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Influence of adjuvants on the deposition of mancozeb

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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



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Contents

1.	Introduction.....	5
2.	Materials and methods	6
2.1	Pot trial lay-out.....	6
2.2	Spray applications.....	6
2.3	Rain simulation	9
2.4	Artificial inoculation	9
2.5	Disease observations	9
2.6	Determination mancozeb residue.....	9
2.7	Statistical analyses.....	9
3.	Results	10
3.1	Late blight control.....	10
3.2	Mancozeb residue	11
4.	Discussion and conclusions	14
4.1	Late Blight control	14
4.2	Mancozeb residue	14
4.3	Conclusions.....	14
4.4	Recommendations.....	14

1. Introduction

Adjuvants are substances without significant agrochemical properties which can increase the efficacy of an agrochemical when tank-mixed with that agrochemical. Adjuvants can enhance the efficacy by modifying the physical, chemical or biological properties of the agrochemical to which it is added. Potato and tomato are preventively sprayed with fungicides to protect against late blight caused by *Phytophthora infestans*. Especially in the rainy season, adjuvants are added to reduce the run-off of the fungicides from the leaf surface. High water volumes of 600-750 l/ha are commonly used to spray crops in Indonesia. This often leads to residues at the tips of the leaves which could be an indication that run-off is taking place (Photo 1). This study was carried out to investigate the influence of a range of adjuvants used in Indonesia on the deposition of mancozeb on the potato leaves in a pot experiment in the glasshouse of Applied Plant Research In Lelystad, the Netherlands.



Photo 1. Residue at the tips of potato leaves indicating that run-off is taking place (June 2014).

2. Materials and methods

2.1 Pot trial lay-out

The cultivated potato plants (cv. Bintje) were grown in pots. The pots with a content of 5 liter were filled with soil and the potato tubers were placed at a depth of 10 cm on 22 April 2014. From emergence until inoculation the plants were placed in the greenhouse. Each treatment consisted of 4 replicates of 1 plant each.

2.2 Spray applications

In Table 1 and Photo 2 the fungicide and adjuvants used are presented. The adjuvants Agristick, Acrobatick, APSA and Indostick were bought in Indonesian agro shops, Bond was kindly provided by Nufarm. Potato plants were sprayed in a spraying cabin developed by Applied Plant Research (Photo 3). The fungicides were sprayed using a spray boom with three spray nozzles, placed 50 cm apart, which was moving approximately 40 cm over the top of the potato plants. Spray volume was 750 l/ha (Photo 3). Plants were sprayed on 28 May 2014 with the treatments presented in Table 2.



Photo 2. Adjuvants available in Indonesia and used in the experiment.



Photo 3. Spray cabine at PPO Lelystad used to spray the plants



Photo 4. Plants rained with 30 mm of tap water in 15 minutes.

Table 1. The fungicide and adjuvants used in the pot experiment.

Fungicide/adjuvant	Product name	Active ingredients	Dose rate
fungicide	Brabant Mancozeb Flowable	mancozeb (500 g/l)	3.2 l/ha
adjuvant	Agristick 400 L	alkilaril poliglikol eter 400 ml/l	0.05%
adjuvant	Acrobatick 400 SL	alkohol poliglikol ether 40%	0.4%
adjuvant	APSA 800 WCS	alki aril alkoksilat 775,2 g/l + asam oleat 40,89 g/l	0.05%
adjuvant	Bond	45% w/w styrene butadiene co-polymer + 10% w/w alcohol alkoxylate	0.14%
adjuvant	IndoStick 100/20 SL	kondensat nonifenol etilen oksida 95 g/l	0.15%

Table 2. The treatments applied in this pot experiment

Treatment	Product name	Dose rate	Volume (l/ha)	Rain 30 mm
1	Untreated Control		-	No
2	Brabant Mancozeb Flowable	3.2 l/ha	750	No
3	Brabant Mancozeb Flowable + Agristick 400 L	3.2 l/ha + 0.05%	750	No
4	Brabant Mancozeb Flowable + Acrobatick 400 SL	3.2 l/ha + 0.4%	750	No
5	Brabant Mancozeb Flowable + APSA 800 WCS	3.2 l/ha + 0.05%	750	No
6	Brabant Mancozeb Flowable + Bond	3.2 l/ha + 0.14%	750	No
7	Brabant Mancozeb Flowable + IndoStick 100/20 SL	3.2 l/ha + 0.15%	750	No
8	Untreated Control		-	Yes
9	Brabant Mancozeb Flowable	3.2 l/ha	750	Yes
10	Brabant Mancozeb Flowable + Agristick 400 L	3.2 l/ha + 0.05%	750	Yes
11	Brabant Mancozeb Flowable + Acrobatick 400 SL	3.2 l/ha + 0.4%	750	Yes
12	Brabant Mancozeb Flowable + APSA 800 WCS	3.2 l/ha + 0.05%	750	Yes
13	Brabant Mancozeb Flowable + Bond	3.2 l/ha + 0.14%	750	Yes
14	Brabant Mancozeb Flowable + IndoStick 100/20 SL	3.2 l/ha + 0.15%	750	Yes
15 ¹	Brabant Mancozeb Flowable	3.2 l/ha	250	No
16 ¹	Brabant mancozeb Flowable	3.2 l/ha	250	Yes

¹ Two samples (15 and 16) were added of pot plants from another pot experiment that was also treated on 28 May 2014 with 3.2 l/ha Brabant Mancozeb Flowable but with a spray volume of 250 l/ha instead of 750 l/ha.

2.3 Rain simulation

Rain simulation was carried out 30 minutes after spraying the fungicides. A total of 30 mm of rain was applied at a rain intensity of approximately 2 mm per minute (Photo 4). The untreated control was also included in the rain simulation.

2.4 Artificial inoculation

An inoculum suspension was made by rinsing a one week old culture of *P. infestans* (Blue 13) with water. The inoculum density was set at approximately 10,000 sporangia per ml. Inoculation was carried out by spraying potato plants over head with approximately 10 ml of inoculum five days after spraying the fungicides. Inoculation was carried out on air dry plants on 2 June 2014. After inoculation, plants were incubated at a high relative humidity for 18 hours.

2.5 Disease observations

Late blight observations were carried out 5, 7 and 10 June, which is 3, 5 and 8 days after inoculation. The percentage infected foliage was estimated for each plant. The average percentage infected foliage was calculated per treatment.

2.6 Determination mancozeb residue

Five days after spraying, 4 compound leaves were picked per plant. The leaflets were separated from the petioles and all leaflets of all 4 replicates were collected in one sample for that specific treatment. Two samples (15 and 16) were added of pot plants from another pot experiment that was also treated on 28 May 2014 with 3.2 l/ha Brabant Mancozeb Flowable but with a spray volume of 250 l/ha instead of 750 l/ha. The samples were sent to the TLR laboratory for analysis. With a gas chromatographic method Cf. EN 12396-2 the dithiocarbamate and thiuran residues were determined.

2.7 Statistical analyses

Analysis of variance on the average percentage necrotic foliage of three assessment dates was made using GENSTAT 16th Edition. The experiment was carried out with four replications. Each replication consisted of one plant. Transformation of data was carried out when necessary.

3. Results

3.1 Late blight control

The infected foliage of the potato plants sprayed with the different treatments is presented in Table 3 and Figure 1. The untreated control was severely infected indicating that the artificial inoculation was successful. All treatments significantly reduced the percentage infected foliage compared to the untreated control.

- Assessment 5 June: the rain significantly increased the percentage infected foliage on plants sprayed with mancozeb and mancozeb + Acrobatick;
- 7 June: the rain significantly increased the percentage infected foliage on plants sprayed with mancozeb, mancozeb + Acrobatick, mancozeb + Agristick and mancozeb + IndoStick;
- 10 June: the rain significantly increased the percentage infected foliage on plants sprayed with mancozeb, mancozeb + Acrobatick and mancozeb + Agristick;
- Average: the rain significantly increased the percentage infected foliage on plants sprayed with mancozeb, mancozeb + Agristick, mancozeb + Acrobatick and mancozeb + Indostick. The rain did not significantly increase the percentage of infected foliage of plants treated with mancozeb + APSA and mancozeb + Bond.

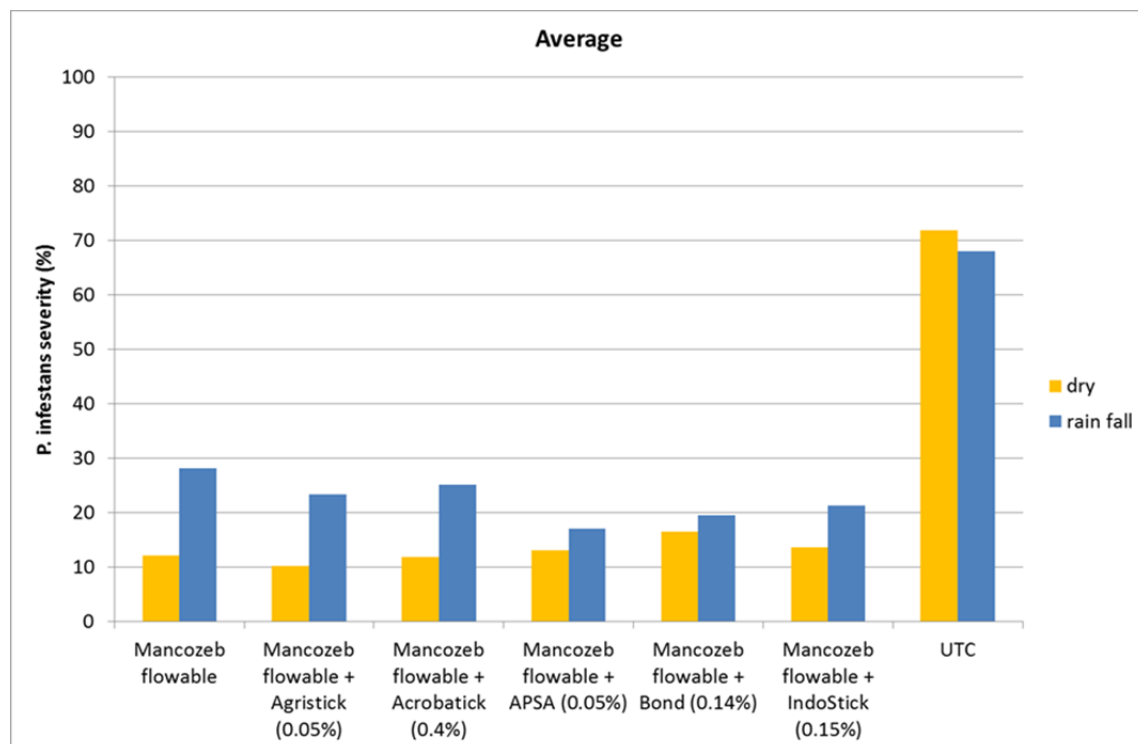


Figure 1. Infected foliage (*P. infestans*) of potato plants sprayed with different treatments.

Table 3. Infected foliage of potato plants sprayed with different treatment.

Treatment	Product name	Rain	Infected foliage (%)			
			5 June	7 June	10 June	Average
1	Untreated Control	No	36.2 f ¹⁾	82.5 g	97.0 e	71,9 g
2	Brabant Mancozeb Flowable	No	2.5 a	12.5 abc	21.2 ab	12,1 ab
3	Brabant Mancozeb Flowable + Agristick 400 L	No	2.7 ab	7.7 a	20.0 a	10,2 a
4	Brabant Mancozeb Flowable + Acrobatick 400 SL	No	3.0 ab	8.7 ab	23.7 abc	11,8 ab
5	Brabant Mancozeb Flowable + APSA 800 WCS	No	2.7 ab	13.7 abcd	22.5 abc	13,0 ab
6	Brabant Mancozeb Flowable + Bond	No	4.0 abcd	14.2 abcd	31.2 abcd	16,5 bcd
7	Brabant Mancozeb Flowable + IndoStick 100/20 SL	No	4.0 abcd	13.0 abc	23.7abc	13,6 abc
8	Untreated Control	Yes	32.5 f	73.7 g	97.7 e	68,0 g
9	Brabant Mancozeb Flowable	Yes	10.5 de	31.2 f	42.5 d	28,1 f
10	Brabant Mancozeb Flowable + Agristick 400 L	Yes	7.5 bcde	26.2 ef	36.2 cd	23,3 def
11	Brabant Mancozeb Flowable + Acrobatick 400 SL	Yes	9.2 cde	25.0 ef	41.2 d	25,2 ef
12	Brabant Mancozeb Flowable + APSA 800 WCS	Yes	3.5 abc	15.0 bcde	32.5 abcd	17,0 bcd
13	Brabant Mancozeb Flowable + Bond	Yes	4.7 abcde	18.7 cdef	35.0 bcd	19,5 cdef
14	Brabant Mancozeb Flowable + IndoStick 100/20 SL	Yes	3.7 abcd	23.7 def	36.2 cd	21,3 def

¹⁾ Values followed by the same letter are not significantly different (p=0.05).

3.2 Mancozeb residue

The amount of mancozeb measured on the leaf samples of the different treatments is presented in Table 4. Only one sample per treatment was taken, therefore no statistical analyses can be carried out. There was a tendency that when plants were not rained, the adjuvants resulted in lower levels of mancozeb residue compared to mancozeb alone. Also the level of mancozeb residue was higher on the leaves sprayed with the 250 l/ha compared to the leaves sprayed with 750 l/ha. Rain clearly reduced the residue level. Tankmixing mancozeb with Agristick, APSA, Bond and Indostick resulted in a higher level of residue compared to mancozeb alone.

Table 4. Mancozeb residue measured on the leaf samples of the different treatments.

Treatment	Product name	Rain	Mancozeb µg/gram blad
1	Untreated Control	No	3.8
2	Brabant Mancozeb Flowable	No	162.0
3	Brabant Mancozeb Flowable + Agristick 400 L	No	137.0
4	Brabant Mancozeb Flowable + Acrobatick 400 SL	No	145.0
5	Brabant Mancozeb Flowable + APSA 800 WCS	No	102.0
6	Brabant Mancozeb Flowable + Bond	No	132.0
7	Brabant Mancozeb Flowable + IndoStick 100/20 SL	No	92.3
8	Untreated Control	Yes	0.7
9	Brabant Mancozeb Flowable	Yes	12.3
10	Brabant Mancozeb Flowable + Agristick 400 L	Yes	39.4
11	Brabant Mancozeb Flowable + Acrobatick 400 SL	Yes	8.2
12	Brabant Mancozeb Flowable + APSA 800 WCS	Yes	44.5
13	Brabant Mancozeb Flowable + Bond	Yes	22.6
14	Brabant Mancozeb Flowable + IndoStick 100/20 SL	Yes	38.5
15	Brabant Mancozeb Flowable (KAS 834) 250 l/ha	No	199.0
16	Brabant Mancozeb Flowable (KAS 834) 250 l/ha	Yes	13.3

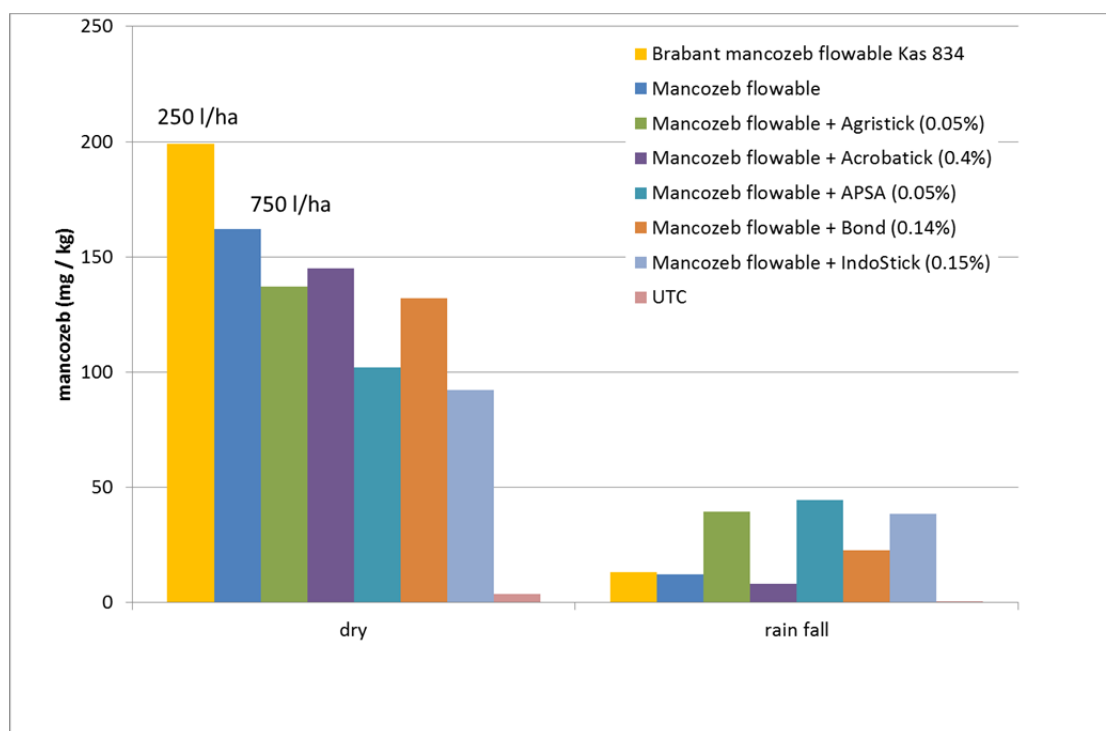


Figure 1. Mancozeb residue measured on the leaf samples of the different treatments.

4. Discussion and conclusions

4.1 Late Blight control

The untreated control was severely infected indicating that the artificial inoculation was successful. All treatments significantly reduced the percentage infected foliage compared to the untreated control. The rain did not significantly increase the percentage of infected foliage of plants treated with mancozeb + APSA and mancozeb + Bond. The rain strategy in this trial was a worst case scenario with only 30 minutes between spraying and rain simulation.

4.2 Mancozeb residue

There was a tendency that when plants were not rained, the adjuvants resulted in lower levels of mancozeb residue compared to mancozeb alone. Also the level of mancozeb residue was higher on the leaves sprayed with the 250 l/ha compared to the leaves sprayed with 750 l/ha. Rain clearly reduced the residue level. Tankmixing mancozeb with Agristick, APSA, Bond and Indostick resulted in a higher level of residue compared to mancozeb alone.

4.3 Conclusions

- Without rain simulation there was a clear trend that spraying with 750 l/ha compared to 250 l/ha resulted in a lower mancozeb residue on the leaves, most probably caused by run-off.
- Without rain simulation there was a clear trend that mancozeb mixed with adjuvants resulted in lower mancozeb residue levels compared to mancozeb alone. The adjuvants probably also have surfactant properties resulting in an increased run-off.
-
- Rain significantly decreased the efficacy of all treatments. Tankmixing mancozeb with Agristick, APSA, Bond and Indostick resulted in a higher level of residue compared to mancozeb alone. Tankmixing mancozeb with Bond and APSA also resulted in a better late blight control compared to mancozeb alone.

4.4 Recommendations

- Compare the influence of lower and higher spray volumes and tankmixing adjuvants in a late blight demo.
- Test the influence of tankmixing adjuvants also with insecticides.
- Increase the time between spraying and rain in a follow-up pot trial.