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Results of fertilizer demonstration trials in Pangalengan and Garut, Indonesia, May – August 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

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1. Introduction

In Indonesia, the amount of nitrogen applied to potato crops is very high. A survey conducted in 2013 under 20 farmers in Pangalengan and Garut showed an average application of 232 kg N/ha from organic manure (range 140 – 473 kg N/ha) together with an average application of 172 kg N/ha from chemical fertilizers (range 63 – 350 kg N/ha). The high use of fertilizers results in high costs for farmers, potentially reduces the financial benefits from potato production, and is undesired from an environmental point of view.

To gain a better understanding of optimum nitrogen fertilization levels two fertilizer demo fields were laid out in Garut and Pangalengan. These demo fields also served as training material for the training of farmers in both locations. One of the treatments in the demo fields represented the current fertilizer management of the farmers (A: 20 ton organic manure/ha and 200 kg N/ha from inorganic fertilizers). This fertilization level was compared with three treatments in which the fertilization with organic manure was reduced to 10 ton/ha combined with inorganic fertilizer of 100 kg N/ha (B), 150 kg N/ha (C) and 200 kg N/ha (D).

Photo 1. Observation of the demo field in Pangalengan by farmers at day 56 after planting.

2. Materials and methods

2.1 Demo-plot lay-out

Demonstration fields in Pangalengan and Garut were planted with the potato varieties Granola and Atlantic on 7 and 8 May 2014, respectively (dry season). The plots consisted of 6 rows of 20 plants each. The row distance was 0.75 m and the plant distance within rows was 0.30 m. The beds were covered with silver-colored plastic mulch. At harvest four rows in the middle of each plot were harvested while the first and the last plants of these rows were not harvested. The net size of the harvested plot was 3 m (4 rows) x 5.4 m (18 plants per row), totaling 16.2 m^2. In total eight, four (N levels) times two (varieties), unique plots were laid out in the demo with three replications.

2.2 Fertilization treatments

Fertilizer treatments are presented in Table 2.1. Treatments B, C and D differed only in (inorganic/chemical) nitrogen fertilization. Inorganic phosphate and potash fertilization were the same in all treatments. On both locations, the mineral content of organic manure (*Ayam postal*) was analyzed (Table 2.2).

Table 2.1. Treatments in demo fields in Pangalengan and Garut in the dry season of 2014.

Treatments		Organic manure (ton/ha)	N from inorganic fertilizer (kg/ha)	P2O5 from inorganic fertilizer (kg/ha)	K2O from inorganic fertilizer (kg/ha)
A	Farmers practice	20	200	200	200
B	N-level 1	10	100	200	200
C	N-level 2	10	150	200	200
D	N-level 3	10	200	200	200

Table 2.2. Mineral percentage (on the basis of fresh weight) of organic manure (Ayam postal) applied to demo fields in Garut and Pangalengan.

	Garut	Pangalengan
Nitrogen (%)	0.57	1.49
P2O5 (%)	1.25	1.22
K2O (%)	0.67	1.46
C/N-quotient	9.4	8.2
Dry matter (%)	41.2	73.7

From both demo fields soil samples were analyzed (Table 2.3).

Table 2.3. Chemical soil properties of the demo fields in Garut and Pangalengan.

	Garut	Pangalengan
pH-KCl	5.1	4.9
N Kjeldahl (%)	0.55	0.69
P2O5 (ppm)	424.3	776.3
K (ppm)	82.4	386.0

Inorganic N was supplied as ZA (ammoniumsulphate), P_2O_5 as SP36 (Super Phosphate) and K_2O as KCl. In each treatment 50% of the N was applied at planting and 50% four weeks after planting.

Control of pest and diseases was carried out as optimal as possible.

2.3 Observations during growing period

At several moments during the growing season the number of stems, percentage soil cover and plant height was monitored. Additionally, crop health and drought symptoms were observed. At two moments, 56 days after planting and at harvest potato plants were analyzed on dry matter content and N content. At 56 days after planting from each plot three plants were harvested and the dry matter content and the nitrogen content were determined of aboveground biomass and tubers. At harvest, from each plot the tubers of one plant were analyzed on dry matter content and nitrogen content.

Crops were manually harvested in Pangalengan on 13 August 2014 and in Garut on 14 August 2014, i.e. 108 days after planting in both locations. The tubers were classified into three grades: class > 100 gram, class 50-100 gram and class < 50 gram. Also the weight of rotten tubers was assessed.

2.4 Weather data

Table 2.4 presents the rain fall and the number of rainy days in Pangalengan and Garut during the demo period. The total rainfall in the period May-August 2014 was 626 mm in Garut, considerably higher than in Pangalengan (466 mm).

Table 2.4. Rainfall characteristics during the 2014 growing season in Garut and Pangalengan.

	Garut		Pangalengan	
	Precipitation (mm)	Number of days with rain	Precipitation (mm)	Number of days with rain
May	222	16	193	16
June	133	9	124	12
July	213	13	62	8
August	58	3	88	10

3. Results

3.1 Pangalengan

The number of plants per m^2, number of stems per m^2 and plant height at different moments during the growing period are presented in Table 3.1. Differences between fertilizer treatments are generally smaller than between both varieties, especially with respect to plant height. Figure 3.1 shows the development of the plant height and clearly illustrates the more erect nature of Atlantic plants compared to Granola plants.

Table 3.1. Number of plants, number of stems and plant height in Granola and Atlantic at different moments in Pangalengan. A, B, C, D refer to different N levels, see Table 2.1.

	Number of plants/m^2		Number of stems/m^2		Plant height in cm					
	3WAP*	4WAP	3WAP	4WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP
Granola A	4.3	4.4	11.5	15.0	6.6	14.9	35.1	51.9	67.9	69.6
Granola B	4.0	4.4	10.2	13.9	4.5	12.6	30.6	45.4	66.6	68.2
Granola C	3.9	4.4	10.3	14.6	6.3	15.1	37.7	51.6	66.0	67.3
Granola D	4.0	4.4	10.3	15.1	5.1	13.3	32.9	50.0	67.9	68.9
Atlantic A	4.4	4.4	15.4	14.9	20.2	39.3	63.6	71.9	84.4	85.6
Atlantic B	4.4	4.4	14.3	14.0	21.6	39.9	64.8	71.2	82.8	83.8
Atlantic C	4.4	4.4	15.4	15.0	21.0	39.0	62.6	73.9	82.6	83.3
Atlantic D	4.4	4.4	15.4	14.5	20.8	40.2	64.5	72.7	83.1	84.0
F Prob	0.005	0.215	0.004	0.973	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
LSD 5%	0.3	0.1	3.3	3.0	2.5	2.7	4.3	5.9	7.5	7.4

* WAP= Weeks After Planting

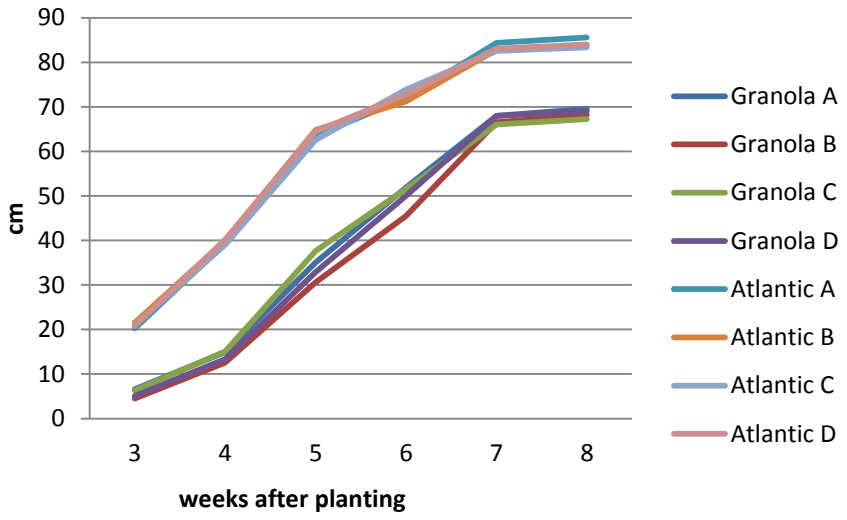

Figure 3.1. Plant height of Granola and Atlantic at different moments during the 2014 growing season in Pangalengan. A, B, C, D refer to different N levels, see Table 2.1.

Photo 2. Atlantic plants in demo field in Pangalengan at 56 days after planting.

The percentage soil cover in Pangalengan is presented in Table 3.2 and Figure 3.2. Both Table 3.2 and Figure 3.2 show the clear difference in morphology between Atlantic and Granola up to week 9 after planting when the percentage soil cover of both varieties is the same.

Table 3.2. Percentage soil cover in Granola and Atlantic at different moments during the 2014 growing season in Pangalengan. A, B, C, D refer to different N levels, see Table 2.1.

	4WAP*	5WAP	6WAP	7WAP	8WAP	9WAP	10WAP
Granola A	22.3	36.8	46.5	76.6	80.9	100.0	100.0
Granola B	19.9	32.5	48.6	65.2	70.4	100.0	93.8
Granola C	23.4	33.6	51.3	66.2	72.8	100.0	98.0
Granola D	19.6	33.5	50.3	70.3	82.0	100.0	99.6
Atlantic A	46.9	79.6	80.5	95.0	95.2	99.4	84.8
Atlantic B	48.8	81.3	87.5	91.9	92.9	100.0	73.3
Atlantic C	55.3	82.7	84.9	96.3	96.2	100.0	82.3
Atlantic D	53.5	82.0	85.0	94.0	94.6	100.0	86.4
F Prob	<0.001	<0.001	<0.001	<0.001	0.007	0.471	0.02
LSD 5%	6.5	6.4	13.7	10.8	14.8	0.6	15.4

* WAP = Weeks After Planting

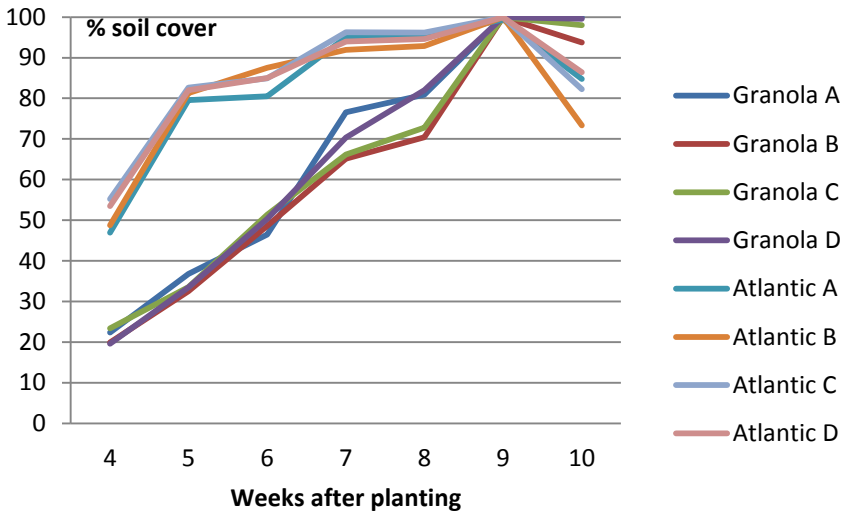

Figure 3.2. Percentage soil cover of Granola and Atlantic during the growing season in the demo plot in Pangalengan. A, B, C, D refer to different N levels, see Table 2.1.

Photo 3. Granola plants in the demo plot at 56 days after planting in Pangalengan.

Numbers of tubers per class are presented in Table 3.3 and Figure 3.3. The number of tubers per m^2 is clearly much higher in Granola than Atlantic. The total number of tubers does not differ between fertilizer treatments.

Table 3.3. Number of harvested tubers of Granola and Atlantic in the 2014 growing season in Pangalengan. A, B, C, D refer to different N levels, see Table 2.1.

	Number of tubers per class (number/m^2)					
	Healthy tubers			rotten	Total number of	Total number of
	<50 gr	50-100 gr	>100 gr	tubers	healthy tubers/m^2	tubers/m^2 (incl. rotten)
Granola A	6.9	6.3	16.5	6.3	29.7	36.0
Granola B	7.2	5.8	14.6	8.3	27.6	35.8
Granola C	8.7	5.1	17.9	8.0	31.7	39.7
Granola D	7.8	6.1	16.3	7.1	30.1	37.2
Atlantic A	2.8	3.9	6.8	7.9	13.5	21.5
Atlantic B	1.9	2.0	5.9	7.9	9.8	17.7
Atlantic C	4.9	3.7	8.7	8.5	17.2	25.7
Atlantic D	3.6	3.0	6.7	8.4	13.3	21.7
F.prob	0.001	0.004	0.012	0.935	<0.001	<0.001
LDS 5%	5.8	3.3	2.4	4.1	10.1	9.1

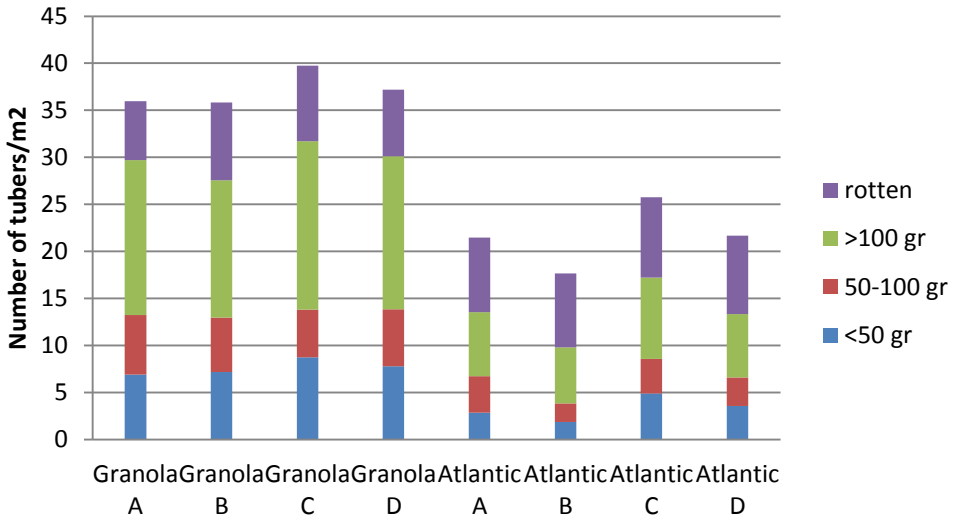

Figure 3.3. Number of tubers/m^2 per yield class of Granola and Atlantic at four N levels in the demo plot in Pangalengan. A, B, C, D refer to different N levels, see Table 2.1.

Yield data presented in Table 3.4 and Figure 3.4 show relatively small yield differences between N levels, except for treatment B, the lowest N level that tends to result in the lowest yield both in Granola and Atlantic. Yields of Granola tend to be higher than yields of Atlantic at the same N level.

Table 3.4. Yield classes of Granola and Atlantic in the demo plot in Pangalengan. A, B, C, D refer different N levels, see Table 2.1.

	Yield per class (ton/ha)				Total healthy	Total healthy	Total yield
	Healthy tubers			Rotten	yield >50 gr	yield	(incl. rotten)
	<50 gr	50-100 gr	>100 gr	tubers	(ton/ha)	(ton/ha)	(ton/ha)
Granola A	6.9	7.1	11.1	4.6	18.2	25.1	29.7
Granola B	5.9	4.9	10.2	4.9	15.1	21.0	25.9
Granola C	6.9	8.7	9.1	4.4	17.8	24.7	29.1
Granola D	6.2	7.7	10.4	4.1	18.2	24.4	28.5
Atlantic A	2.9	3.3	8.5	6.6	11.8	14.8	21.3
Atlantic B	2.7	4.8	4.3	6.3	9.1	11.8	18.1
Atlantic C	4.3	6.1	8.1	6.1	14.2	18.5	24.6
Atlantic D	3.2	4.3	6.2	6.4	10.5	13.7	20.1
F.prob	0.021	0.328	0.092	0.55	0.18	0.075	0.147
LDS 5%	2.9	5.0	4.6	3.3	8.3	10.5	9.7

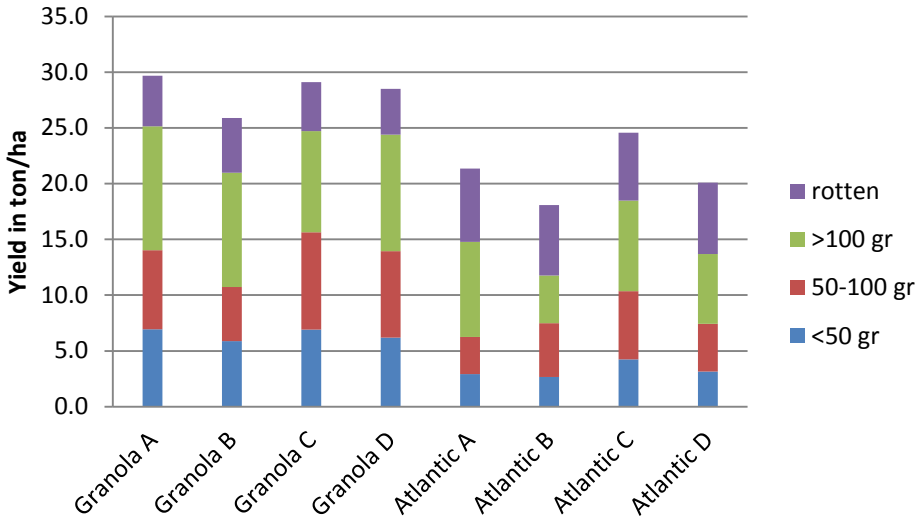

Figure 3.4. Total yield and yield classes (ton/ha) of Granola and Atlantic at four N levels in the demo field in Pangalengan. A, B, C, D refer to different N levels, see Table 2.1.

Table 3.5 presents the results of the dry matter and N content measurements at 56 days after planting and at harvest. Dry matter content of Atlantic tubers is higher than that of Granola, but differences across N levels are not significant.

Table 3.5. Dry matter content and nitrogen content of haulm and tubers in Granola and Atlantic in Pangalengan. A, B, C, D refer to different N levels, see Table 2.1.

	Dry matter %			N-content (% in dry matter)		
		Tubers			Tubers	
	Stem and leaves 58 days after Planting	58 days after Planting	At harvest	Stem and leaves 58 days after Planting	58 days after Planting	At harvest
Granola A	10.6	11.9	16.0	4.95	1.61	1.71
Granola B	9.3	10.6	16.2	4.63	1.66	1.66
Granola C	8.8	12.1	16.0	4.87	1.56	1.91
Granola D	8.6	10.1	15.9	4.98	1.59	1.82
Atlantic A	8.7	16.8	21.2	4.08	2.18	1.61
Atlantic B	8.6	16.1	20.8	4.15	1.99	1.69
Atlantic C	9.5	15.1	20.5	4.03	2.28	1.72
Atlantic D	9.2	16.1	20.7	3.98	2.12	1.62
F.prob	0.760	0.033	<0.001	no variation between reps		
LDS 5%	2.70	4.64	1.07			

3.2 Garut

Number of plants per m^2, number of stems per m^2 and plant height at different moments during the growing season are shown in Table 3.6. Figure 3.5 shows the development of plant height during the growing season with a similar pattern as in Pangalengan, i.e. Atlantic is much taller than Granola.

Table 3.6. Number of plants, number of stems and plant height in Granola and Atlantic at different moments in Garut. A, B, C, D refer to different N levels, see Table 2.1.

	Number of plants/m^2		Number of stems/m^2		Plant height in cm					
	3WAP*	4WAP	3WAP	4WAP	3WAP	4WAP	5WAP	6WAP	7WAP	8WAP
Granola A	3.9	4.4	11.3	14.4	7.9	17.2	31.9	47.9	54.3	57.8
Granola B	4.0	4.4	9.5	13.0	7.5	17.6	33.5	45.9	52.2	54.9
Granola C	3.9	4.4	10.7	14.1	8.8	19.9	35.9	48.7	53.8	57.4
Granola D	4.0	4.4	10.8	14.0	8.2	18.5	34.5	49.9	55.9	58.9
Atlantic A	4.4	4.4	14.0	14.4	23.8	46.3	64.8	70.6	75.3	77.3
Atlantic B	4.4	4.4	14.8	16.5	25.3	47.3	63.0	68.9	71.7	75.8
Atlantic C	4.4	4.4	15.2	15.7	25.8	48.4	65.3	73.7	76.8	80.6
Atlantic D	4.4	4.4	14.3	14.5	25.1	47.4	61.2	66.8	69.3	74.3
F Prob	<0.001	0.240	<0.001	0.286	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
LSD 5%	0.3	0.1	2.3	2.8	2.6	4.6	3.5	4.5	5.6	5.1

* WAP = Weeks After Planting

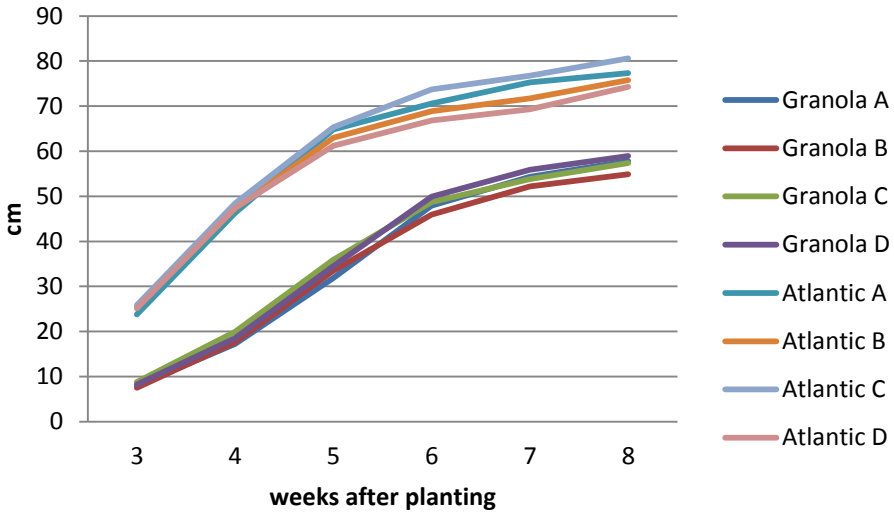

Figure 3.5. Plant height of Granola and Atlantic at different moments during the 2014 growing season in Garut. A, B, C, D refer to different N levels, see Table 2.1.

Photo 4. Observation of Granola plants in Garut by farmers at 56 days after planting.

The percentage soil cover is presented in Table 3.7 and in Figure 3.6. Approximately in week 7 after planting in both Granola and Atlantic the highest soil cover is observed. After week 7 soil cover decreased.

Table 3.7. Percentage soil cover in Granola and Atlantic at different moments during the 2014 growing season in Garut. A, B, C, D refer to different N levels, see Table 2.1.

	% soil cover						
	4WAP*	5WAP	6WAP	7WAP	8WAP	9WAP	10WAP
Granola A	27.3	40.9	52.3	70.6	55.2	52.3	52.1
Granola B	22.8	40.8	50.8	66.9	57.2	47.5	47.2
Granola C	25.6	37.9	51.5	67.8	56.0	51.6	52.1
Granola D	25.1	39.9	51.3	72.8	60.5	50.8	47.3
Atlantic A	76.7	78.5	85.3	93.6	92.0	77.0	62.0
Atlantic B	78.3	77.8	79.1	98.3	91.3	77.3	48.5
Atlantic C	78.9	84.1	87.1	99.1	97.8	79.2	67.5
Atlantic D	73.6	82.4	80.8	96.8	92.3	72.2	64.3
F Prob	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
LSD 5%	9.7	5.8	14.6	15.0	8.2	9.9	9.3

* WAP= Weeks After Planting

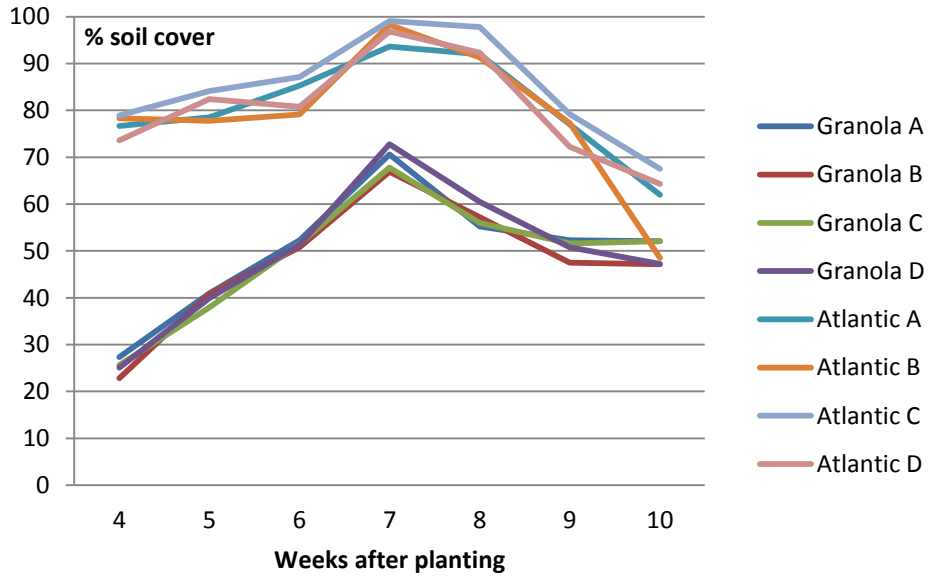

Figure 3.6. Percentage soil cover of Granola and Atlantic during the growing season in the demo plot in Garut. A, B, C, D refer to different N levels, see Table 2.1.

The number of tubers per yield class is shown in Table 3.8 and Figure 3.7. As in Pangalengan but with lower statistical significant difference, the number of tubers in Granola is higher than in Atlantic at most N levels.

Table 3.8. Number of harvested tubers of Granola and Atlantic in the 2014 growing season in Garut. A, B, C, D refer to different N levels, see Table 2.1.

	Number of tubers per class (number/m2)					
	Healthy tubers			rotten	Total number of	Total number of
	<50 gr	50-100 gr	>100 gr	tubers	healthy tubers	tubers (incl. rotten)
Granola A	15.0	10.9	6.2	3.2	32.1	35.3
Granola B	14.8	9.3	6.2	5.2	30.4	35.5
Granola C	18.2	10.8	5.1	3.3	34.1	37.3
Granola D	15.0	9.4	6.9	4.2	31.3	35.5
Atlantic A	7.7	3.7	8.4	4.7	19.9	24.6
Atlantic B	7.5	4.1	5.5	5.1	17.2	22.3
Atlantic C	9.6	6.3	8.2	4.8	24.1	28.9
Atlantic D	6.5	3.7	5.8	7.3	16.0	23.2
F.prob	0.003	0.007	0.181	0.016	0.004	0.009
LDS 5%	5.6	4.5	2.8	2.0	9.7	9.1

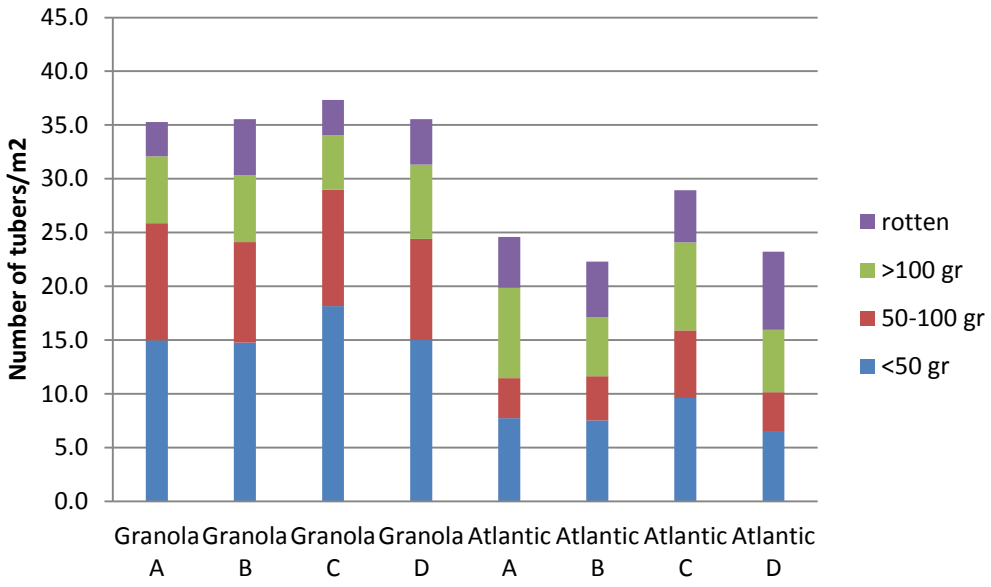

Figure 3.7. Number of tubers/m^2 per yield class of Granola and Atlantic at four N levels in the demo plot in Garut. A, B, C, D refer to different N levels, see Table 2.1.

In Table 3.9 and Figure 3.8 potato yields of Granola and Atlantic at four N levels are presented. In general, Granola yields were higher than Atlantic yields at the same N level, but the difference was not always significant.

Table 3.9. Yield classes of Granola and Atlantic in the demo plot in Garut. A, B, C, D refer to different N levels, see Table 2.1.

	Yield per class (ton/ha)				Total healthy yield >50 gr (ton/ha)	Total healthy yield (ton/ha)	Total yield (incl. rotten) (ton/ha)
	Healthy tubers			rotten tubers			
	<50 gr	50-100 gr	>100 gr				
Granola A	4.8	9.5	9.6	2.2	19.1	23.8	26.0
Granola B	5.0	7.8	9.1	2.8	17.0	21.9	24.7
Granola C	5.5	9.9	7.3	1.7	17.2	22.6	24.3
Granola D	5.3	8.8	10.6	2.3	19.4	24.7	27.0
Atlantic A	3.2	3.3	12.3	3.6	15.6	18.8	22.4
Atlantic B	2.8	3.4	7.7	3.9	11.1	14.0	17.8
Atlantic C	3.6	5.0	11.3	3.7	16.3	19.9	23.5
Atlantic D	2.3	2.6	8.1	5.3	10.7	13.1	18.3
F.prob	0.019	0.004	0.046	<0.001	0.017	0.003	0.011
LDS 5%	1.9	4.0	3.2	1.1	5.2	5.6	5.0

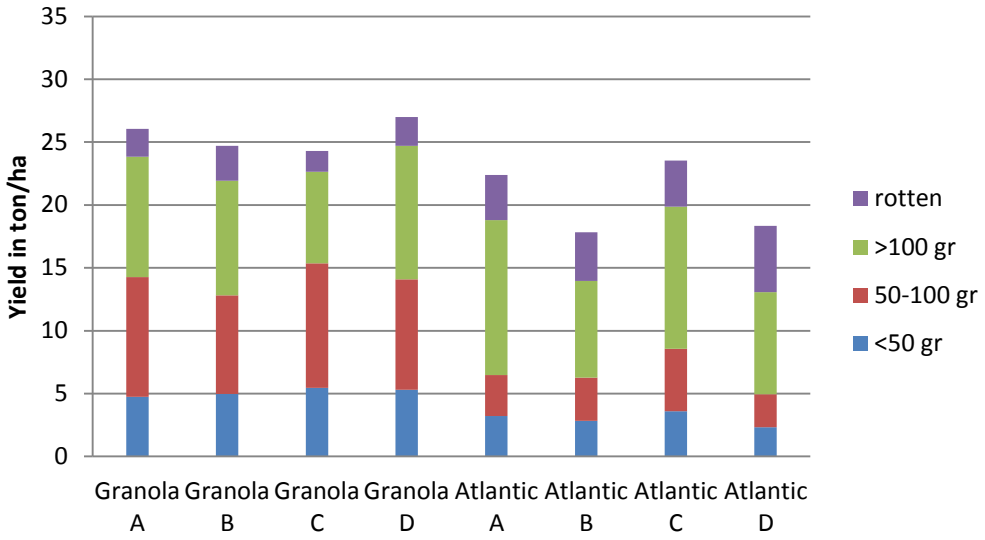

Figure 3.8. Total yield and yield classes (ton/ha) of Granola and Atlantic at four N levels in the demo field in Garut. A, B, C, D refer to different N levels, see Table 2.1.

Table 3.10 shows the results of the dry matter and N content measurements at 56 days after planting and at harvest. Dry matter content of Atlantic tubers is much higher than of Granola tubers, as observed in Pangalengan (Table 3.5). Differences in dry matter content between N levels are not significant.

Table 3.10. Dry matter content and nitrogen content of haulm and tubers in Granola and Atlantic in Garut. A, B, C, D refer different N levels, see Table 2.1.

	Dry matter %			N-content (% in dry matter)		
		Tubers			Tubers	
	Stem and leaves 58 days after Planting	58 days after Planting	At harvest	Stem and leaves 58 days after Planting	58 days after Planting	At harvest
Granola A	9.5	13.8	15.4	3.93	2.19	1.69
Granola B	8.6	12.9	15.9	3.94	2.03	1.56
Granola C	9.6	12.8	16.1	4.38	2.08	1.70
Granola D	9.4	13.6	15.4	4.51	2.01	1.77
Atlantic A	8.8	17.4	20.8	3.76	1.80	1.58
Atlantic B	8.6	18.7	20.5	3.32	1.85	1.70
Atlantic C	8.3	17.9	20.6	3.56	1.79	1.57
Atlantic D	8.4	18.5	20.6	3.59	1.79	1.68
F.prob	0.178	<0.001	<0.001	no variation between reps		
LDS 5%	1.207	1.23	0.83			

4. Discussion and conclusions

The soil analysis of the demo fields showed a low soil N content at both Garut and Pangalengan (Table 2.3). The soil in Pangalengan contained more phosphate and potassium than in Garut Table 2.3), but both demo fields received high amounts of phosphate potassium through the manure and fertilizer applications (Table 2.1). So, it is not expected that these nutrients have limited production.

The chemical analysis of the applied manure showed large differences between Garut and Pangalengan in terms of nitrogen content, i.e. 0.57% N in Garut and 1.49% N in Pangalengan (Table 2.2). Table 4.1 shows the amount of nitrogen (theoretically) available at each location based on the nitrogen in both the applied manure and inorganic N fertilizer. The actual availability of nitrogen from manure for the potato crop is not exactly known, but because of the low C/N-quotient it is assumed that 50% of the manure N is available for crop uptake.

Table 4.1. Applied and available nitrogen in the demo plots (kg N/ha) in Garut and Pangalengan in 2014.

Treatment		Garut			Pangalengan		
		N present in organic manure	N from chemical fertilizer	Total N available*for crop	N present in organic manure	N from chemical fertilizer	Total N available* for crop
A	Farmers practice	114	200	257	298	200	349
B	N-level 1	57	100	129	149	100	175
C	N-level 2	57	150	179	149	150	225
D	N-level 3	57	200	229	149	200	275

* Assuming 50% of the N in manure is available for crop uptake

The N availability at Garut ranged from 129 to 257 kg N/ha^{-1}, while the N availability at Pangalengan was substantially higher and ranged from 175 to 349 kg/ha^{-1}. The higher N availability in Pangalengan did not result in higher yield of healthy tubers despite water shortages in the second half of the growing period in Garut. Table 3.7 and Figure 3.6 show that the soil cover decreased after seven weeks in Garut due to water shortages.

The nitrogen use efficiency (NUE) defined as the ratio between the amount of harvested potato yield and available nitrogen varied between 80 and 171 kg potatoes/kg N in Garut and between 73 and 148 kg potatoes/kg N in Pangalengan across the different N treatments. Granola tended to have higher NUE's associated with higher yields. The crop N uptake as fraction of the N supply (available N) varied between 0.22 and 0.56 in Garut and 0.30 and 0.67 in Pangalengan across different N treatments. Granola showed more response in N uptake to available N and a higher N uptake at the same level of N availability than Atlantic (Fig. 4.1).

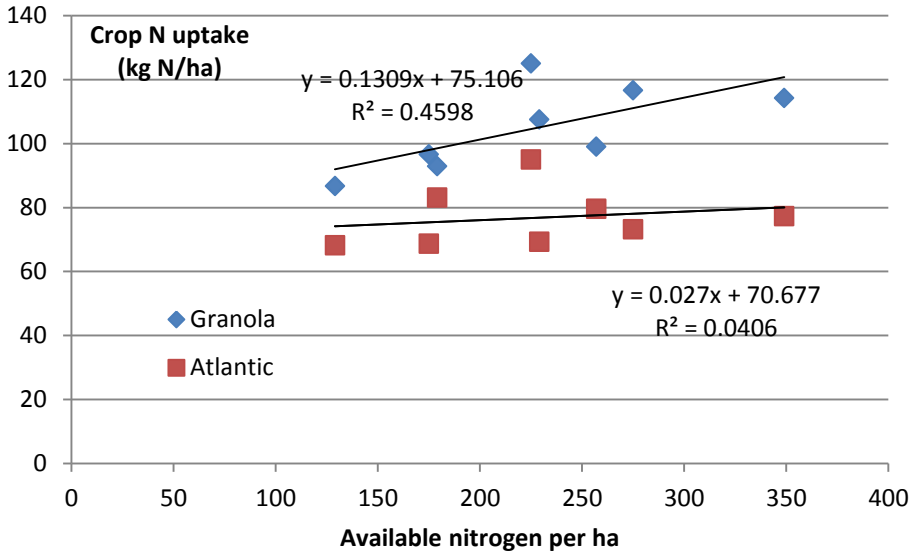

Figure 4.1 *The relationship between crop N uptake by potatoes and available nitrogen (Table 4.1) in Granola and Atlantic (combined data of Garut and Pangalengan).*

The percentage of rotten tubers at harvest was very high in both demo fields, especially in the variety Atlantic, ranging across N levels from 20 to 29% in Garut and 25 to 32% in Pangalengan (weight%). In Granola the percentages were lower, ranging from 7 to 11% in Garut and from 14 to 19% in Pangalengan. Probably these rotten tubes are caused by bacterial wilt due to poor seed quality and soil infection.

At both demo fields Granola showed severe virus symptoms during the growing period due to infected seed potatoes. However, yields of Granola were higher than Atlantic and the effects of four nitrogen fertilization levels in Granola were similar as the N effects in Atlantic.

The plant analysis showed at both demo fields differences in dry matter content between Atlantic and Granola. Atlantic is a variety with a high dry matter content, therefore it is mainly grown for the processing industry. Differences between fertilizer treatments in dry matter content and nitrogen content were relatively small and not significant.

For both varieties no significant yield differences were observed among the four N levels. However, at both locations the lowest nitrogen level (B) showed the lowest yield of healthy tubers in both varieties: Atlantic and Granola had 20 and 16% lower yields, respectively, than treatment A (farmers practice) in Pangalengan, and 26 and 8% lower, respectively, than treatment A in Garut. The lower yield of treatment B was also visible in less vigorous growth (lower plant height and soil cover in Granola at Pangalengan). This suggests that treatment B with 10 ton manure and 100 kg inorganic N/ha has reduced yields compared to the farmer practice of 20 ton manure and 200 kg inorganic N/ha.

Treatment C (10 ton manure and 150 kg inorganic N/ha) showed similar yields as treatment A (farmers' practice) for both varieties at both locations. Prices of manure are ranging from 350 to 500 IDR/kg and reducing the amount of manure with 10 ton/ha reduces input costs with 3,500,000 to 5,000,000 IDR/ha. According to De Putter et al. (2014) total production costs of potato are on average 75,500,000 IDR/ha. Application of 10 ton manure instead of 20 ton also reduces labor requirements and costs for transport and broadcasting of manure. Therefore, it is estimated that the

total costs of current potato production can be reduced by approximately 10% using less manure and fertilizers, i.e. 10 t manure/ha and 150 kg N/ha instead of using 20 t manure/ha and 200 kg N/ha (farmers' practice).

These first findings show promising perspectives for reducing nutrient inputs and input costs in potato production while maintaining potato yields and potato quality in Garut and Pangalengan. To confirm these results it is recommended to conduct a similar fertilizer demo with good potato seed.

5. References

De Putter, H., Gunadi, N., Uka, Wustman, R., Schepers, H., 2014. Economics and agronomics of Atlantic and Granola potato cultivation in the dry season of 2013 in West Java. vegIMPACT Internal report 10, Wageningen UR, The Netherlands.