Nutritional and chemical implications of long-term irrigation with recycled wastewater in olive orchard

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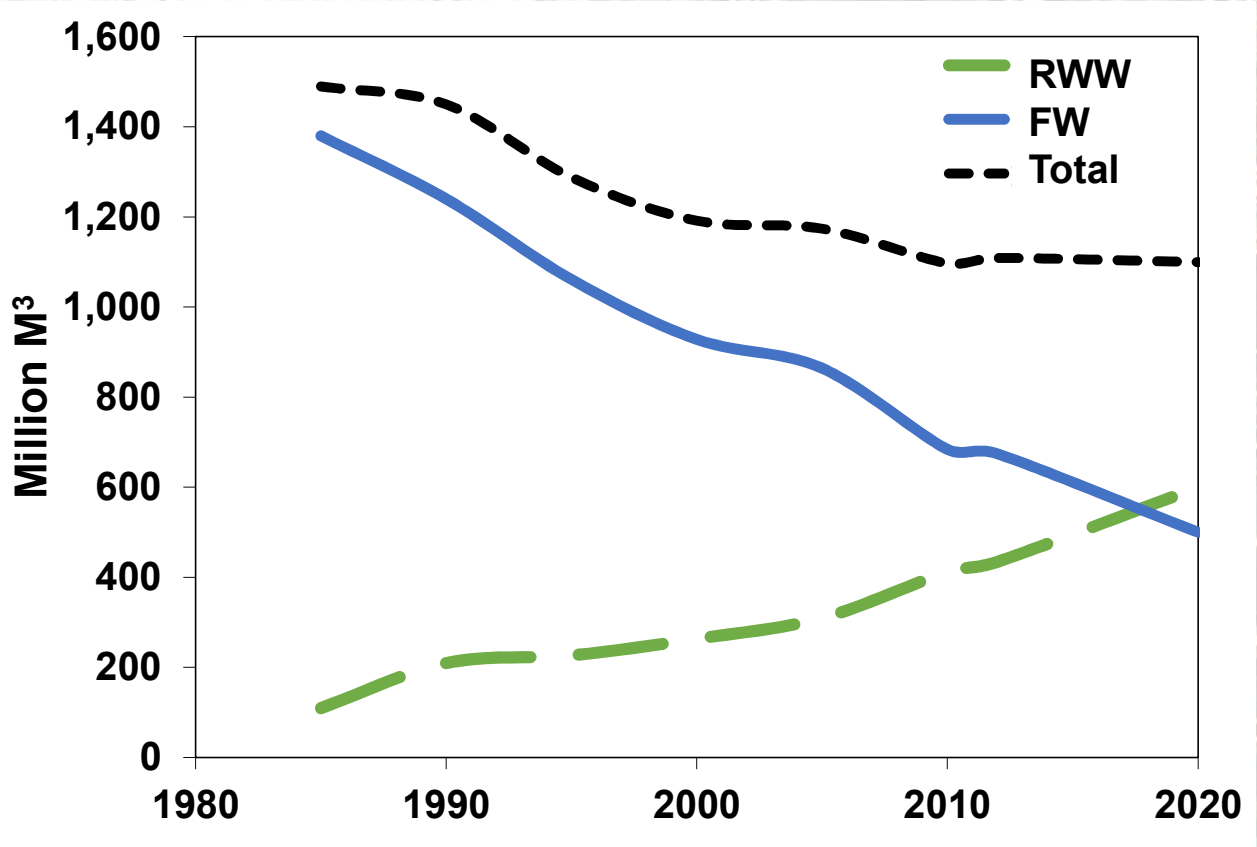
Sources of water for irrigation in Israel



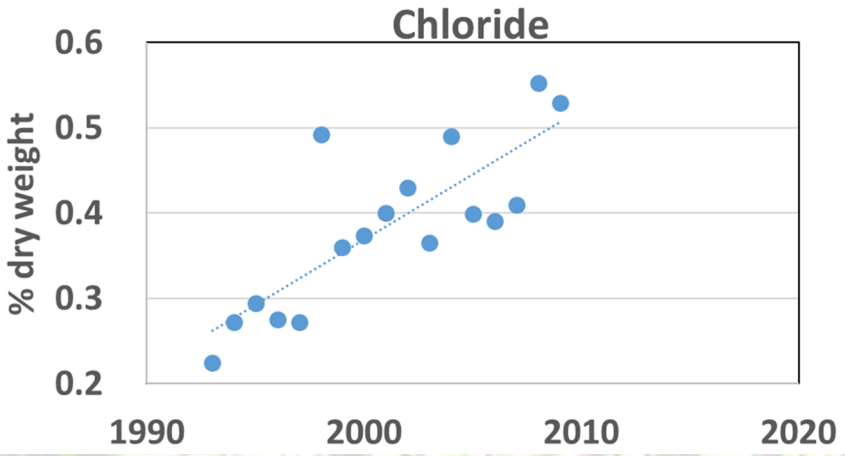
'Shafdan' treatment plant

Implications of RWW utilization

Positive	Negative	???
"Free" nutrients (NPK and micro)	Contamination of soil and water	Modification of soil properties (pH, OM etc.)
Continuous supply	Over-fertilization	Increased minerals solubility
Recycle	Salinity and soil sodicity	NH_4, main N source

Questions:

- Long-term effect of RWW on soil properties
- Effect of RWW on plant performance
- The contribution of RWW to plant nutrition



~30,000 citrus leaf samples tested for Cl between 1993 and 2012.

Raveh and Ben-Gal 2016 Agric Water Man


Olive irrigation with RWW
Intensification
Tolerance to salinity
Processed product

Experimental orchard

- Planted on 2002 (1,000 trees ha^{-1})
- Eight consecutive years: 2006-2013
- Soil: 50-55% clay

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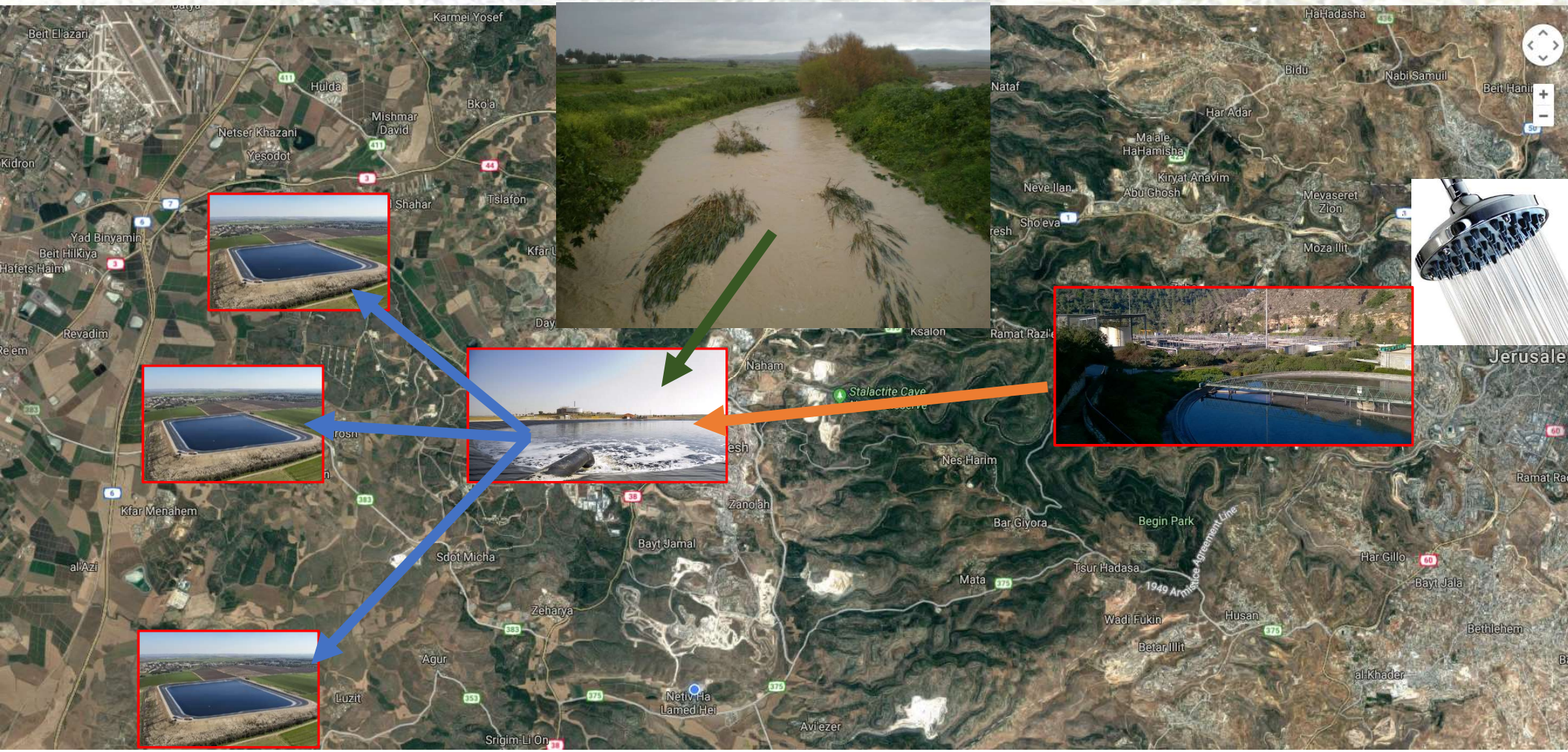
Treatment: Year	Fresh water Fr	Effluent Re+	Effluent Re-
2006-2009	Standard fertilization **200-0-300**	Standard fertilization **200-0-300**	Reduced fertilization **120-0-130**
2010-2013	Standard fertilization **200-0-300**	Reduced fertilization **100-0-130**	No fertilization **0-0-0**

“The trip of a drip”



Water characteristics

Constituent	Units	Effluent	Fresh water
pH		7.7 (0.3)	7.5 (0.2)
EC	dS/m	1.71 (0.22)	0.8 (0.2)
Cl	mg/L	326 (38)	138 (56)
Na	mg/L	202 (27)	69 (28)
Total N	mg/L	20.3(6.7)	2.5 (2.2)
K	mg/L	31.2 (6.8)	3.5 (2.8)
P	mg/L	5.6 (2.8)	0.0 (0.0)
Ca	mg/L	66.9 (8.8)	48.0 (12.9)
Mg	mg/L	35.6 (6.5)	22.1 (11.8)
SAR		5.1 (0.9)	2.1 (0.6)

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The national TWW survey

Citrus:
56 plots FW
109 plots TWW
Avocado:
10 plots FW
29plots TWW
Field crops:
13 plots

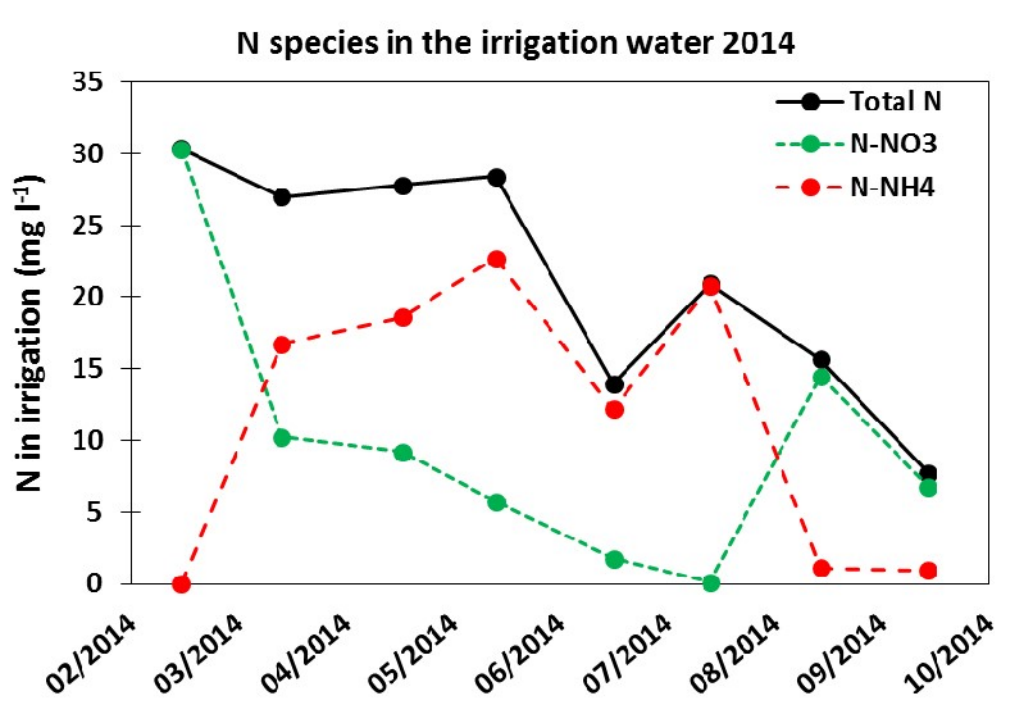
Water, soil and plant analysis

Nutrients allocation from RWW

		2006-2013	2010-2013	
N	RWW	94	124	N – 39 kg ha^{-1}
	Fr	9	12	
P	RWW	26	34	P – 4.5 kg ha^{-1}
	Fr	0	0	
K	RWW	146	193	K – 73 kg ha^{-1}
	Fr	16	22	

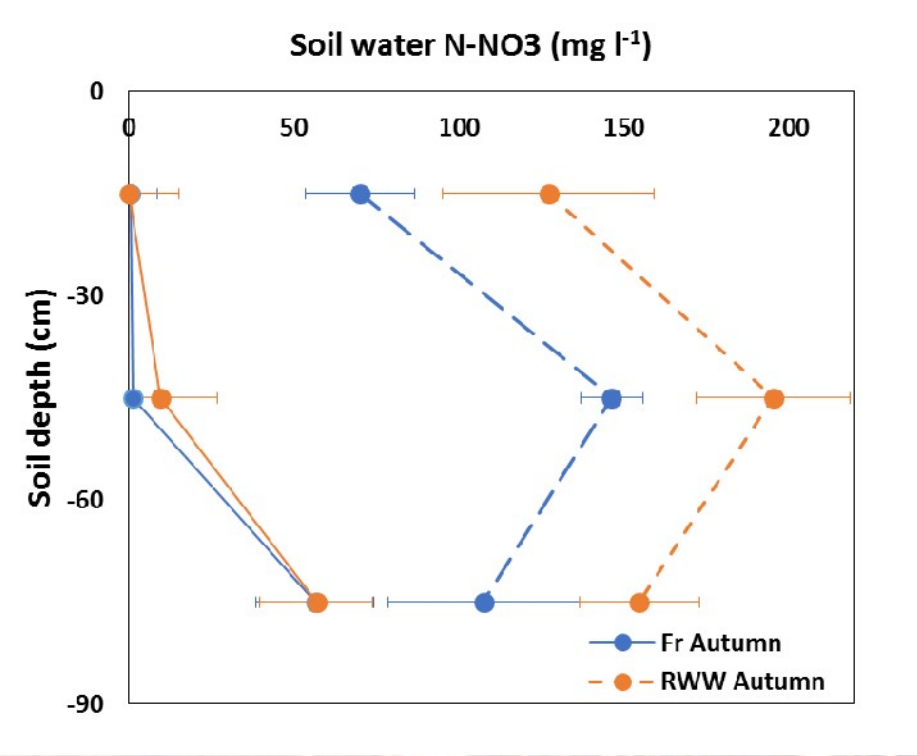
Nutrients offtake at harvest (10 to ha^{-1})

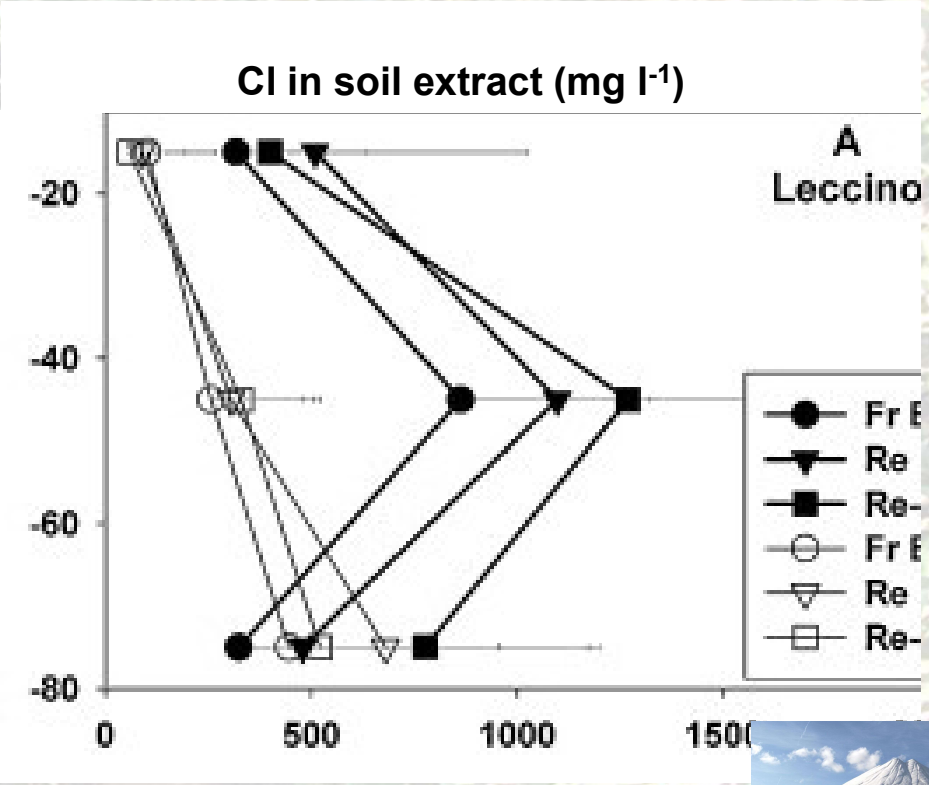
Av. Fruit NPK concentration: 0.78% 0.09% 1.46%



Nutrients supplied with the TWW are ~ 2, 6 and 2 times higher of the average offtake

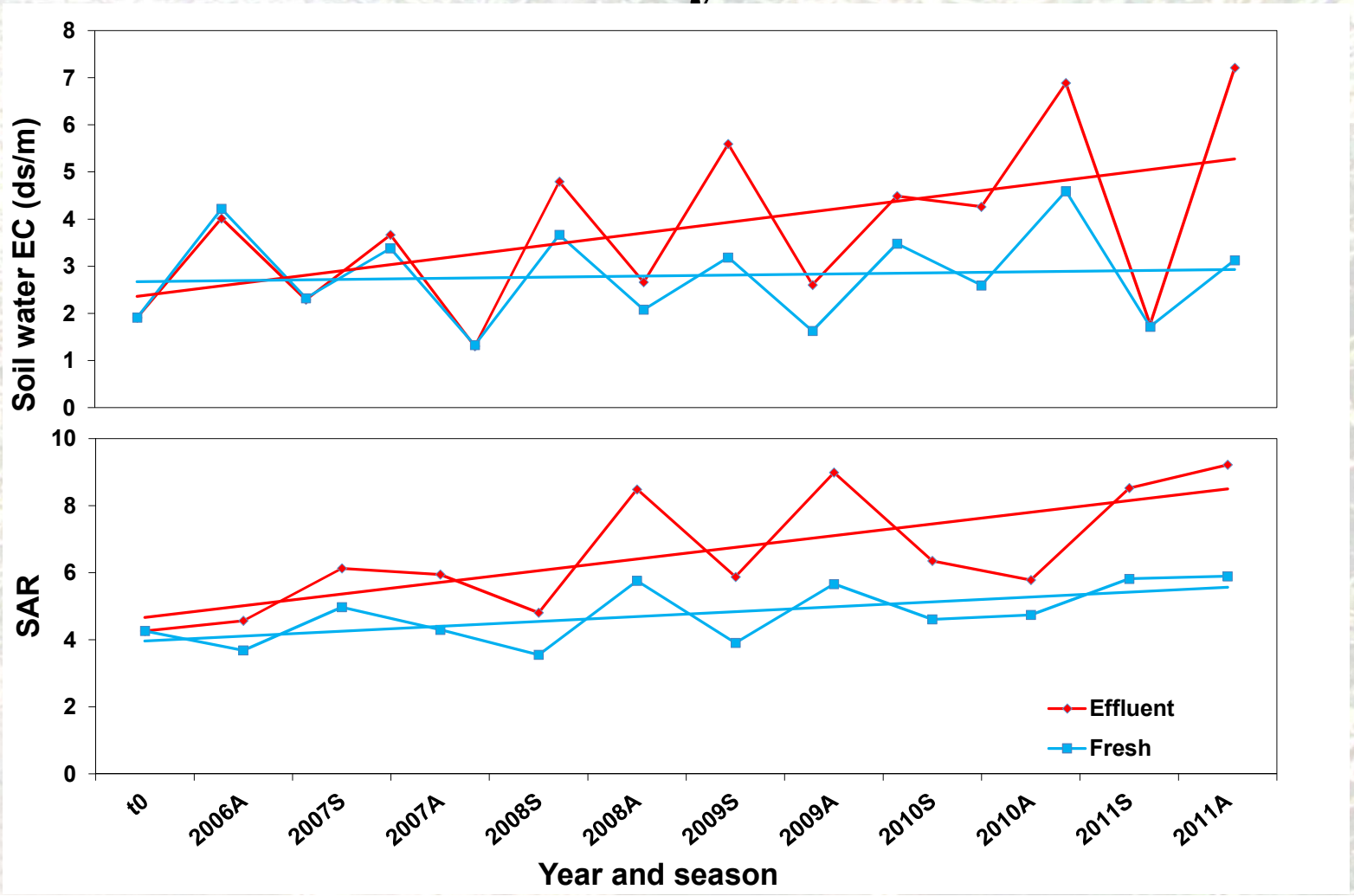
Nutrients and salts transport



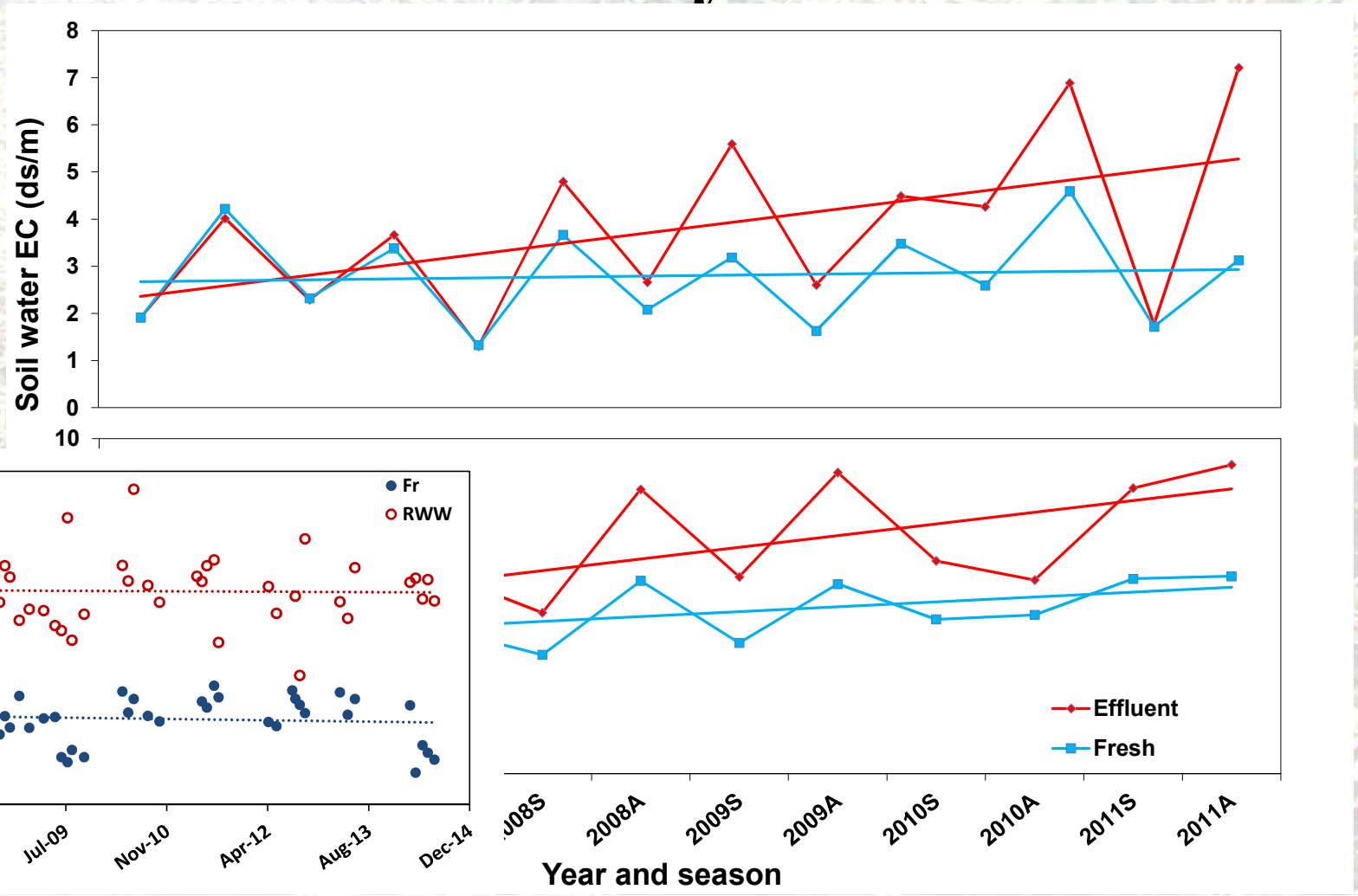


Segal et al. 2011. *Agric. Ecosyst. Environ*

Soil salinity and SAR

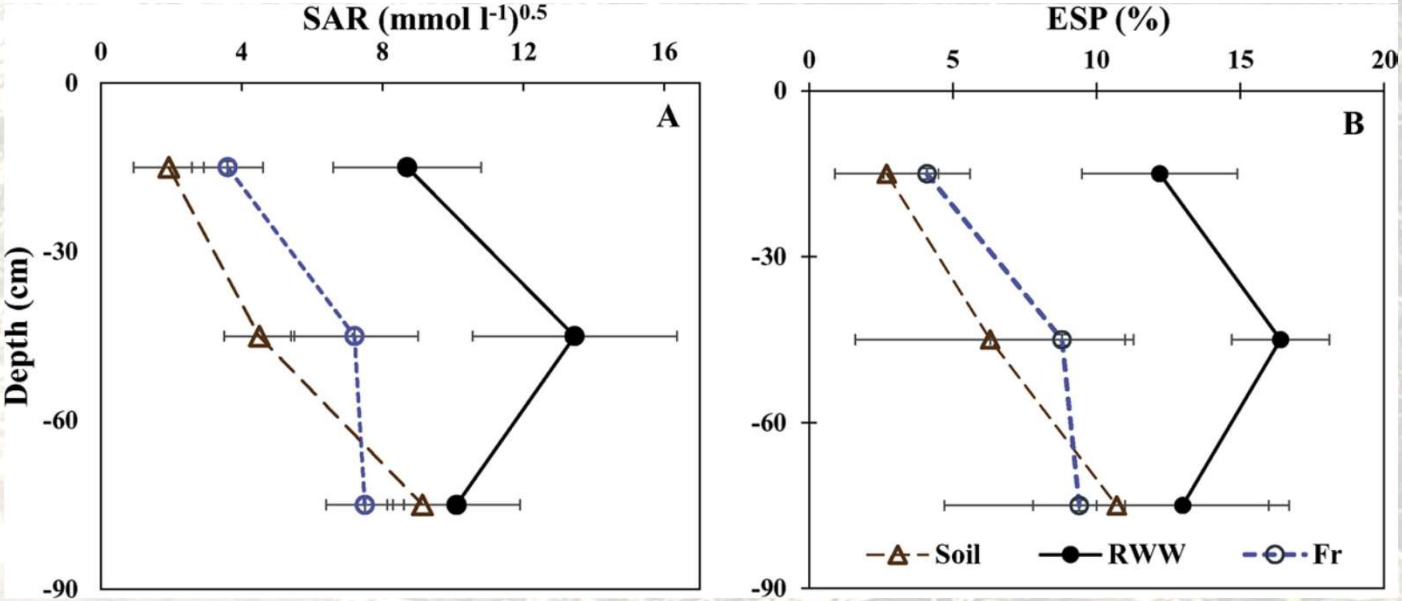


Soil salinity and SAR



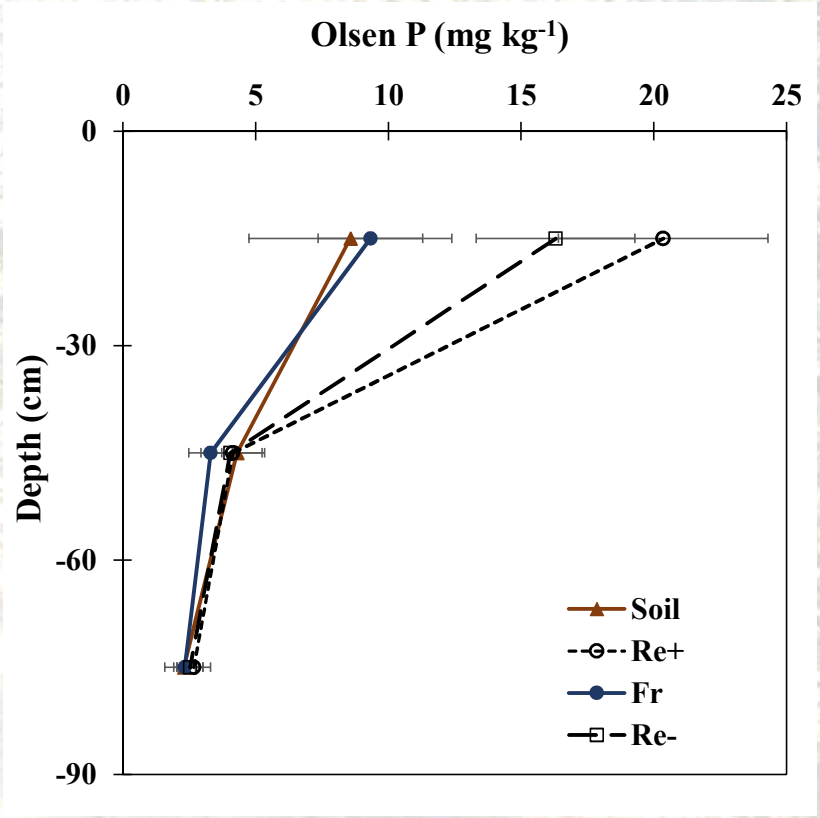
Soil salinity and SAR

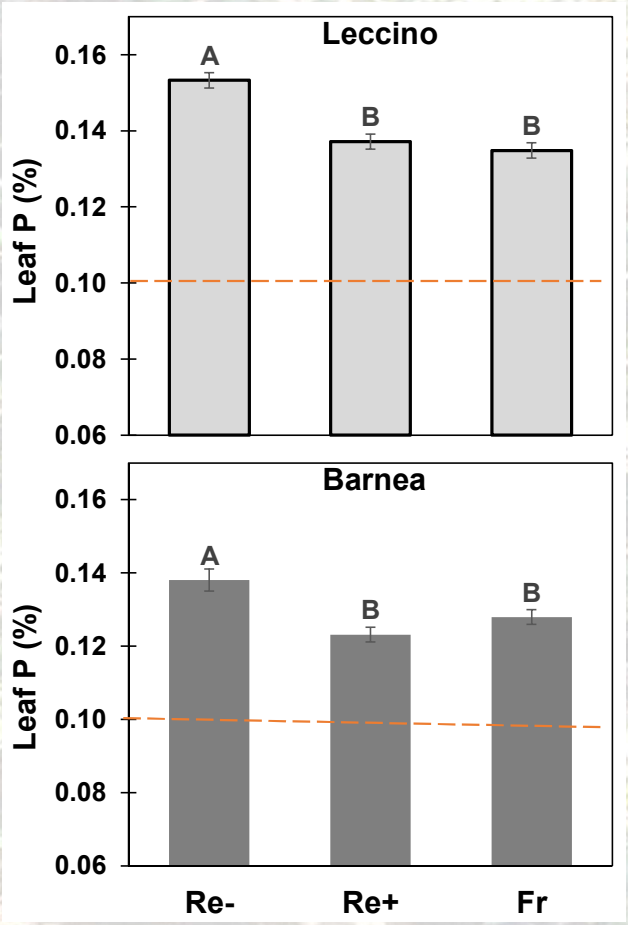
Soil SAR and exchangeable Na percentage after 8 years



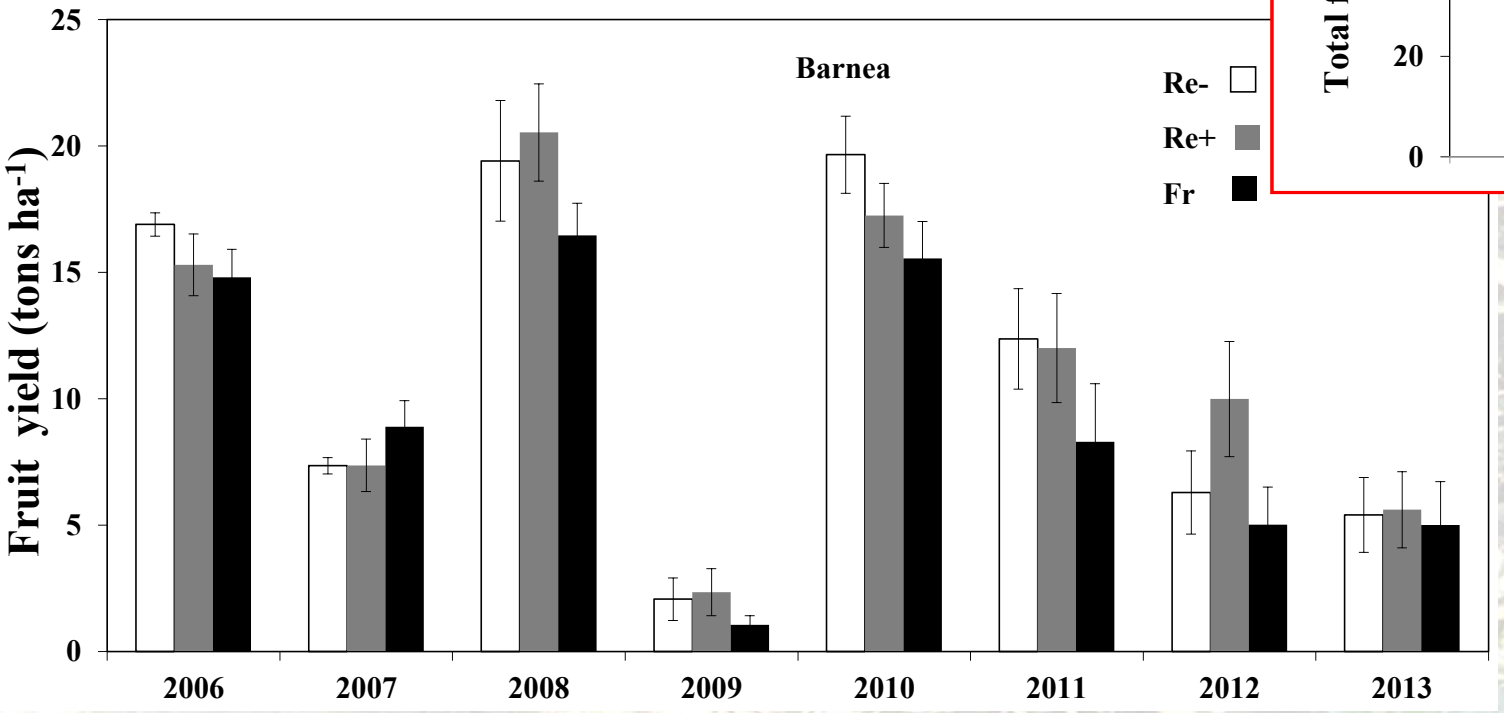
Erel et al. 2019. *Agric. Water. Manag.*

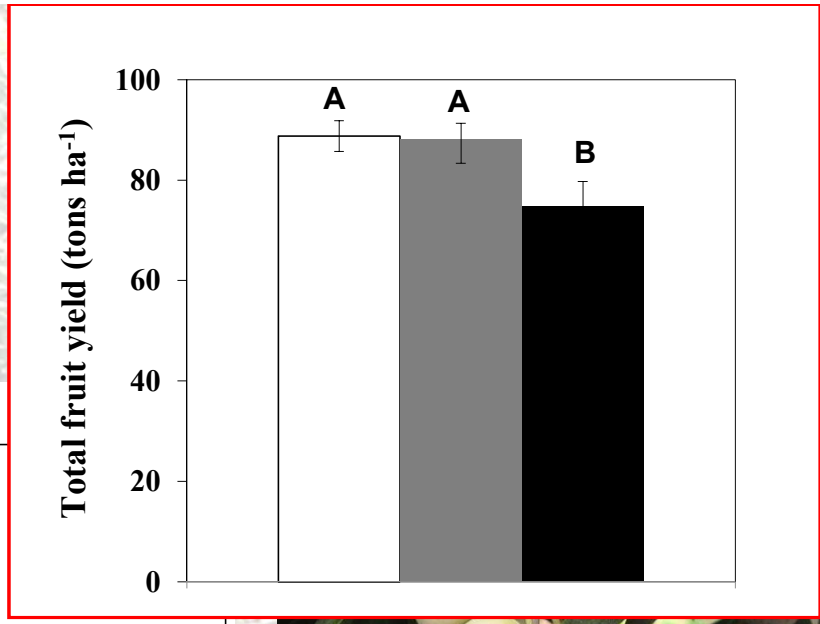
Phosphorus in soil and plant





Fruit yield


Barnea
Re-
Re+
Fr
Fruit yield (tons ha-1)
25
20
15
10
5
0
2006
2007
2008
2009
2010
2011
2012
2013

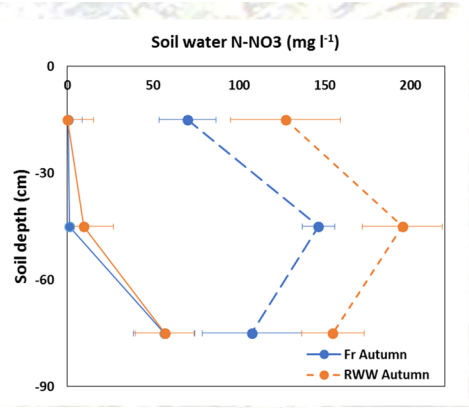

Total fruit yield (tons ha-1)
100
80
60
40
20
0
A
A
B

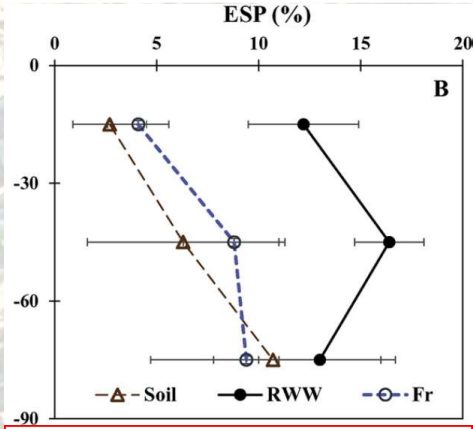
Conclusions

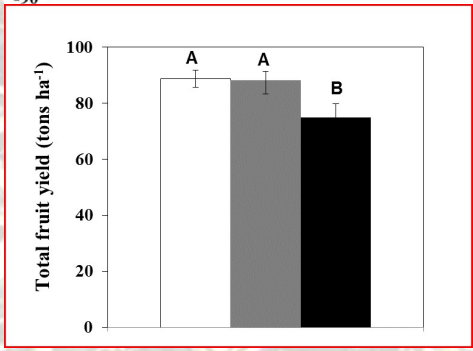
RWW in highly heterogeneous

Under our environmental conditions:

1. **Nutrients** in the RWW support high yield (and save costs)
2. RWW and over-fertilization have **environmental impact**
3. Hazard of **long-term soil degradation** following RWW utilization
4. **Phosphorus** nutrition is probably underestimated







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