	H1	97	98	92	90	94.25	62.9
2	K	H1	95	98	85	90	92	68.2
3	F	H1	60	85	85	75	76.25	53.3
4	C	H1	98	95	95	98	96.5	74.7
5	A	H1	95	97	92	100	96	74.1
6	G	H1	95	95	90	95	93.75	69.8
7	H	H1	98	95	98	98	97.25	68.7
8	M	H1	0	0	0	0	0	0.0
9	J	H1	90	97	92	95	93.5	64.5
10	E	H1	55	40	40	40	43.75	24.9
11	B	H1	40	40	65	65	52.5	33.0
12	D	H1	30	45	25	25	31.25	18.5
13	D	H2	30	35	40	30	33.75	18.5
14	F	H2	75	75	80	80	77.5	45.9
15	H	H2	92	95	90	100	94.25	73.9
16	L	H2	95	98	100	98	97.75	73.8
17	M	H2	0	0	0	0	0	0.0
18	J	H2	97	95	90	97	94.75	77.0
19	G	H2	99	95	85	90	92.25	72.0
20	A	H2	97	98	100	100	98.75	75.0
21	C	H2	98	98	90	97	95.75	76.3
22	E	H2	45	50	55	55	51.25	33.9
23	B	H2	40	30	40	55	41.25	20.7
24	K	H2	97	98	95	95	96.25	77.7
25	B	H3	50	60	65	55	57.5	32.4
26	C	H3	97	98	97	99	97.75	76.5
27	M	H3	0	0	0	2	0.5	0.3
28	J	H3	92	100	95	90	94.25	72.3
29	H	H3	9	98	90	100	74.25	63.9
30	F	H3	70	75	70	75	72.5	43.5
31	D	H3	15	55	30	30	32.5	23.8
32	K	H3	97	95	85	90	91.75	64.3
33	G	H3	90	97	85	95	91.75	67.3
34	E	H3	30	60	60	40	47.5	28.1
35	A	H3	97	97	100	85	94.75	73.3
36	L	H3	97	90	90	98	93.75	70.0
37	F	H4	70	80	60	65	68.75	36.4
38	G	H4	97	98	98	99	98	71.4
39	K	H4	98	80	100	100	94.5	72.8
40	M	H4	0	0	0	0	0	0.0
41	H	H4	97	90	97	100	96	69.5
42	E	H4	50	55	50	55	52.5	30.9
43	D	H4	25	20	35	30	27.5	15.0
44	B	H4	30	55	40	35	40	21.1
45	J	H4	95	95	90	98	94.5	66.9
46	C	H4	92	95	95	85	91.75	75.6
47	A	H4	90	97	x	95	94	68.6
48	L	H4	97	92	92	90	92.75	71.1

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