Evaluation of soil and plant nitrogen tests in potato (*Solanum tuberosum* L.) production

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4th CASEE conference
July, 1st-3rd 2013

Introduction

- Nitrogen is the plant nutrient that most frequently limits crop production and is needed by most crops at higher quantities than other plant nutrients (Olfs et al., 2005).

- Application of N at rates exceeding plant utilization represents:
- unnecessary input cost
- may harm environment
- energy inefficient plant production

- Potatoes as shallow-rooted crops need a high level of nitrogen to ensure acceptable yield (Darwish et al., 2006).

Introduction

- Management, rate and timing of nitrogen application are critical factors in optimizing potato tuber yield and quality (Haase et al., 2006)

- Several soil and plant test methods that could improve N management in potato has been reported in the literature (Olfs et al., 2005)

Introduction

- Analysis of soil mineral nitrogen:
- at the beginning of the growth
- during the vegetation period

- Plant analysis:
- Plant sap nitrate test
- Chlorophyll content
- Leaf N mineral concentration

Materials and Methods – site

- Field experiment was conducted in 2011 in the North West region of Croatia

Materials and Methods – site

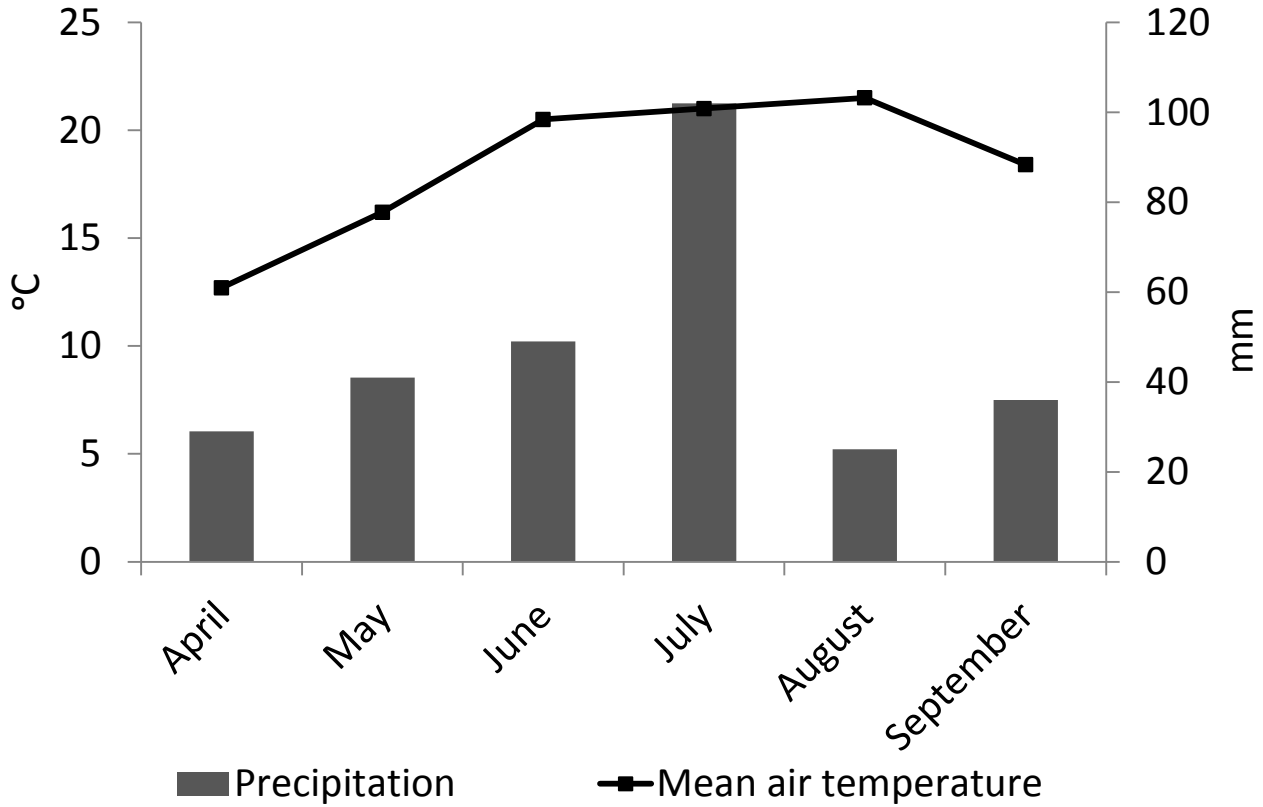
Physicochemical properties of the soil used in the study

Sand	Silt	Clay	pH		C_{org}	N_{min}	K_2O	P_2O_5
————%————			H_2O	KCl	%	kg ha^{-1}	—mg 100 g^{-1}—	
12.1	77.3	10.6	6.01	4.97	1.53	50.56	23.45	16.45

- silt loam
- slightly acidic
- good supplied with P and K
- high organic content

Materials and Methods – site

The mean air temperature (line; ºC) and sum of precipitation (bars; mm) during the vegetation period.



Materials and Methods – planting

- potato variety Sylvana

- Fully sprouted tubers were planted on 4 April 2011,
- 0.75 m between row space and 0.33 m within row space.

Materials and Methods – treatments

- Experiment was set out as RCBD (4 replications)

- N treatments: 50, 100, 150 and 200 kg N ha^{-1}
- pre-plant fertilization with 50 kg N ha^{-1} (NPK 7:20:30)
- N side-dressing with 0, 50, 100 and 150 kg N ha^{-1} (KAN 27%)

Materials and Methods - measurements

N tests:

- Soil mineral nitrogen (N_{min}) contents
- during the vegetation (58 and 98 days after planting (DAP))
- after harvest

- Chlorophyll content index (CCI)
- Petiole NO_3-N concentrations

} -during the vegetation (58 and 98 DAP)

Materials and Methods - measurements

- Yield:

- Fresh tuber yield was calculated by harvesting two middle rows of each plot.
- Tubers >5.5 cm were classified as first class, while tubers between 5.5 and 3.5 cm were classified as second class.

Materials and Methods – data analysis

- SAS system for Windows 9.2 (SAS Institute Inc., Cary, NC, USA, 2002).
- ANOVA was performed for yield and residual N_{min} and Tukey's HSD Test was used for comparison of the mean values.
- Polynomial regression was used to analyse the response of CCI, petiole sap NO_3-N concentrations and soil N_{min} content versus nitrogen treatments, at different DAP.
- Regression coefficients were tested for significance and best-fitted equation was selected for each dependent.
- Correlation between all measurements

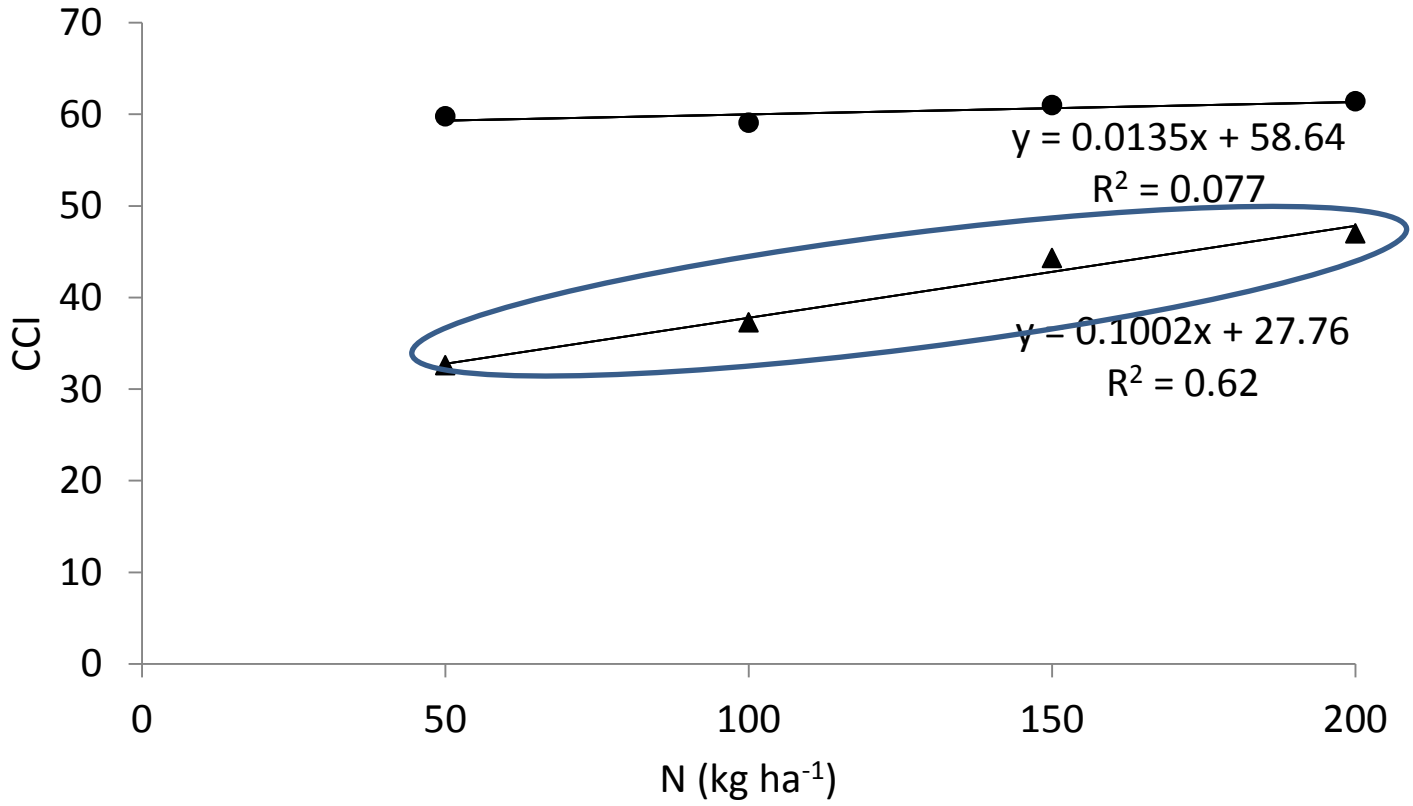
Results

First class, second class and total tuber yield of potato.

N treatments (kg ha^{-1})	Tuber yield (t ha^{-1})		
	1st class	2nd class	Total
50	21.2 c	3.8 ab	25.0 b
100	23.1 bc	4.3 a	27.4 a
150	24.5 ab	3.4 b	27.9 a
200	25.9 a	3.2 b	29.1 a
Tukey's LSD	**1.97**	**0.80**	**1.93**

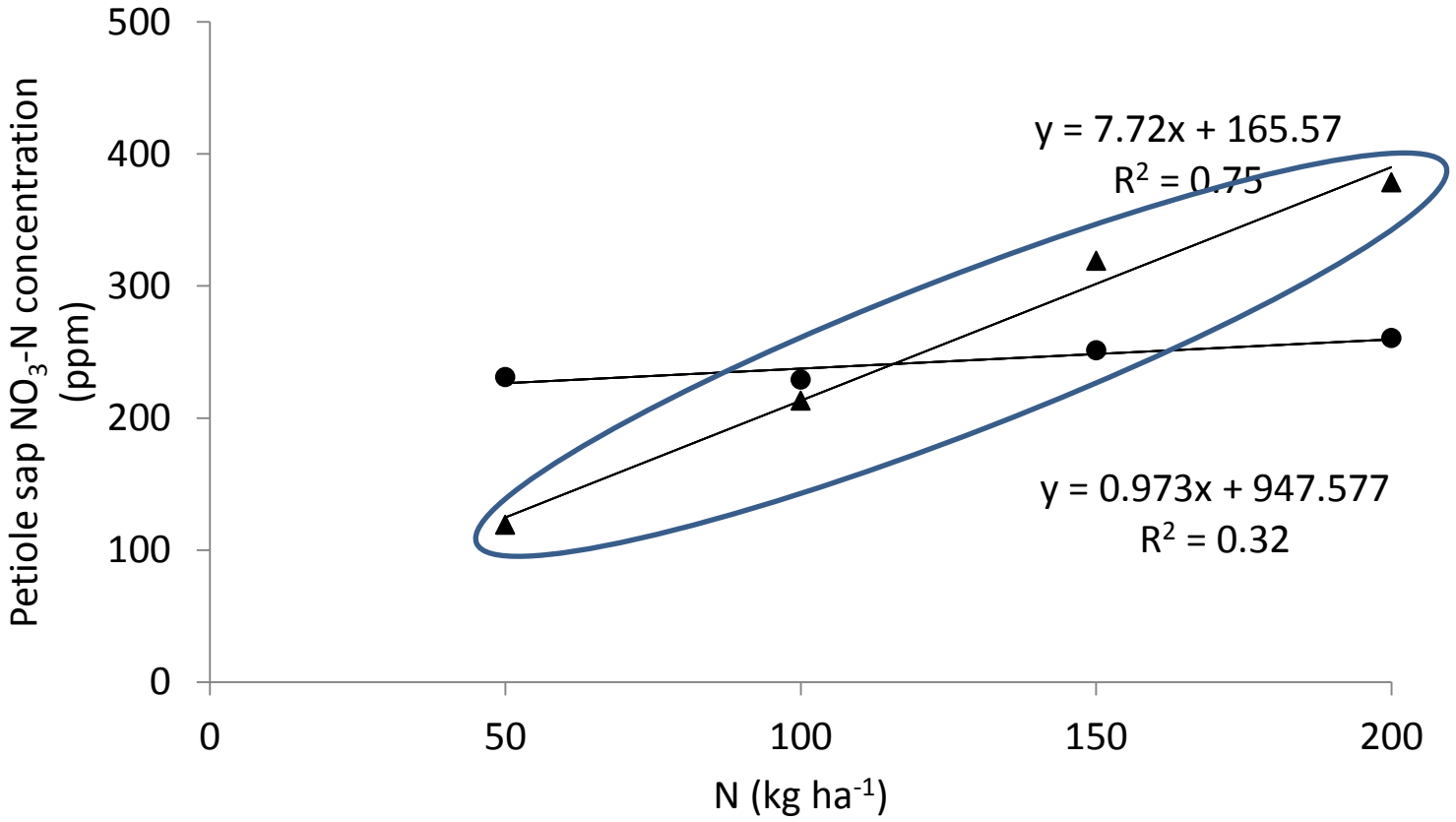
Results

Relationship between nitrogen applied and CCI of potato at 58 (●) and 98 (▲) day after planting.



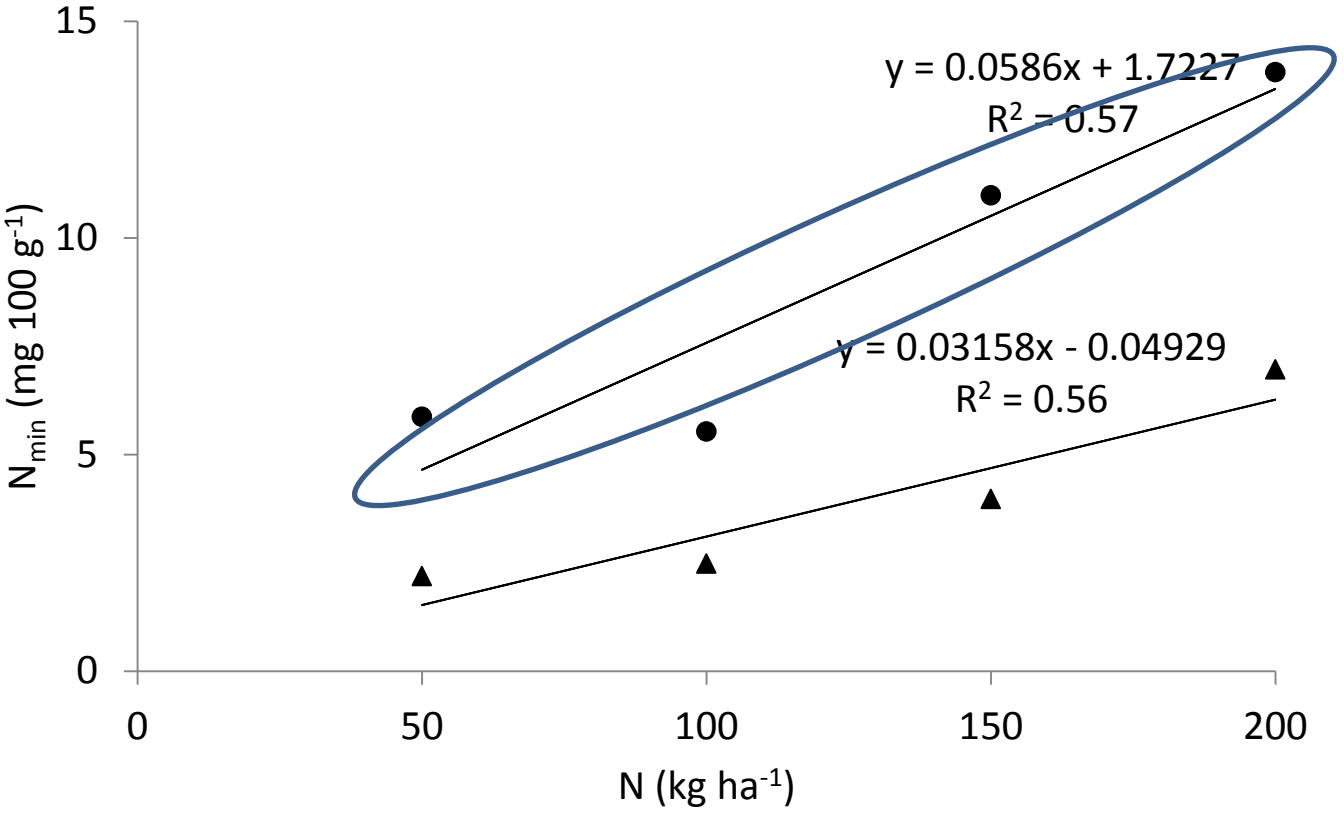
Results

Relationship between nitrogen applied and petiole sap NO_3-N concentrations of potato at 58 (●) and 98 (▲) day after planting.



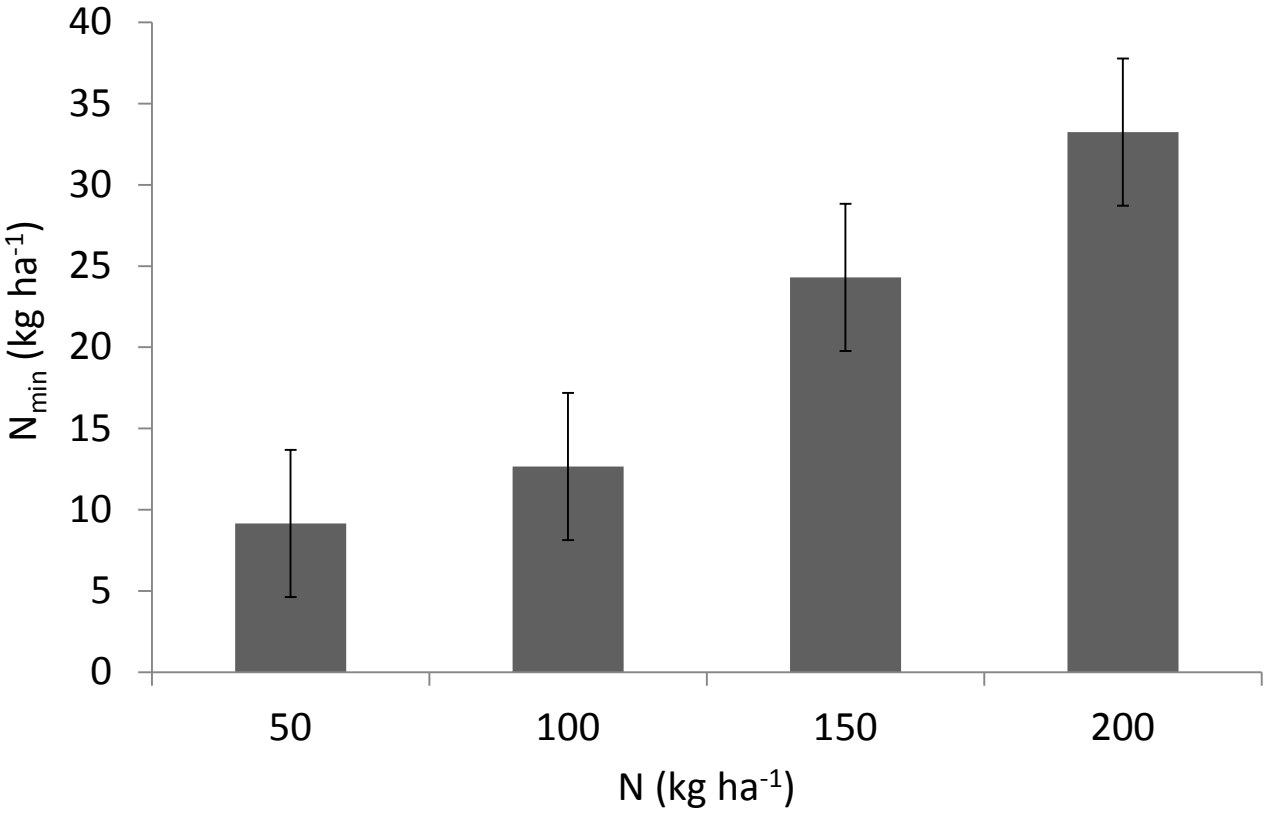
Results

Relationship between nitrogen applied and soil mineral nitrogen content (N_{min}) of potato at 58 (●) and 98 (▲) day after planting



Results

Residual mineral nitrogen (N_{min}) in soil after potato harvest.



Results

Correlation coefficients among yield, yield classes, CCI, petiole sap NO_3-N concentrations and soil N_{min} content.

Parameter	CCI 1	NO_3-N 1	N_{min} 1	CCI 2	NO_3-N 2	N_{min} 2	2nd yield	1st yield	Tot. yield
CCI 1	-	$0.442^{n.s.}$	$0.374^{n.s.}$	$0.450^{n.s.}$	$0.255^{n.s.}$	$0.397^{n.s.}$	$0.089^{n.s.}$	$0.087^{n.s.}$	$0.119^{n.s.}$
NO_3-N 1		-	0.613^{*}	0.693^{**}	0.634^{**}	$0.382^{n.s.}$	$-0.197^{n.s.}$	$0.439^{n.s.}$	$0.409^{n.s.}$
N_{min} 1			-	0.628^{**}	0.637^{**}	0.569^{*}	$-0.380^{n.s.}$	0.670^{**}	0.600^{*}
CCI 2				-	0.756^{**}	0.514^{*}	$-0.212^{n.s.}$	0.546^{*}	0.519^{*}
NO_3-N 2					-	0.615^{*}	$-0.189^{n.s.}$	$0.323^{n.s.}$	$0.287^{n.s.}$
N_{min} 2						-	$-0.141^{n.s.}$	$0.405^{n.s.}$	$0.389^{n.s.}$
2nd yield							-	$-0.358^{n.s.}$	$-0.079^{n.s.}$
1st yield								-	0.959^{**}
Tot. yield									-

Conclusions

- Potato is inefficient in uptake and use of N fertilizers, especially in unfavorable environmental conditions.
- Soil N_{min} content is better indicator of N fertilization in the early stages of vegetation
- Plant based tests are better correlated with N treatments at later growth stages in which applied N could be utilized by the crop.
- Due to the significant impact of environmental factors on the uptake and use of N fertilizers, further long lasting researches in this area are needed.

THANK YOU!

The Potato Eaters - Vincent van Gogh

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