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vegIMPACT

Late Blight demonstrations December 2013-February 2014

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vegIMPACT
Improved Vegetable Production and Marketing for small farmers to Increase the Food Security status and to promote Private Sector Development in Indonesia

vegIMPACT is a program financed by The Netherlands' Government promoting improved vegetable production and marketing for small farmers in Indonesia, contributing to the food security status and private sector development in Indonesia. The program builds on the results of previous joint Indonesian-Dutch horticultural development cooperation projects and aligns with recent developments in the horticultural private sector and retail in Indonesia. The program activities (2012 – 2016) include the Development of Product Market Combinations, Strengthening the Potato Sector, Development of permanent Vegetable Production Systems, Knowledge Transfer and Occupational Health.

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Contents

1. Introduction

Late blight caused by *Phytophthora infestans* is one of the most important diseases worldwide. Also in Indonesia control of late blight is very important in potato and tomato, especially in the rainy season (Photo 1). In order to learn more about the important factors that determine late blight control - such as product choice, application frequency, spray volume and use of adjuvants - two demo plots were laid out in the potato growing regions of Garut and Pangalengan. The treatments in the demo-plots consisted of different fungicide application strategies.

Photo 1. Late infected potato crop in a commercial field (December 2013).

2. Materials and methods

2.1 Demo-plot lay-out

Demonstration plots in Pangalengan and Garut were planted respectively on 4 and 5 December 2013 (rainy season) with the potato varieties Granola and Atlantic. The plots consisted of 3 beds of 2 rows each with in total 40 plants with an area of 6 x 4 m. The demo-plot was laid-out in 4 replicates (Appendix 1). The beds were covered with a silver-coloured plastic mulch. The demo-plots were surrounded by border plots. The plants were not artificially inoculated with late blight.

2.2 Spray applications

In Table 1 and Table 2 the fungicides used and the fungicide application strategies are presented. The strategies consisted of both a Farmers Practice and an alternative 'vegIMPACT' strategy applied in the Atlantic as well as Granola variety. The Farmers Practice strategy, the application interval, the spray volume and adjuvant choice were selected on the basis of the inventory described by De Putter et al. (2014). The vegIMPACT strategies in Granola and Atlantic were selected based on their susceptibility for late blight and the characteristics of the products described in the fungicide table of EuroBlight (www.euroblight.net).
The treatments were applied with a spray interval of 4 days using a battery powered (to provide constant pressure) knapsack sprayer (16 litre) with a spray volume of 600 l/ha (Photo 3). Spray schedules for 18 applications were made but since the growing seasons was shorter than beforehand expected only 13 (Pangalengan) and 14 (Garut) applications were applied. In Garut dates of application were 19, 24, 28 December 2013; 1, 5, 9, 13, 17, 21, 25 and 29 January 2014; 3, 7 and 11 February 2014. In Pangalengan, application dates were 26 and 30 December 2013; 3, 7, 11, 15, 19, 23, 27 and 31 January 2014; 4, 8 and 12 February 2014. The adjuvant Agristick was added to all treatments to provide extra rain fastness to the fungicides.

Photo 2. Lay-out of the demo-plots in Pangalengan, December 2013.

Photo 3. A battery powered knapsack sprayer was used in both demo-plots in Garut and Pangalengan.

Table 1. Fungicide and adjuvant doses and costs used in the demonstration plots.

Product name	**Active ingredients**	**Dose rate**	**Per 4 plots/replicates (96 m^2)**		**Per hectare (10,000 m^2) with 600 liter**	
			Dose (g or ml)	**Cost (IDR)**	**Dose (g or ml)**	**Cost (IDR)**
Daconil 75 WP	chlorothalonil (75%)	100%	9	1,305	936	135,720
Dithane M45 80 WP	mancozeb (80%)	50%	6	570	624	59,280
Curci 10 WP	cymoxanil (10%)	50%	12	1,200	1,248	124,800
Curzate 64/8 WP	mancozeb (64%) + cymoxanil (8%)	100%	24	3,600	2,496	374,000
Akrobat 50 WP	dimethomorph (50%)	50%	1.5	1,050	156	109,200
Trivia 73 WP	propineb (67%) + fluopicolide (6%)	100%	10	3,250	1040	338,000
Revus 250 SC	mandipropamid (250 g/l)	100%	3	2,700	312	280,800
Infinito 687.5 SC	propamocarb (625 g/l) + fluopicolide (62.5 g/l)	100%	15	6,600	1,560	686,400
Agristick 400 L	adjuvant	100%	3	210	312	21,840

Table 2. The spray schedules used in the demonstration plots. In Garut 14 fungicide applications were applied in Pangalengan 13 spray applications were applied.

	Atlantic		Granola	
#	**Farmers practice**	**vegIMPACT**	**Framers practice**	**vegIMPACT**
1	100% Daconil +50% Dithane + 50% Curci	100% Curzate	100% Daconil + 50% Dithane + 50% Akrobat	100% Trivia
2	100% Daconil +50% Dithane + 50% Curci	100% Curzate	100% Daconil + 50% Dithane + 50% Akrobat	100% Trivia
3	100% Daconil +50% Dithane + 50% Curci	100% Curzate	100% Daconil + 50% Dithane + 50% Akrobat	100% Trivia
4	100% Daconil +50% Dithane + 50% Curci	100% Curzate	100% Daconil + 50% Dithane + 50% Akrobat	100% Trivia
5	100% Daconil +50% Dithane + 50% Curci	100% Curzate	100% Daconil + 50% Dithane + 50% Akrobat	100% Trivia
6	100% Daconil +50% Dithane + 50% Curci	100% Curzate	100% Daconil + 50% Dithane + 50% Akrobat	100% Trivia
7	100% Daconil +50% Dithane + 50% Curci	100% Revus	100% Daconil + 50% Dithane + 50% Akrobat	100% Curzate
8	100% Daconil +50% Dithane + 50% Curci	100% Revus	100% Daconil + 50% Dithane + 50% Akrobat	100% Curzate
9	100% Daconil +50% Dithane + 50% Curci	100% Revus	100% Daconil + 50% Dithane + 50% Akrobat	100% Curzate
10	100% Daconil +50% Dithane + 50% Curci	100% Revus	100% Daconil + 50% Dithane + 50% Akrobat	100% Curzate
11	100% Daconil +50% Dithane + 50% Curci	100% Revus	100% Daconil + 50% Dithane + 50% Akrobat	100% Curzate
12	100% Daconil +50% Dithane + 50% Curci	100% Revus	100% Daconil + 50% Dithane + 50% Akrobat	100% Curzate
13	100% Daconil +50% Dithane + 50% Curci	100% Infinito	100% Daconil + 50% Dithane + 50% Akrobat	100% Curzate
14	100% Daconil +50% Dithane + 50% Curci	100% Infinito	100% Daconil + 50% Dithane + 50% Akrobat	100% Curzate

2.3 Disease observations

Late blight observations were carried out every 4 days on the net plots which consisted of 32 plants. The percentage of infected foliage was estimated for each of the 32 plants per plot. The average percentage infected foliage was calculated per plot. For the assessments, two visual keys were used namely:

- Efficacy evaluation of fungicides: *Phytophthora infestans* on potato. EPPO Guideline PP 1/2 (4)
- An illustrated assessment key for foliage blight of potatoes (Cruickshank et al., 1982).

The AUDPC (Area Under the Disease Progress Curve) was calculated and used as an indicator of the efficacy of the strategies during the complete growing season. The AUDPC is a measure of the total amount of disease over a period of time, determined from graphs of disease *vs*. time, which can be used to compare epidemics quantitatively.

2.4 Yield

Crops were harvested by hand in Pangalengan and Garut on 19 February 2014 and 5 March 2014, respectively. The tubers were classified in Class A (1 kg = 5 tubers), Class B (1 kg = 10 tubers) and Class C (1 kg = 20 tubers) and weighed. Also the rotten tubers were weighed.

3. Results

3.1 Pangalengan

Percentage infected foliage per treatment and AUDPC is presented in Table 3. Figure 1 is a graphic representation of the late blight assessments per treatment. On 25 December 2013, one day before the first fungicide application, potato late blight was already observed in some plots, indicating that the natural inoculum pressure at that time was very high.

Till the end of January the percentage infection in all strategies was below 10 %, thereafter the epidemic developed exponentially. In the beginning of February especially Atlantic was seriously infected (Photo 4). In both Atlantic and Granola, the Farmers Practice and vegIMPACT strategy resulted in a similar effect on the late blight epidemic. The AUDPC of both strategies in Atlantic was significantly higher compared to the strategies in Granola. The potatoes were harvested on 19 February 2014 and graded in class A, B and C and rotten tubers. The yield was low caused by the early and severe epidemic of late blight (Table 4). In both Atlantic and Granola the marketable yield of the Farmers Practice strategy was higher compared to the vegIMPACT strategy. Costs for the vegIMPACT strategy were higher than the Farmers practice strategy in both Atlantic and Granola (Table 5).

Photo 4. Seriously infected Atlantic plants in demo plots in Pangalengan (5 February 2014).

Table 3. The percentage foliage infected and AUDPC in the different strategies in Pangalengan.

	Atlantic		Granola	
	Farmers Practice	vegIMPACT	Farmers Practice	vegIMPACT
25 December 2013	3.0	1.4	0	0
29 December 2013	7.1	6.6	2.1	1.4
2 January 2014	9.3	8.0	3.0	2.0
6 January 2014	3.7	1.2	0.7	0
10 January 2014	1.2	1.2	0.1	0
14 January 2014	1.5	1.8	0.2	0.1
18 January 2014	2.4	4.3	0.4	0
22 January 2014	6.2	10.1	3.1	0.3
26 January 2014	14.3	25.8	8.4	1.8
30 January 2014	22.4	31.4	16.8	9.2
3 February 2014	50.3	58.2	29.6	18.7
7 February 2014	91.6	95.1	65.1	63.7
11 February 2014	99.4	99.9	90.6	94.2
15 February 2014	100	100	98.5	99.4
AUDPC	1450 b[1]	1580 b	1078 a	965 a

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

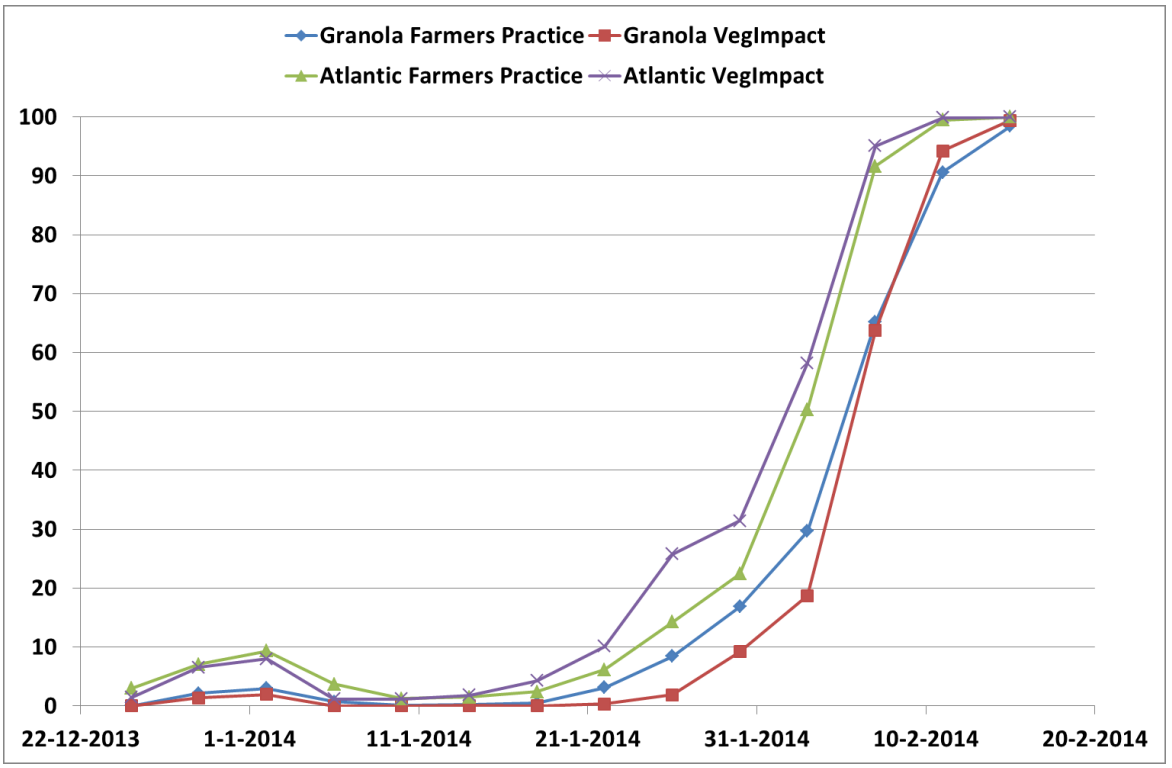

Figure 1. The development of foliar blight (as percentage infected foliage) during the growing season in Pangalengan.

Table 4. Potato yield in the different strategies in Pangalengan.

	Atlantic		Granola	
	Farmers Practice	vegIMPACT	Farmers Practice	vegIMPACT
Class A (ton/ha)	6.7	5.3	0	0
Class B (ton/ha)	4.7	4.8	5.2	4.6
Class C (ton/ha)	2.3	2.4	6.6	5.4
Total Marketable Yield (ton/ha)	13.7 c[1]	12.5 b	11.8 b	10.0 a
Rotten tubers (kg/ha)	0.8	0.6	0.3	0.2

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

Table 5. Cost (IDR) per 4 plots of the 13 fungicide applications sprayed with 600 l/ha per application of the different strategies in Pangalengan.

Strategy	Cost (IDR)
Atlantic: Farmers Practice	42,705
Atlantic: vegIMPACT	47,130
Granola: Farmers Practice	40,755
Granola: vegIMPACT	47,430

3.2 Garut

Percentage infected foliage per treatment and AUDPC is presented in Table 6. Figure 2 is a graphic representation of the late blight assessments per treatment. On 23 December 2013, one day before the second treatment, potato late blight was already observed in some plots, indicating that the natural inoculum pressure at that time was very high.

Till the beginning of February the percentage infection in all strategies was below 10 % (Photo 5), thereafter the epidemic developed exponentially. In both Atlantic and Granola, the Farmers Practice and vegIMPACT strategy resulted in a comparable effect on the late blight epidemic. The AUDPC of both strategies in Atlantic was significantly higher compared to the strategies in Granola. The potatoes were harvested on 5 March 2014 and sorted in class A, B and C and rotten tubers. Marketable yield was much higher compared to Pangalengan caused by a later epidemic of late blight (Table 7). Yield of Atlantic was higher compared to Granola. In both varieties, the Farmers Practice and the vegIMPACT strategy resulted in similar marketable yields. Costs for the vegIMPACT strategy were higher than the Farmers Practice strategy in both Atlantic and Granola (Table 8).

Photo 5. Late blight infection in Atlantic plants in Garut (6 February 2014)

Table 6. The percentage foliage infected and AUDPC in the different strategies in Garut.

	Atlantic		Granola	
	Farmers Practice	vegIMPACT	Farmers Practice	vegIMPACT
18 December 2013	0	0	0	0
23 December 2013	0.2	0.1	0.1	0.01
27 December 2013	2.4	3.4	0.3	0.4
31 December 2013	2.8	3.9	0.4	0.5
4 January 2014	10.7	10.5	0.5	1.3
8 January 2014	4.7	4.8	1.2	1.6
12 January 2014	0.4	0.8	0.3	0.3
16 January 2014	0.3	0.2	0	0.1
20 January 2014	0	0.1	0	0.1
24 January 2014	0.1	0.8	0	0
28 January 2014	2.7	2.8	1.8	3.5
2 February 2014	4.8	6.3	1.9	1.6
6 February 2014	8.7	10.1	4.1	3.2
10 February 2014	48.2	41.8	32.4	36.2
14 February 2014	70.1	66.4	60.4	58.8
18 February 2014	89.5	87.7	76.8	78.2
AUDPC	808 b	788 b	570 a	590 a

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

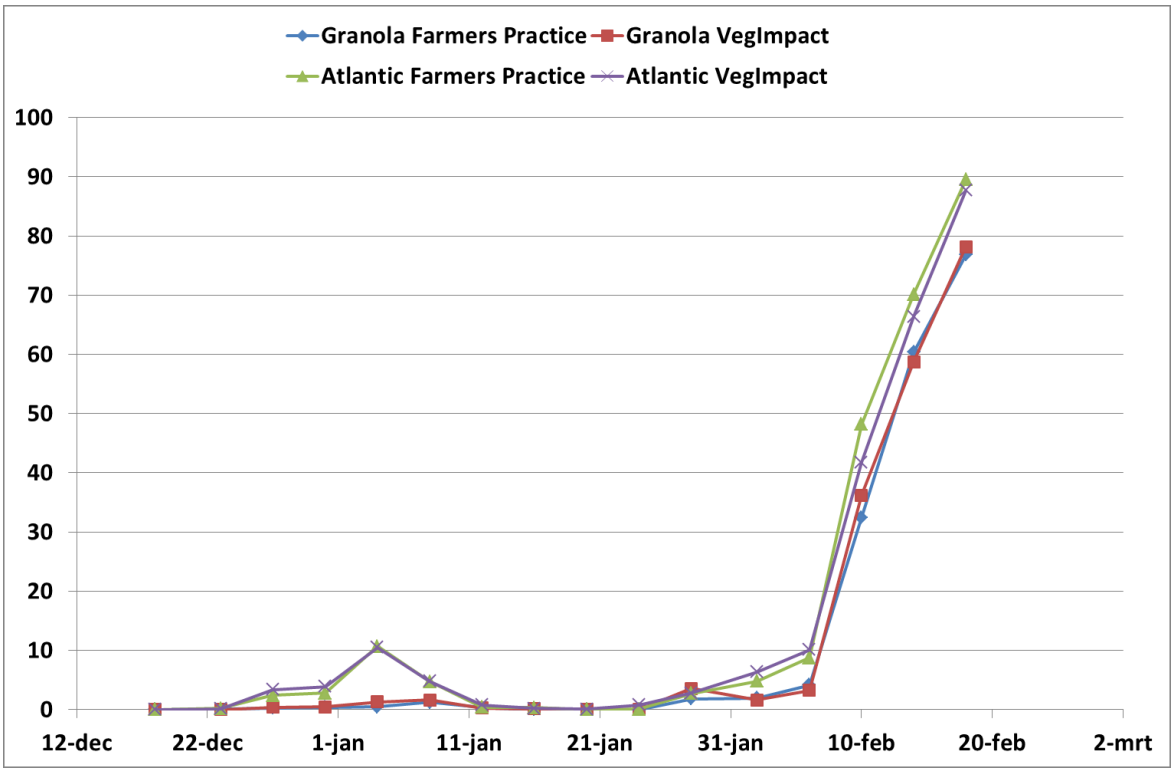

Figure 2. The development of foliar blight (as percentage infected foliage) during the growing season in Garut.

Table 7. Potato yield in the different strategies in Garut.

	Atlantic		Granola	
	Farmers Practice	vegIMPACT	Farmers Practice	vegIMPACT
Class A (ton/ha)	18.9	19.9	0	0
Class B (ton/ha)	6.8	6.9	11.3	11.3
Class C (ton/ha)	1.8	1.9	9.5	9.2
Total Marketable Yield (ton/ha)	27.5 b	28.7 b	20.8 a	20.5 a
Rotten tubers (kg/ha)	0.025	0.1	0	0

Table 8. Cost (IDR) per 4 plots of the 14 fungicide applications with 600 l/ha per application of the different strategies in Garut.

Strategy	Cost (IDR)
Atlantic: Farmers Practice	45,990
Atlantic: vegIMPACT	53,940
Granola: Farmers Practice	43,890
Granola: vegIMPACT	51,240

3.3 Weather data

The rainfall at the demo plots in Garut and Pangalengan are presented in Table 9 and Figure 3.

Table 9. Number of days with rain and amount of rain (mm) in December 2013 and January and February 2014 at the demo plots in Garut and Pangalengan. The high rainfall in Garut in December 2013 (1133 mm) is the total amount of rain for December. In the graph the rainfall is (only) presented from 20 December onwards.

	Rain days		**Total (mm)**	
	Pangalengan	Garut	Pangalengan	Garut
December	25	18	475	1133
January	27	24	329	303
February	19	17	228	430

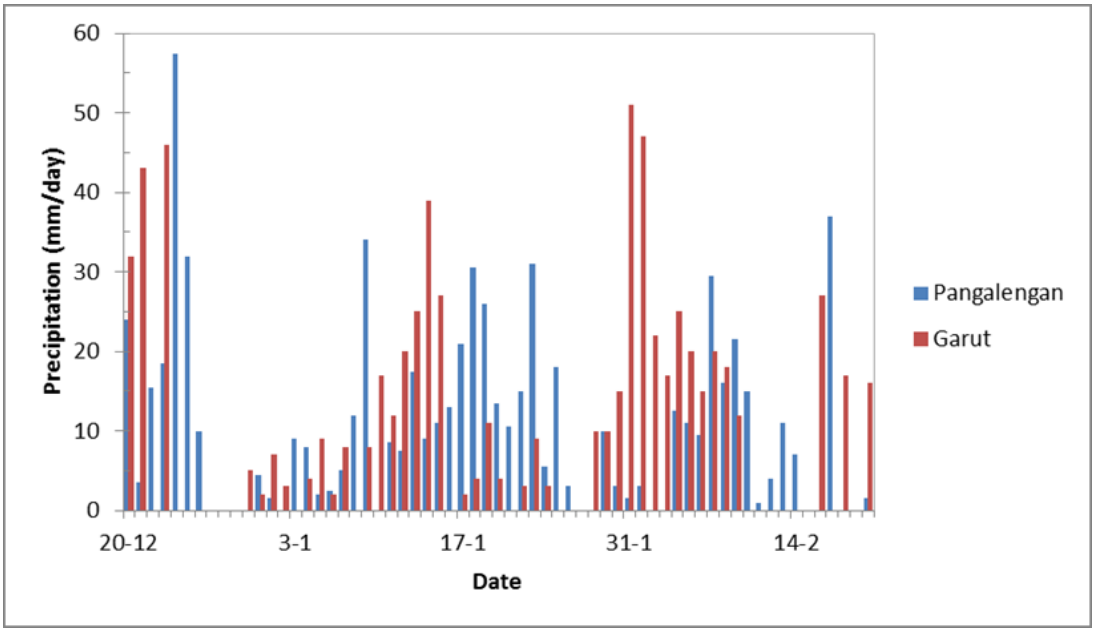

Figure 3. Rain fall (mm/day) at the demo plots in Garut and Pangalengan between 20 December 2013 and February 2014.

4. Discussion and conclusions

The objective of the demonstrations was to gather more information regarding the late blight control in potatoes in the Pangalengan and Garut region. Decisive factors in the late blight control are product choice, application interval, spray volume and the use of adjuvants. For this first demonstration it was decided to only demonstrate differences in product choice. The application interval was set at 4 days for all treatments, the spray volume was 600 l/ha for all treatments and the adjuvant Agristick was added to all treatments.

Although only limited weather data are available (Table 9, Figure 3) it was clear that during the growing season in both regions the weather conditions were very conducive for late blight.

At both locations, in some plots potato late blight was already observed very early in the growing season, indicating that the natural inoculum pressure at that time was very high.

Till the end of January (Pangalengan) or till the beginning of February (Garut) the percentage infection in all strategies was below 10 %, thereafter the epidemics developed exponentially. At both locations, the Farmers Practice strategy and vegIMPACT strategy resulted in a similar effect on the late blight epidemic in both Atlantic and Granola. At both locations, Atlantic showed higher levels of late blight compared to Granola. However, it cannot be concluded that this difference was only caused by the higher susceptibility to late blight of Atlantic compared to Granola because also in Atlantic the control strategy was different compared with the one applied in Granola.

In Pangalengan the yield was low associated with the early and severe epidemic of late blight. In both Atlantic and Granola the marketable yield of the Farmers Practice strategy was higher compared to the vegIMPACT strategy. In Garut, the marketable yield was higher compared to Pangalengan associated with a later epidemic of late blight. Yield of Atlantic was higher compared to Granola. In both varieties the Farmers Practice strategy and the vegIMPACT strategy resulted in similar marketable yields.

At both locations, costs for the vegIMPACT strategy were 10-15 % higher than the Farmers Practice strategy in both Atlantic and Granola. These higher prices were caused by use of more expensive products such as Curzate, Trivia and Infinito in the vegIMPACT strategies. The total costs were relatively high for all strategies because from the first till the last spray a spray volume of 600 l/ha was prepared although this was too much in the beginning of the season when the plants were smaller.

Recommendations for future demonstration trials:

- Design new strategies for the 11 week growing season .
- Position the fungicides with a good rainfastness and curative efficacy earlier in growing season, since infection pressure can already be high directly from emergence onwards.
- Adapt the spray volume to the development of the crop and apply two strategies:
    - Normal practice: week 1-4: 250 l/ha; week 5-8: 350 l/ha; week 9-13: 550 l/ha
    - Normal practice -20%: week 1-4: 200 l/ha: week 5-8: 280 l/ha: week 9-13: 440 l/ha
- Include treatments with and without adjuvant.
- Build in flexibility to adapt strategy during growing season. For example to shorten the spray interval when infection pressure is higher than anticipated.

5. References

- G. Cruickshank, H. E. Stewart & R. L. Wastie (1982) An illustrated assessment key for foliage blight of potatoes. Potato Research 25: 213-214.

- Herman de Putter, Nikardi Gunadi, Uka, Romke Wustman & Huub Schepers (2014) Economics and agronomics of Atlantic and Granola potato cultivation in the dry season of 2013 in West Java. vegIMPACT Internal Report nr. 10.

6. Appendix 1: lay out demo plots