Performance of coffee seedlings as affected by soil moisture and nitrogen application

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UCDAVIS
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Coffee

- ✓ World: Second most valuable commodity
- ✓ Involves ~ 500M people
- ✓ A family business

(Da Matta et al, 2007)

- ✓ Brazil, Taiwan, Indonesia Colombia: larger producers
- ✓ 560K families – Farms <15 Acs

(ICO, 2013; Federacafe, 2013)

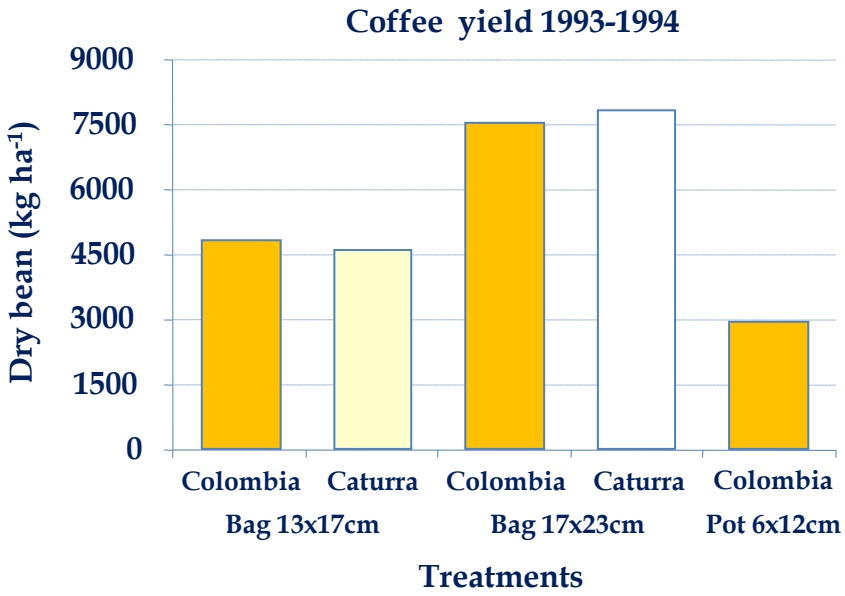
N requirements depend on growth stage

Germinative

Seedling

Vegetative growth

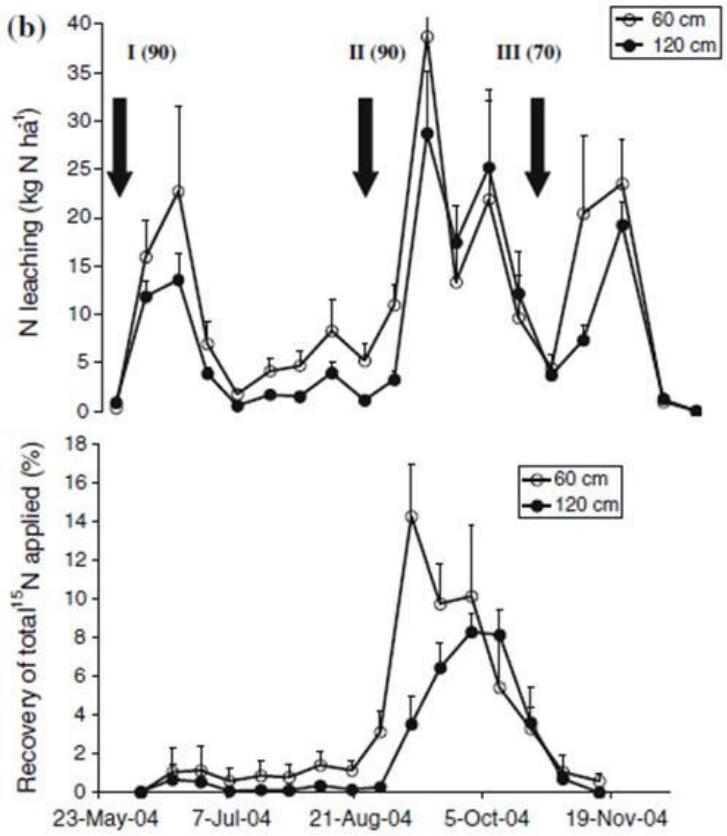
Productive



(Salazar, 1996)

✓ Early growth is the **most critical stage**

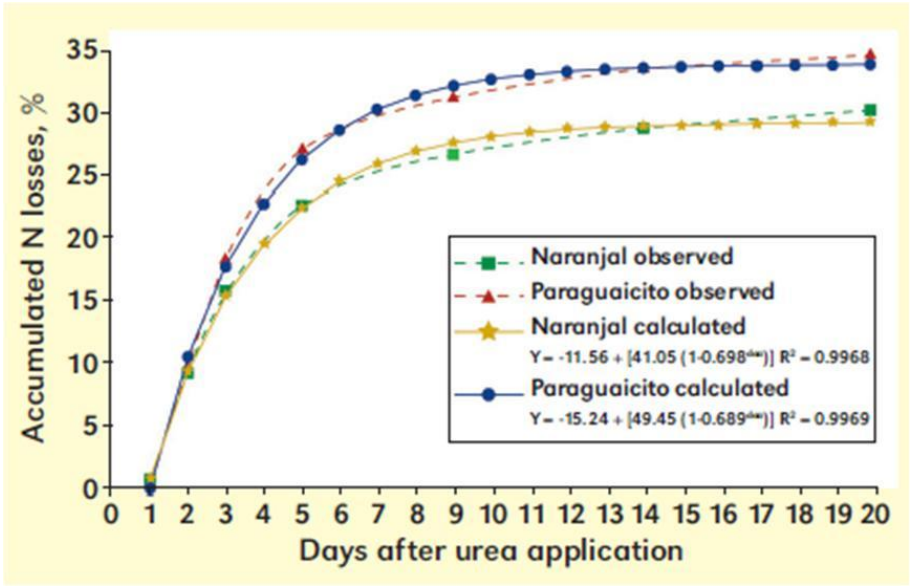
Economic and environmental impact



NO_3^--N losses by leaching

✓ >33% was leached below 120cm

(Cannavo *et al*, 2013)



✓ For the vegetative stage losses reach up to 40%

(Leal *et al*, 2010)

Soil water CRITICAL

NUE < 30%

NUE vs WUE ?

Based on these considerations:

- ✓ It is imperative to study the nutritional requirements of coffee seedlings to ensure maximum yield potential of reproductive coffee trees.
- ✓ We aim to generate knowledge about seedlings response in terms of growth, WUE and NUE to different soil water levels and N rates under greenhouse conditions.
- ✓ The main goal is maximizing early growth and potential yield by improving resources use efficiency to maintain ecosystem services in fragile mountain ecosystems in Colombia.

Materials and methods

Soil	OM	pH		Olsen P	K	Ca	Mg	CEC
	%	water	KCl	ppm	--------	$cmol_+ kg^{-1}$		--------
Andisol	16	6.7	5.5	4	0.62	9.6	1.45	13.7

- ✓ Three months old plants
- ✓ Watered every 3 days

Treatments

Number	Soil Ψm (bars) VWC (%)	N doses (g N $plant^{-1}$)
1	0.1 (50)	**0**
2		0.1
3		0.2
4		0.4
5	0.5 (39)	0
6		0.1
7		0.2
8		0.4
9	1 (33)	0
10		0.1
11		0.2
12		0.4
13	5 (23)	0
14		0.1
15		0.2
16		0.4

Design: A randomized block with a 4x4 factorial and 10 replications

Urea ^{15}N (1 atom %)

Measurements

After 9 months

- ✓ Dry weight of leaves, stems and roots
- ✓ WUE

  $WUE = dry\ biomass / water\ applied$

- ✓ Leaf ^{13}C composition (δ)
- ✓ N content
- ✓ Leaf ^{15}N

  $\delta_{lsr} = (R_{std} - R_{lsr})/(R_{std}) \times 1000$

  $Nddf_l = (\delta^{15}N_l - \delta^{15}N_{air})/(\delta^{15}N_{fert} - \delta^{15}N_{air}) \times 100$
- ✓ NUE

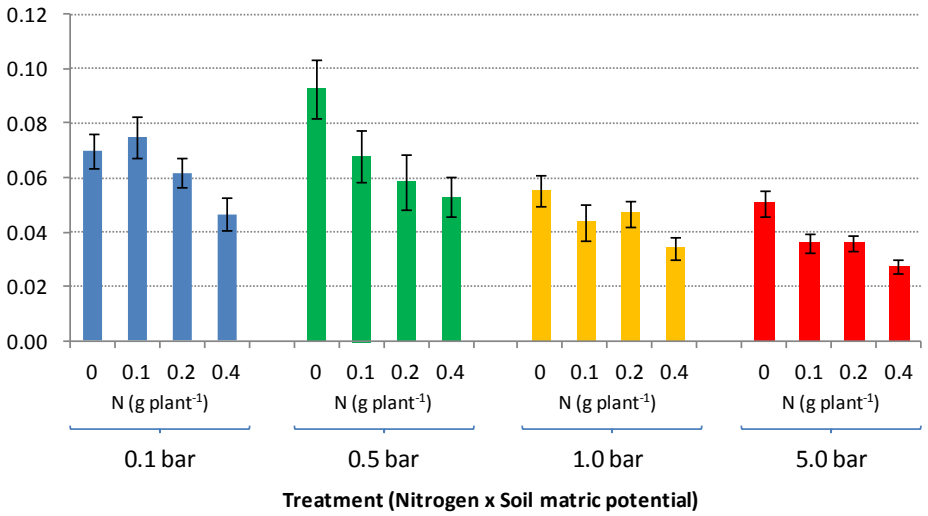
  $N_{Recovered} = (Nddf_l \times N_l)/(N_{applied})$

Last 3 months

- ✓ Photosynthesis
- ✓ Stomatal conductance
- ✓ Transpiration

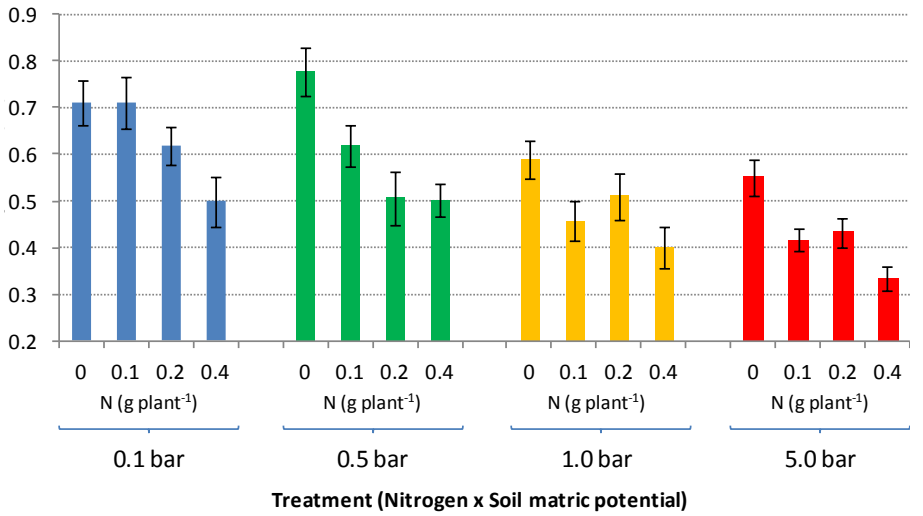
Physiological response

Conductance (mol H_2O / m^2 s)



- ✓ **Water effect** **(p= <.0001)**
- ✓ **N effect** **(p= <.0001)**
- ✓ No interaction (p= 0.3569)

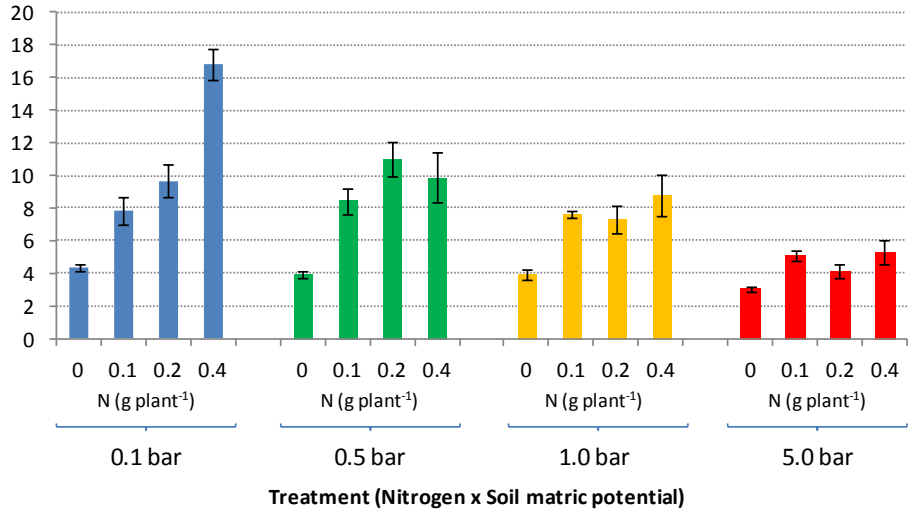
Transpiration (mmol H_2O / m^2 s)



- ✓ **Water effect** **(p= <.0001)**
- ✓ **N effect** **(p= <.0001)**
- ✓ No interaction (p= 0.2036)

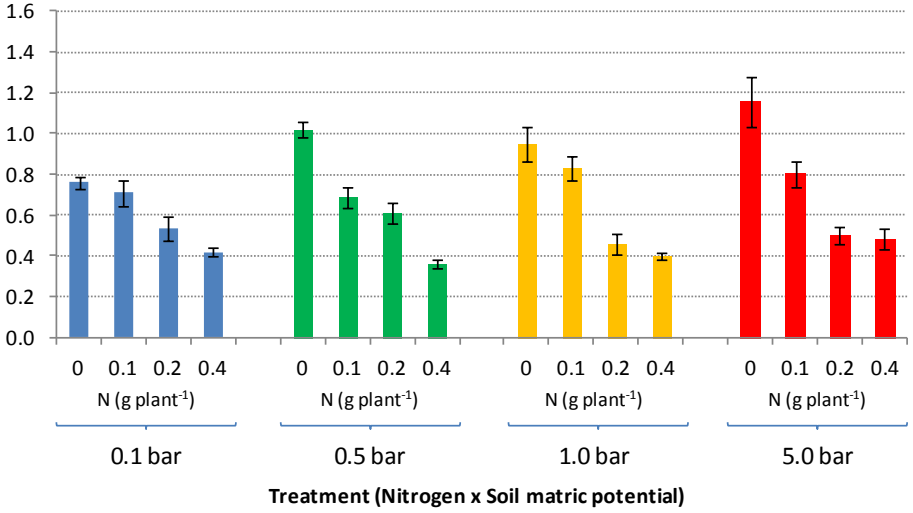
Pant growth

Shoot biomass (g)



- ✓ Water effect (p= <.0001)
- ✓ N effect (p= <.0001)
- ✓ Interaction (p= <.0001)

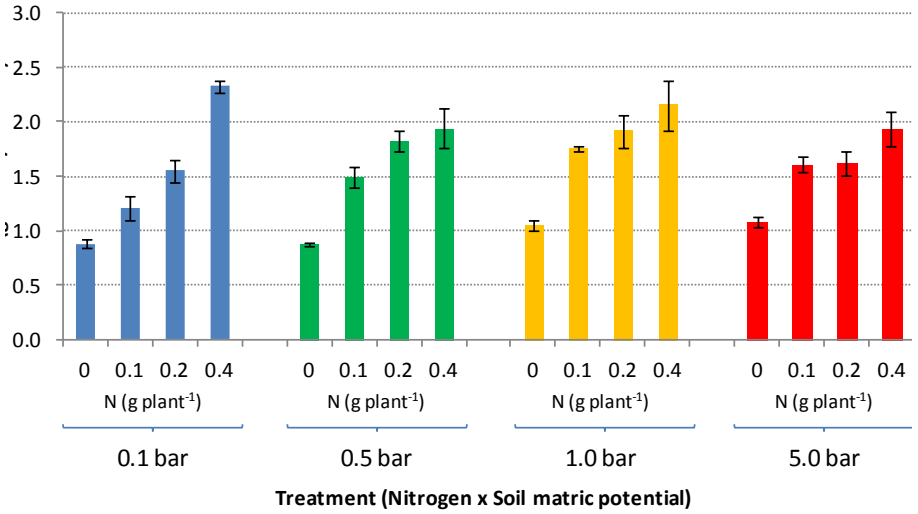
R:S ratio (g/g)



- ✓ Water effect (p= 0.0312)
- ✓ N effect (p= <.0001)
- ✓ Interaction (p= 0.0065)

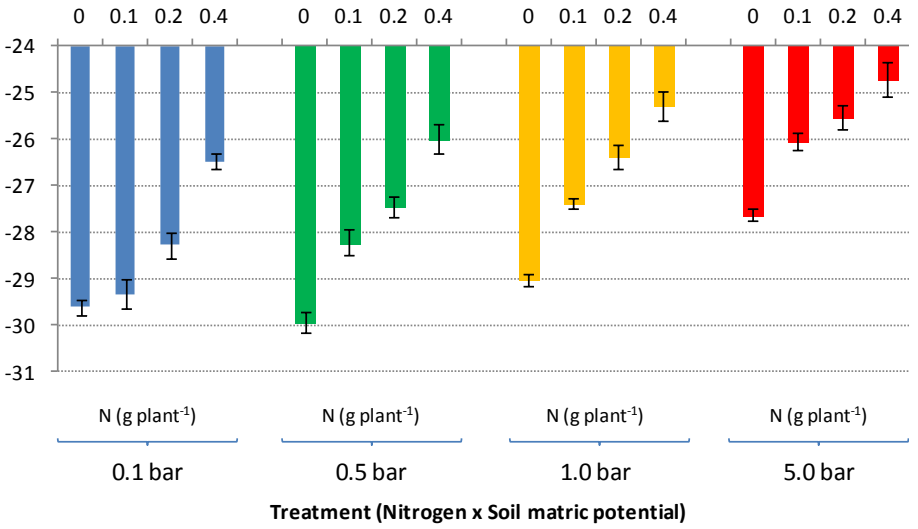
Water Use Efficiency

WUE (g biomass / L water)



- ✓ Water effect (p= 0.0243)
- ✓ N effect (p= <.0001)
- ✓ Interaction (p= 0.0079)

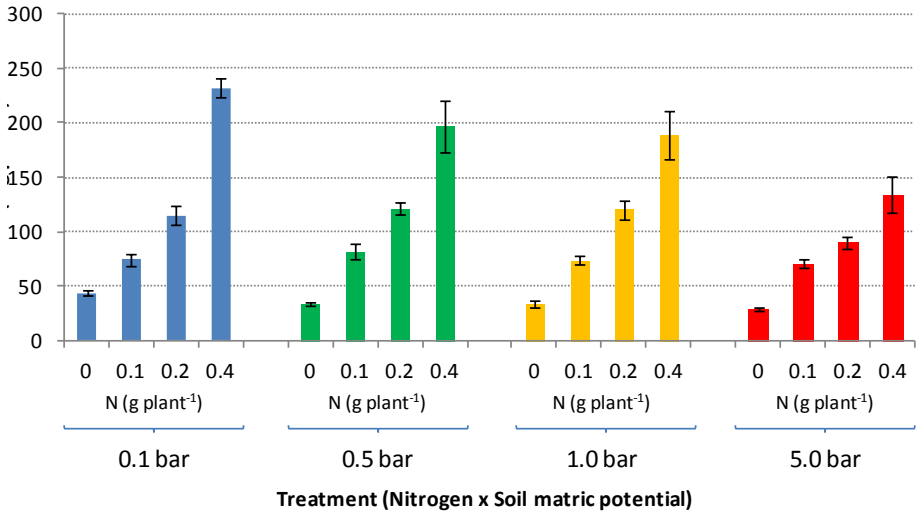
Leaf ^{13}C ($‰$)



- ✓ Water effect (p= <.0001)
- ✓ N effect (p= <.0001)
- ✓ Interaction (p= 0.0179)

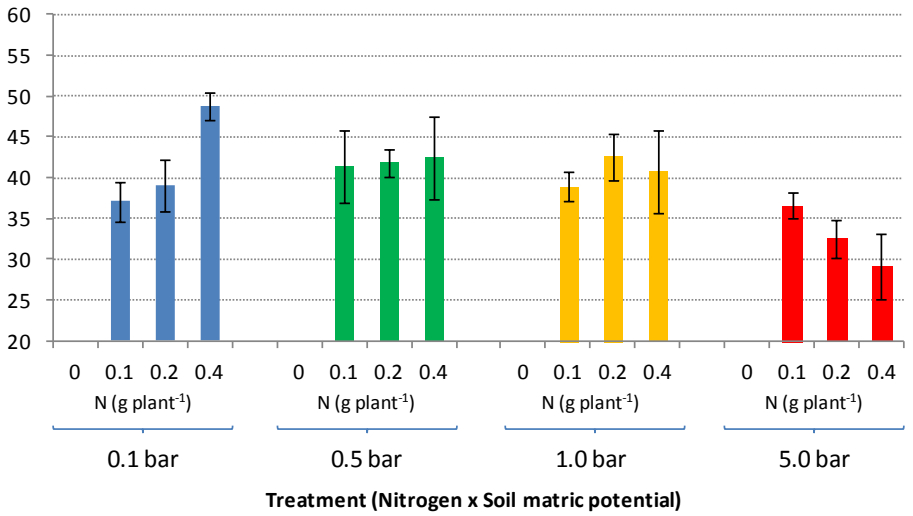
N Use Efficiency

Leaf N [ ] (mg / g of leaf)



- ✓ Water effect (p= <.0001)
- ✓ N effect (p= <.0001)
- ✓ Interaction (p= 0.0175)

Leaf N recovery (%)



- ✓ Water effect (p= 0.0030)
- ✓ N effect (p= <.0001)
- ✓ Interaction (p= 0.0385)

Final considerations

- ✓ The water*N interaction did not affect physiological response in terms of conductance and transpiration. Both decreased as water decreased and N increased.
- ✓ Shoot growth decreased by decreasing soil water but increased when N increased. Root growth exhibited the opposite behavior.
- ✓ WUE increased by increasing N in a greater proportion than by decreasing water
- ✓ By increasing N application leaf N contents increased but NUE decreased. Both were less affected by soil water content.

THANKS

Enjoy

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