Strategies to increase nutrient and water use efficiency in vegetable crops fertigated with saline water

EUVRIN
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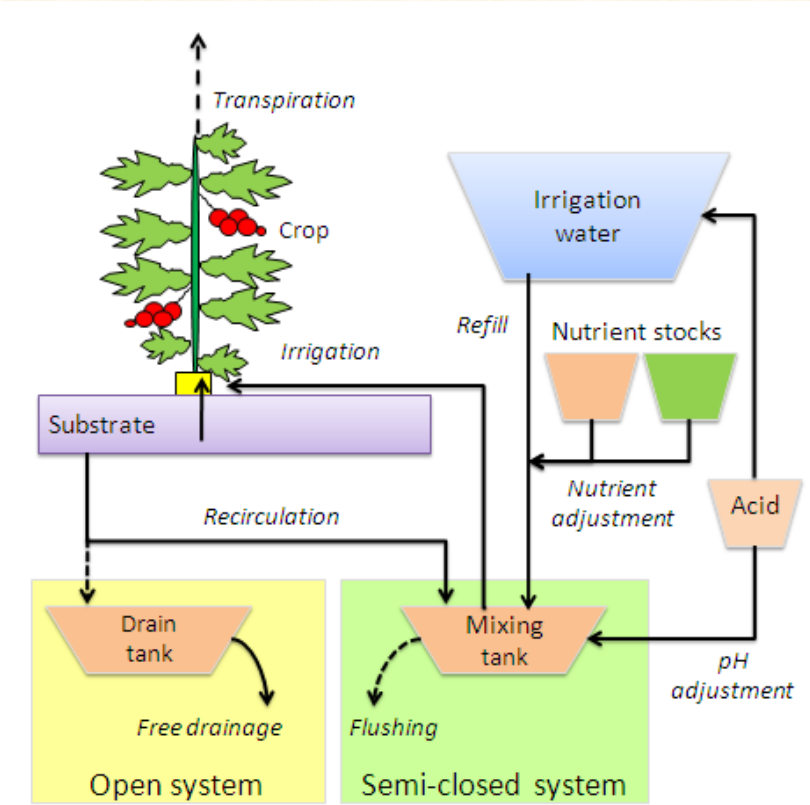
Closed systems: towards zero emissions

- Drainage water reused in successive irrigation cycles
- Theoretical efficiency of 100%: no emission of water and nutrients
- In presence of poor quality (e.g. saline) water the recirculation is discontinuous (flushing for nutrient solution renewal)
- Salinity
  - Common problem in many irrigated lands, especially costal areas e.g. in Mediterranean Countries
  - Tolerant crops may take benefits by salinity (increased EC), which is often increased by nutrients under operative conditions (e.g. basil up to 4 dS m^{-1})



Combination of increasing salinity and short periods of nutrient depletion before flushing

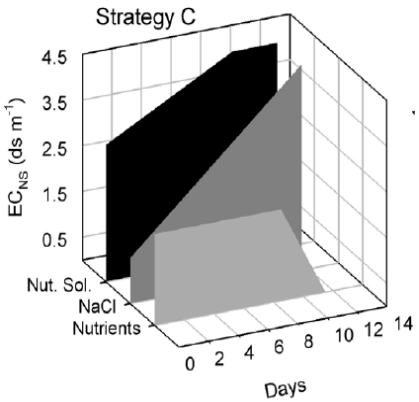
Contents lists available at ScienceDirect

Agricultural Water Management

journal homepage: www.elsevier.com/locate/agwat

Strategies to decrease water drainage and nitrate emission from soilless cultures of greenhouse tomato

D. Massa[a,*], L. Incrocci[b], R. Maggini[b], G. Carmassi[b], C.A. Campiotti[c], A. Pardossi[b]



Plant Soil (2009) 318:101–115
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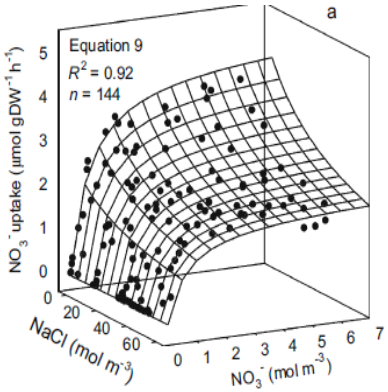
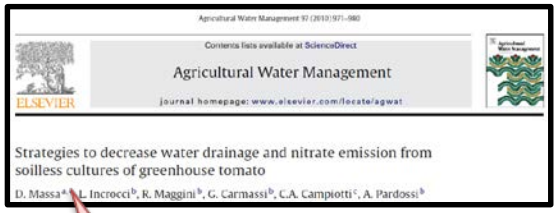
REGULAR ARTICLE

Effects of saline root environment (NaCl) on nitrate and potassium uptake kinetics for rose plants: a Michaelis–Menten modelling approach

Daniele Massa · Neil S. Mattson · Heinrich J. Lieth



Experiment: soilless-grown tomato


Agricultural Water Management 97 (2010) 971–980
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Strategies to decrease water drainage and nitrate emission from soilless cultures of greenhouse tomato

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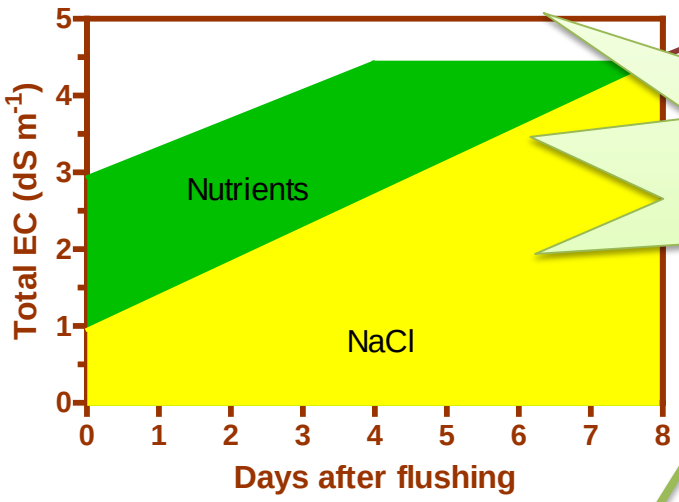
Flushing @
EC > 4.5 dS/m
[N] < 1 mM

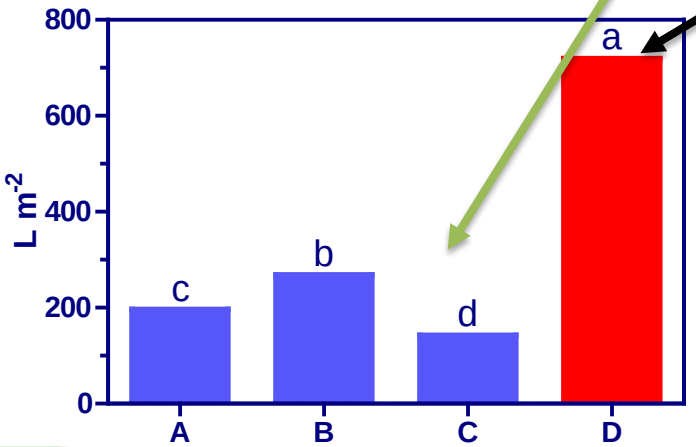
Strategy C



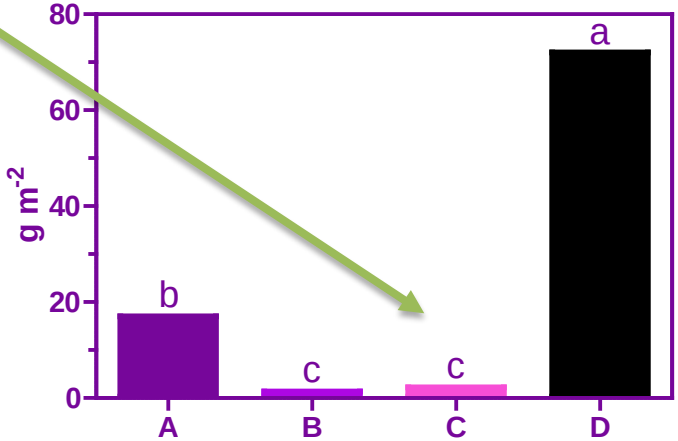
No decrease in yield and quality

Open system

Water drainage



Nitrogen leaching



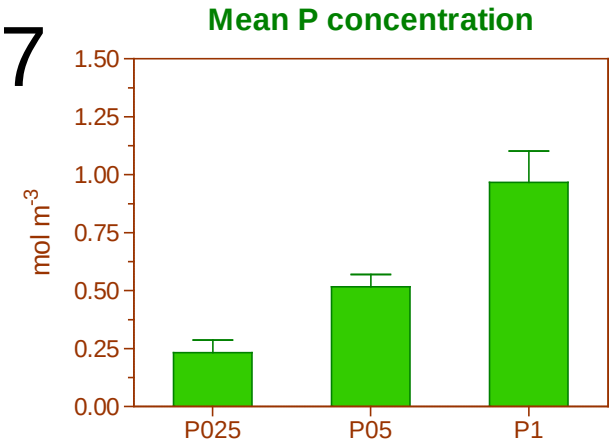
HydroTools: nutrient simulations in soilless systems

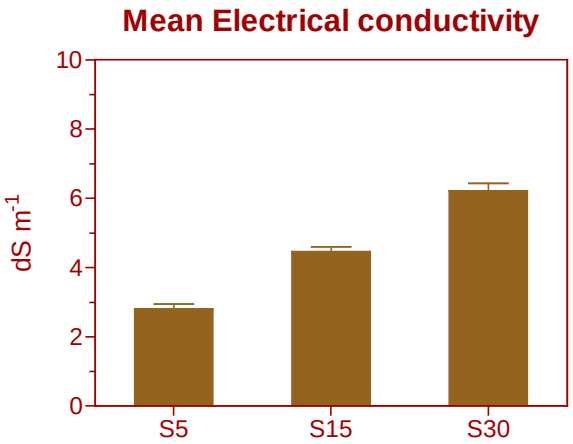
- DSS for soilless crops
- Composed of two main tools:
  - SolNutri: preparation of nutrient solutions
  - SimulHydro: simulations of nutrient and non-nutrient concentration in closed and semi-closed systems
- Simulations with saline water and different strategies for both refill and renewal of the recirculated nutrient solution
- Simulations of different scenarios to estimate water and nutrient use or water and nutrient losses for many vegetable crops and with different strategies

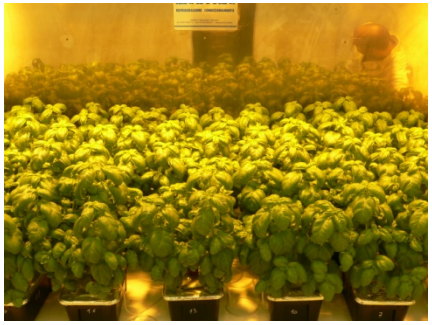
(http://www.wur.nl/en/Research-Results/Projects-and-programmes/Euphoros-1/Calculation-tools/Hydrotools.htm)

Experiment on basil 2016-17

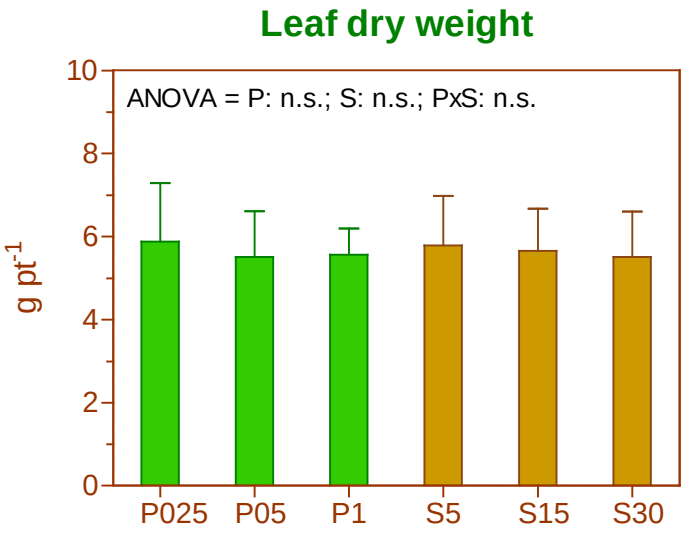
- Possibility of increasing P use efficiency by reducing P concentration in the nutrient solution in combination with saline water
- Basil (*Ocimum basilicum* L.) grown hydroponically (floating system)
- Two factors of variability:
  - P concentration: P1, P05 and P025 mol m^{-3}
  - NaCl concentration (salinity): S5, S15 and S30 mol m^{-3}

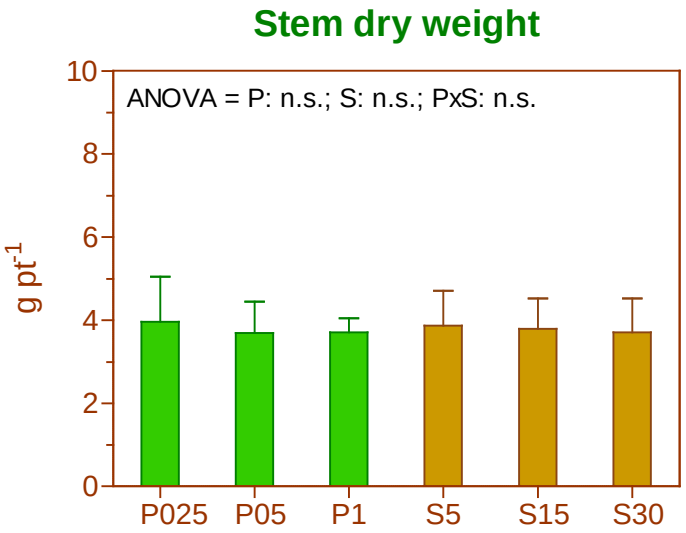






Results: biomass and biometric parameters

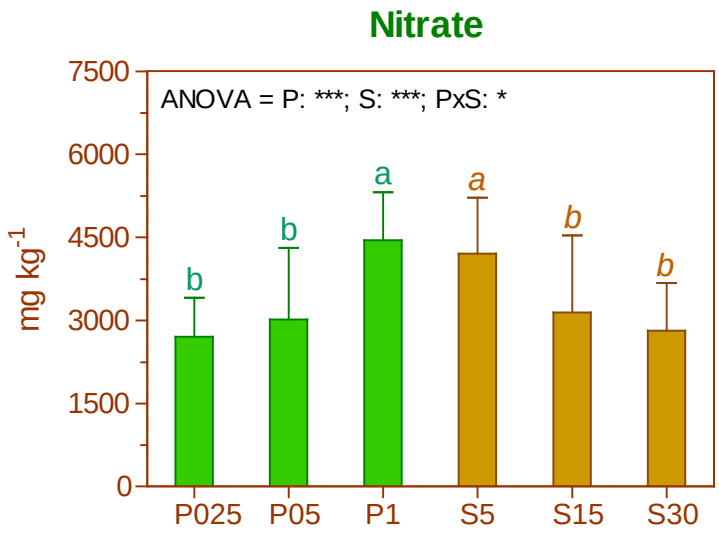


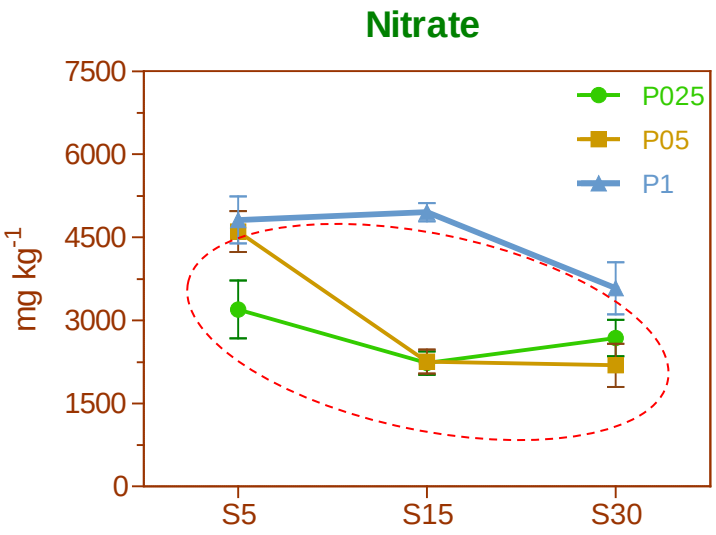


- No effect on leaf dry weight, specific leaf area and leaf area
- No effect on stem dry weight
- No effect on plant eight and node number
- No effect on tissue dry matter percentage
- Low P increased root/shoot ratio

Average ±SD; two-way ANOVA for phosphorus (P), salinity (S), and their interaction (PxS): n.s. = non significant or *,**,*** = significant at $P \leq 0.05$, 0.01 and 0.001, respectively. Different indicate significant differences according to Duncan's multiple-range test ($p \leq 0.05$).

Results: nitrate accumulation in leaves (mg kg^{-1} FW)

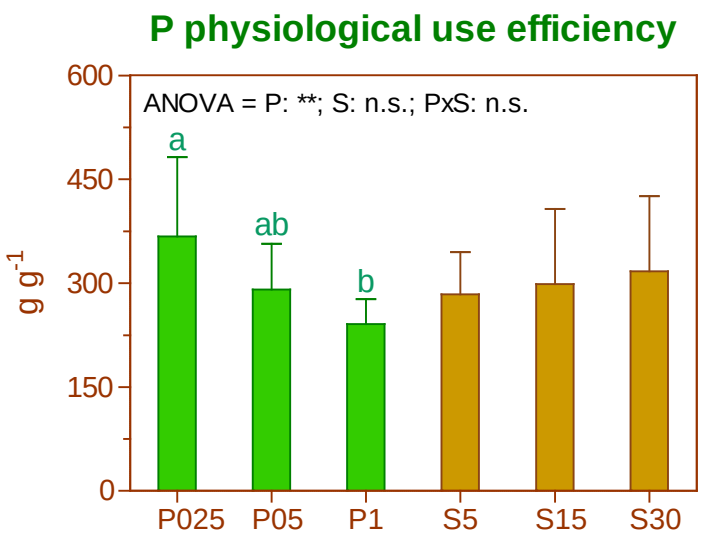


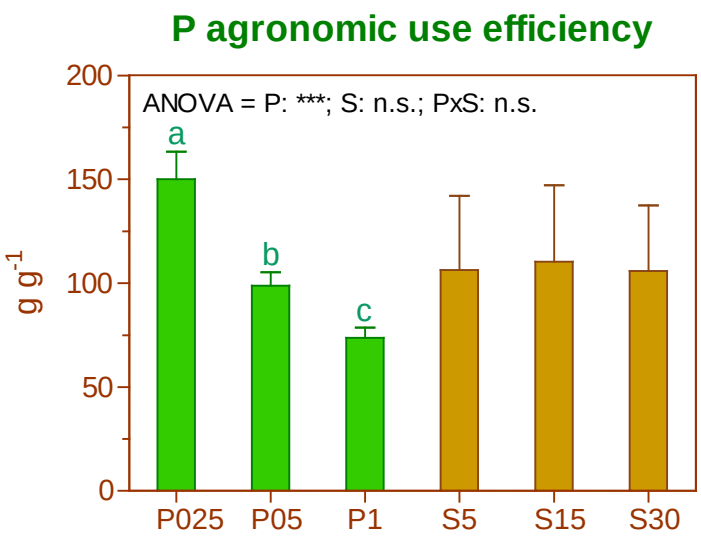


- Nitrate accumulation in leaves (fresh weight basis) was reduced by both decreasing P concentration and increasing NaCl
- A significant interaction was found between the two factors of variability
- Combining decreased P and increased NaCl concentration was more effective in reducing NO_3 accumulation than salinity itself
- Many other quality paramemeters were not negatively affected by the treatments

Average ±SD; two-way ANOVA for phosphorus (P), salinity (S), and their interaction (PxS): n.s. = non significant or *,**,*** = significant at $P \leq 0.05$, 0.01 and 0.001, respectively. Different indicate significant differences according to Duncan's multiple-range test ($p \leq 0.05$).

Results: physiological and agronomic use efficiency of P





- P physiological use efficiency calculated as the ratio between total plant dry weight and total P uptake
- P agronomic use efficiency calculated by the ratio between yield (shoot dry weight) and total P supply
- Both physiological and agronomic use efficiency of P were significantly increased by decreasing P supply

Average ±SD; two-way ANOVA for phosphorus (P), salinity (S), and their interaction (PxS): n.s. = non significant or *,**,*** = significant at $P \leq 0.05$, 0.01 and 0.001, respectively. Different indicate significant differences according to Duncan's multiple-range test ($p \leq 0.05$).

Conclusions

- Strategies are available to get “advantages” by the use of saline water
- Nutrient depletion is possible to reduce nutrient leaching related to the flushing of the exhausted nutrient solution
- Could these strategies to be useful for the diffusion of closed systems?
- The “mantra” of the EUVRIN meeting: how can we transfer these information to growers for the operative management?

…thanks for your attention!

…questions?

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