



USE OF A PORTABLE ANALYSIS SYSTEM TO MEASURE NITRATE CONCENTRATION IN NUTRIENT AND SOIL SOLUTION AND IN PETIOLE SAP

María Teresa Peña-Fleitas, Rodney B. Thompson¹

*UAL Crop Nitrogen and Irrigation Lab,
University of Almeria, Almeria, Spain*

UAL Crop Nitrogen and Irrigation Lab web page:
<https://w3.ual.es/GruposInv/nitrogeno/index.shtml>

¹E-mail: rodney@ual.es

Portable analysis system

LAQUAtwin NO₃⁻ meter (model B-741T)

- ❑ Ion selective electrode
- ❑ Time for measurement: < 1 minute
- ❑ Cost: approx. 465€
- ❑ Dimensions: 17 x 3 x 2 cm
- ❑ Weight: 52 g
- ❑ Sample volume: 1.0 mL
- ❑ Suggested analytical range:
 - ❑ 100 to 9990 mg NO₃⁻ L⁻¹
 - ❑ 23 to 2200 mg N-NO₃⁻ L⁻¹
 - ❑ 1.6 to 157 mmol L⁻¹
- ❑ Claimed analytical error: ±10%
- ❑ Results as either NO₃⁻ or N-NO₃⁻



LAQUAtwin



Almeria greenhouses: fertigation and irrigation

- ❑ 100% combined drip irrigation and fertigation

Fertigation of soil-grown crops (90% of crop surface)



Simple fertiliser tanks



Computer-controlled multiple nutrient tank system

Multiple tank systems

- ❑ Approx. 65% with multiple tank systems; this percentage is increasing
- ❑ **Complete nutrient solutions applied in every irrigation, every 1–4 days**
- ❑ In these systems, **nutrients applied on basis of concentration**

Uses of portable analysis systems in fertigated vegetable crops, for on-farm analysis

NUTRIENT SOLUTION [NO₃⁻]

- ❑ Uncertainty in [NO₃⁻] actually applied
- ❑ Based on spreadsheets, venturi valve operation, and EC measurement
- ❑ Generally, not verified by analysis

SOIL SOLUTION [NO₃⁻]

- ❑ Sampled with ceramic cup suction samplers
- ❑ Tendencies and values of [NO₃⁻] inform of adequacy of N supply

PETIOLE SAP [NO₃⁻]

- ❑ Sensitive indicator of crop N status
- ❑ Particularly of N deficiency
- ❑ See poster by Alejandra Rodriguez



Materials and Methods - Samples analysed

Crop	Nutrient solution	Soil solution	Sap	Diluted sap ¹
Pepper 2014	661	144	319	-
Pepper 2016	360	262	160	160
Pepper 2017	773	194	180	200
Cucumber 2017	46	-	250	215
Cucumber 2018	170	134	216	216
Tomato 2010	-	-	-	56
Total no. samples	2010	734	1125	847

¹Dilution 1:10 in cucumber, and 1:5 in pepper and tomato

MATERIALS AND METHODS: crops and treatments

CROPS AND N TREATMENTS

- ❑ Samples from seven different crops
- ❑ In each crop, 3–5 different N concentrations applied during crop
- ❑ [N]'s were 1–2 deficient concentrations, a conventional concentration, and excessive concentration, and a very excessive concentration
- ❑ Example of [N]: 2, 6, 10, 14 and 18 mmol L⁻¹; approx. 90% as NO₃⁻
- ❑ Four experimental plots (6 x 6 m)/treatment, each with 72 plants per plot



Fertigation system of experimental greenhouse

MATERIALS AND METHODS: samples and analyses

SAMPLE COLLECTION

1) *NUTRIENT SOLUTION (NS)*

- 2 samples collected in trays at dripper in each treatment, 2 times/week

2) *SOIL SOLUTION (SS)*

- 4 samples per treatment every 1–2 weeks

3) *PETIOLE SAP*

- 4 samples (8–12 petioles) per treatment every 1–2 weeks

ANALYSES

1) LAQUAtwin NO_3^- meter (model B-741T)

- NS, SS and sap samples analysed on day of sampling, in laboratory

2) SKALAR San⁺⁺ automatic analyser system (lab. system)

- Sap samples on day of sampling
- NS and SS 1–2 days after sampling

3) **Linear regression analysis**

- To compare $[\text{N-NO}_3^-]$ measured with both systems

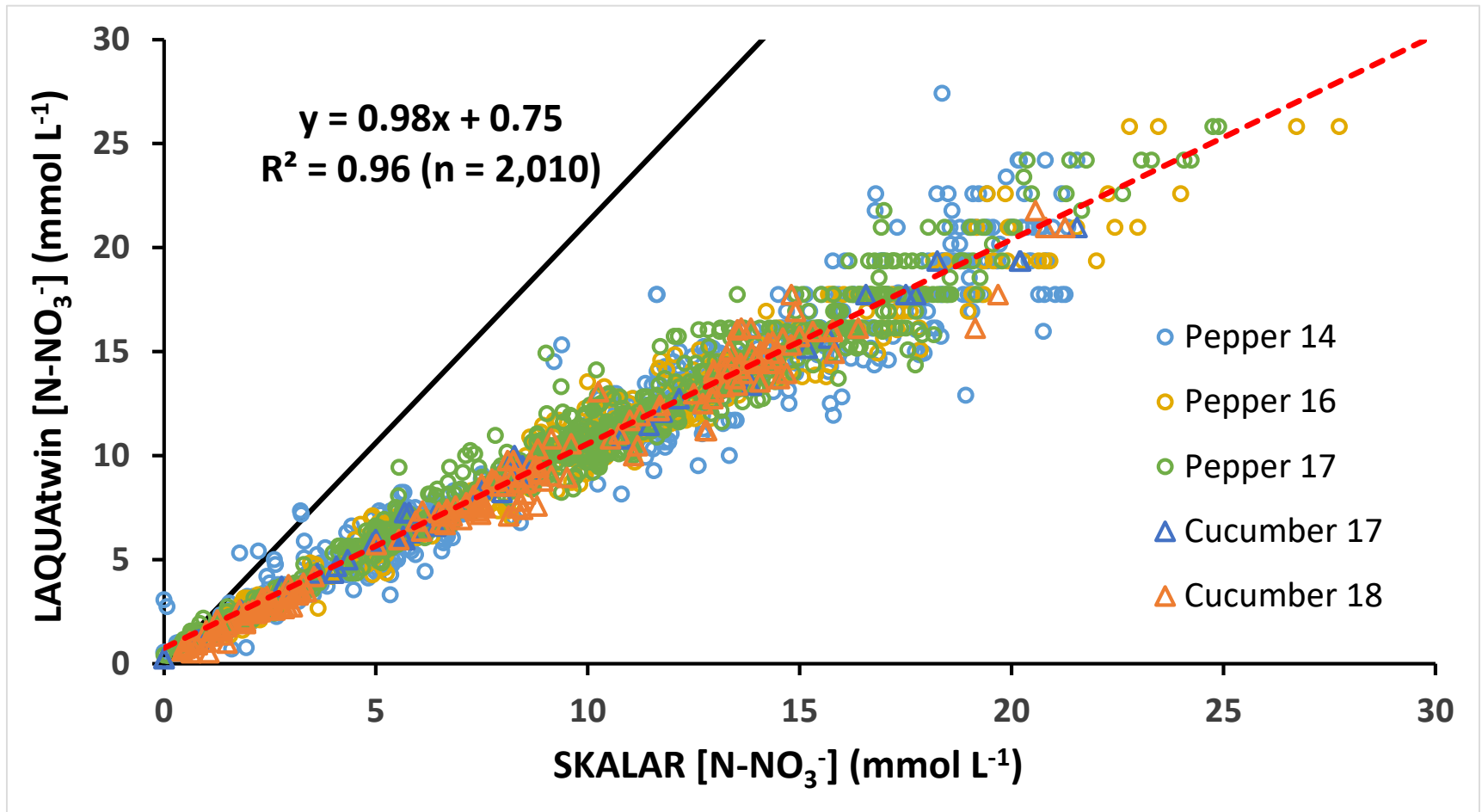


LAQUAtwin



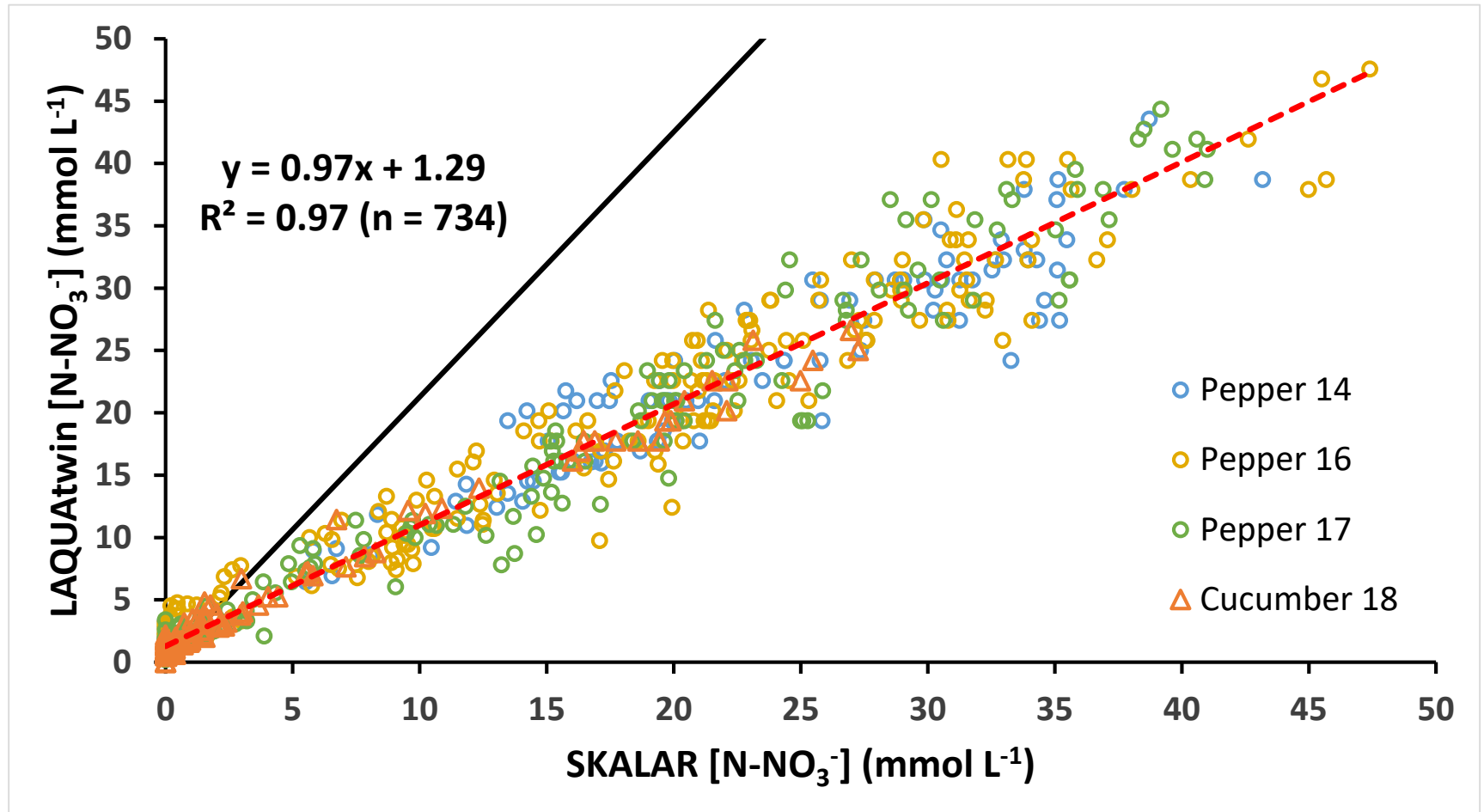
SKALAR San⁺⁺ auto analyser

RESULTS: N-NO₃⁻ in nutrient solution



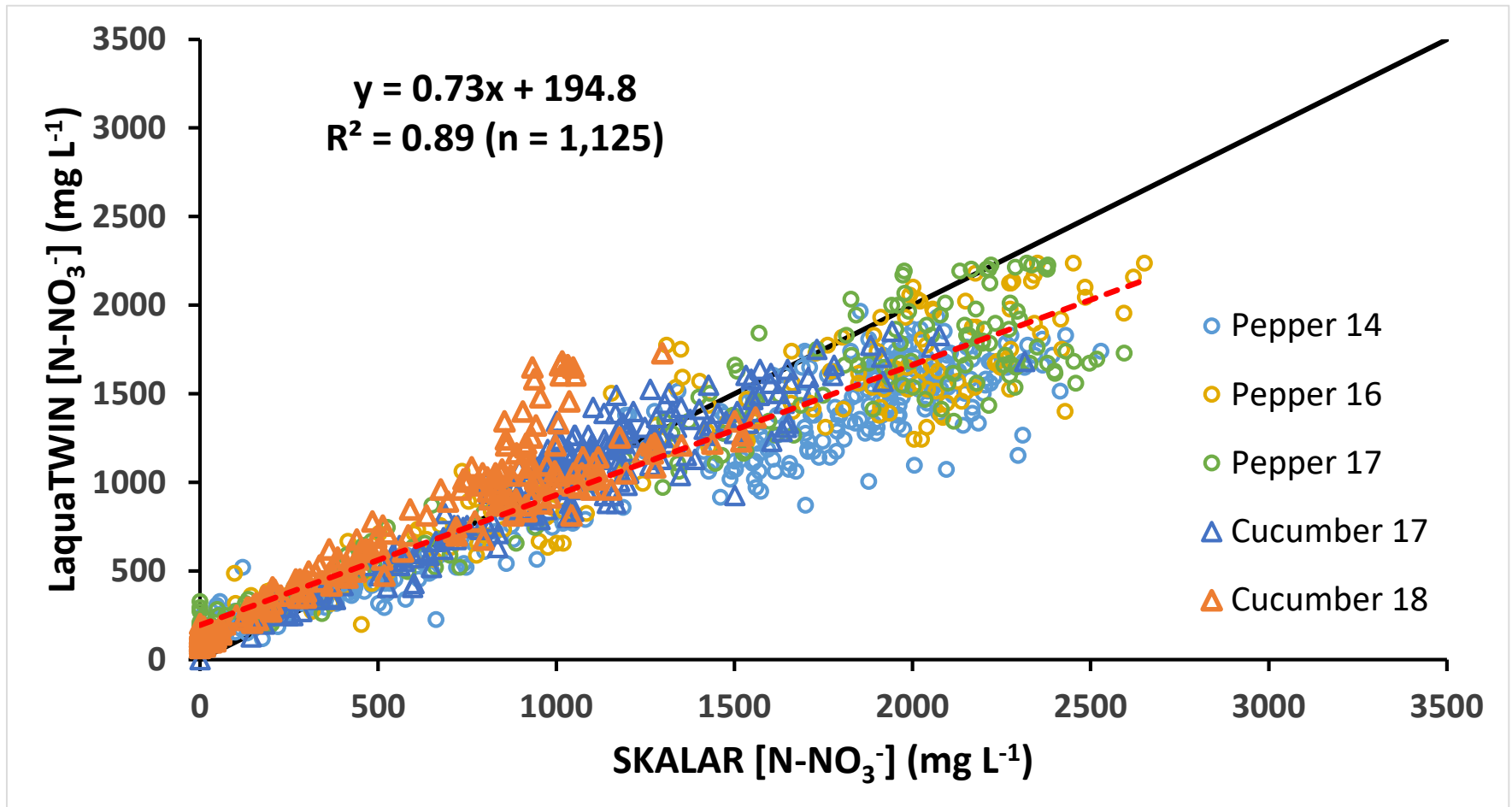
Observation: Strong linear relationship close to 1:1 over range of 0–25 mmol L⁻¹

RESULTS: N-NO₃⁻ in soil solution



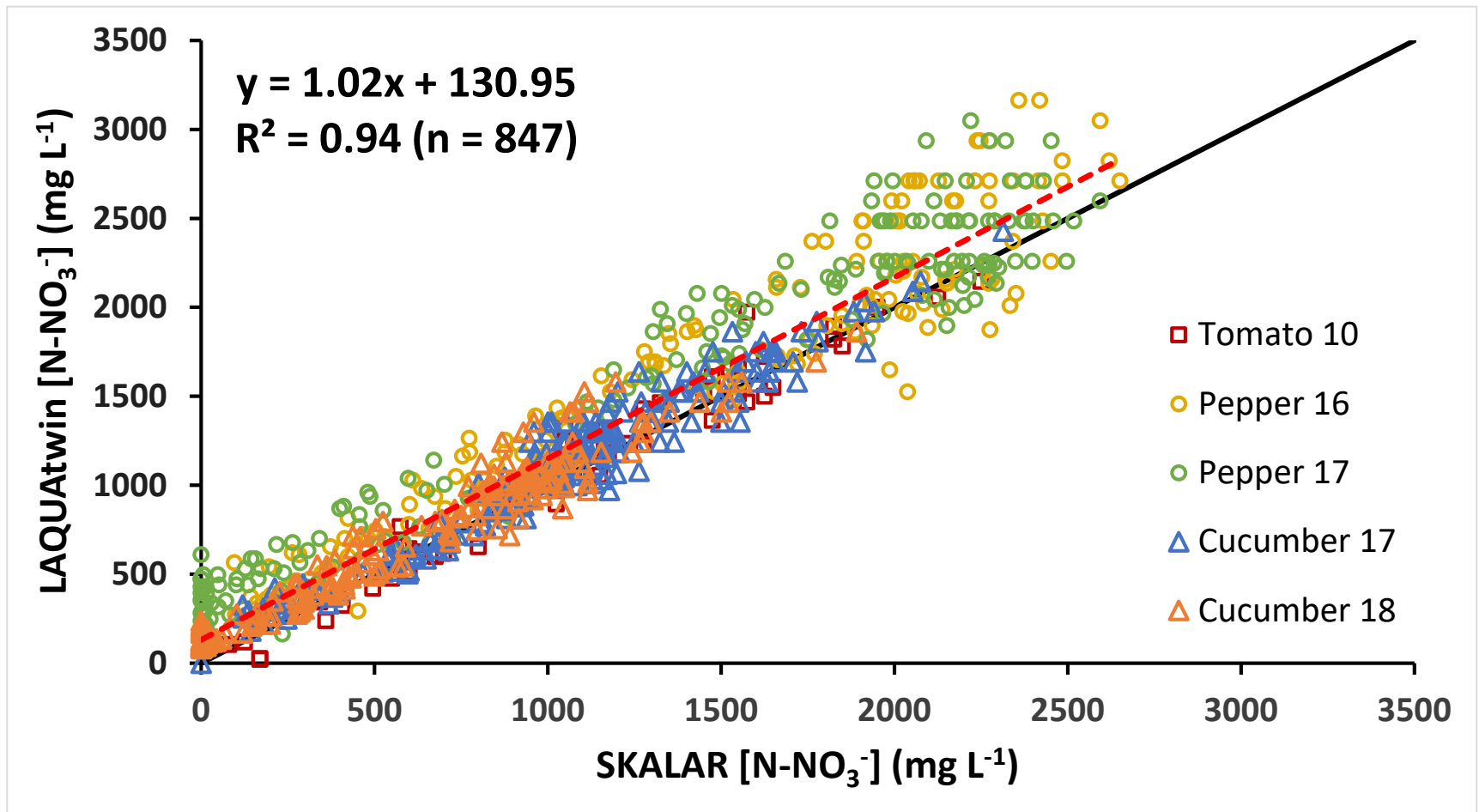
Observation: Strong linear relationship close to 1:1 over range 0–40 mmol L⁻¹

RESULTS: N-NO₃⁻ in pure (undiluted) sap



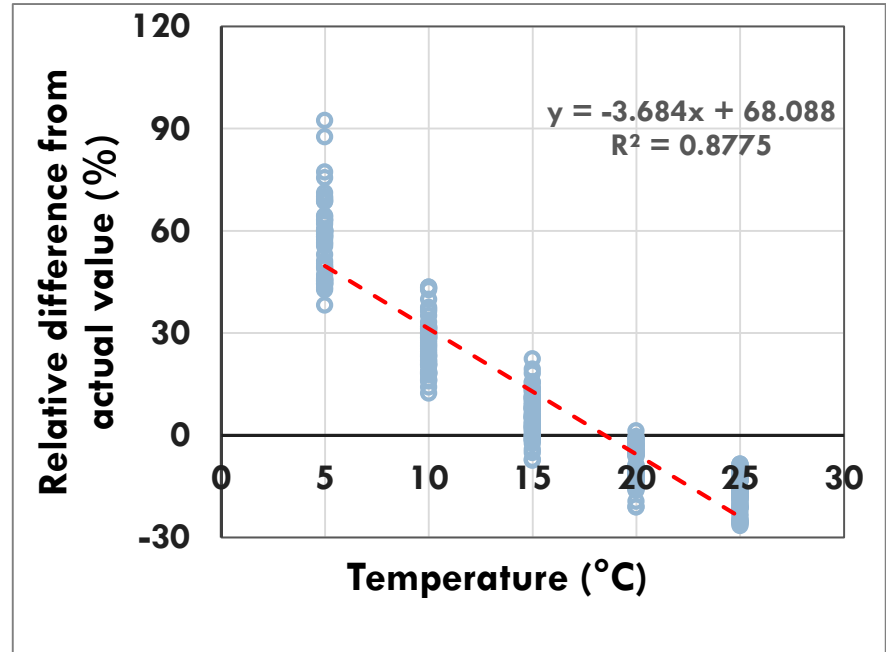
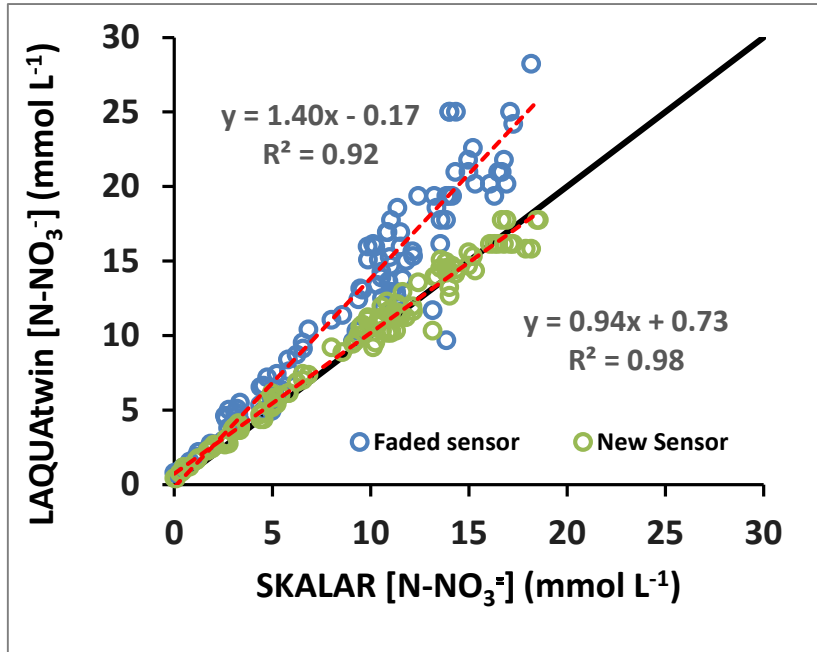
Observation: At $>1,500$ mg L⁻¹ (i.e. approx. 107 mmol L⁻¹) clear tendency for under-estimation

RESULTS: N-NO₃⁻ in diluted sap



Observations: 1) Strong linear relation over full range; 2) no underestimation at higher values

RESULTS: Electrode deterioration and temperature effects



Observations:

- 1) Electrode deterioration results in appreciable error
 - ❖ Company say that life is 1,000 measurements; for us it lasts one cropping season
- 2) Sample temperature has strong effect on measurements
- 3) Optimal sample temperature is 18.5°C

CONCLUSIONS: LAQUAtwin nitrate sensor

- ❑ Provided reasonably accurate measurement $[\text{NO}_3]$ in nutrient solution, soil solution and diluted sap
- ❑ Average relative error was approximately $\pm 20\%$
- ❑ In undiluted sap, there was tendency to under-estimate at $[\text{N-NO}_3]$ of $> 1500 \text{ mg L}^{-1}$
- ❑ Electrode deterioration can cause appreciable errors (of over-estimation)
 - ❑ Accuracy should be checked with independent standard
- ❑ Sample temperature can appreciably affect measurement
 - ❑ At $< 18.5^\circ\text{C}$, over-estimation
 - ❑ At $> 18.5^\circ\text{C}$, under-estimation

GRAZIE