



# Lettuce irrigation with wastewater from pistachios processing Effect on soil properties

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# Dehulling pistachio waste

So far little is known regarding the fate of pistachio's waste in Greece and in other Mediterranean countries.

It is known, however, that, on average, **2m<sup>3</sup>/h of water are required for dehulling 1tn fresh nuts**, while the processing of **1tn of pistachios produces almost 2.5tn of sludge, which consists of hulls, nuts and water.**

## Management practices:

- Disposal in evaporation ponds
- Disposal on soils and on water recipients



# Wastewater from pistachios dehulling

Parameters	Value
Electrical Conductivity (mS/cm)	<b>6,4 (6,08)</b>
pH	<b>5,22</b>
Polyphenols, g L <sup>-1</sup>	<b>5,5</b>
COD g L <sup>-1</sup>	12
NH <sub>4</sub> <sup>+</sup> mg L <sup>-1</sup>	9,0
NO <sub>3</sub> <sup>-</sup> mg L <sup>-1</sup>	102
Potassium g L <sup>-1</sup>	<b>1,0</b>
Calcium (%) (w/v)	0,03
Magnesium (%) (w/v)	0,01
Sodium mg L <sup>-1</sup>	180
PO <sub>4</sub> <sup>3-</sup> mg L <sup>-1</sup>	91
Iron mg L <sup>-1</sup>	0,51
Copper mg L <sup>-1</sup>	0,13
Zinc, mg L <sup>-1</sup>	1,39
Mangannese, mg L <sup>-1</sup>	0,68
Boron, mg L <sup>-1</sup>	5,5
Chloride, mg L <sup>-1</sup>	<b>1000 (2122)</b>



# Soil used for the experiment

Parameters	Value	Normal values
Texture	Sandy Loam	Medium coarse
Electrical Conductivity ( $\mu\text{S}/\text{cm}$ )	1250	< 2000
pH	7,39	6,1-7,8
Organic Matter (%)	5,6	> 2,0
Total Nitrogen (mg/g)	3,4	> 1,5
CaCO <sub>3</sub> (%)	28	0,2-5,0
Exchangeable K (cmol <sup>+</sup> /kg)	0,80	0,3-1,2
Exchangeable Ca (cmol <sup>+</sup> /kg)	30	
Exchangeable Mg (cmol <sup>+</sup> /kg)	1,8	0,4-1,5
Available P (mgP/kg)	33	5-20
Available Fe (mg/kg)	8,9	12-50
Available Cu (mg/kg)	1,3	0,9-3,0
Available Zn (mg/kg)	18	3,0-8,0
Available Mn (mg/kg)	4,4	15-50



# The 10 weeks greenhouse experiment

Lettuce seedlings were irrigated with 5 wastewater/water ratios treatments

**1:10, 1:6, 1:2, No dilution and fresh water**

Each treatment 5 replicates  
in a Latin square  
experimental design

Plants were irrigated twice a week  
by adding 100ml of liquid while  
leachates were collected at a  
weekly basis.

The experiment lasted 10  
weeks. During the 5<sup>th</sup> week  
the plants were fertilized  
with KNO<sub>3</sub> (13-0-46) by  
adding 6,2 g per pot

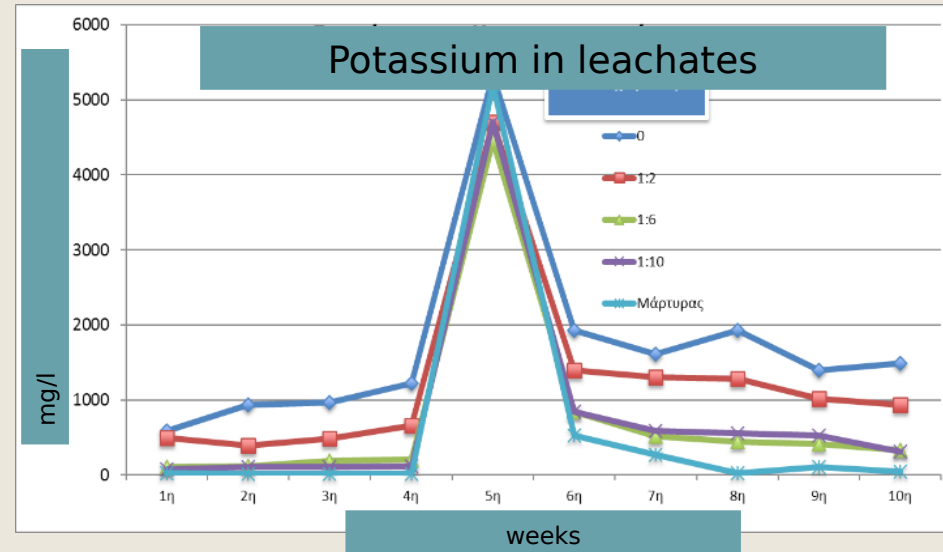
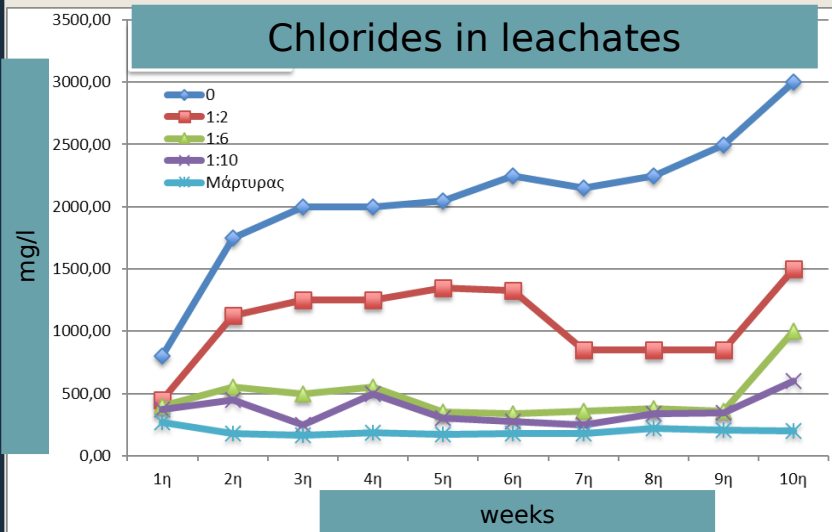
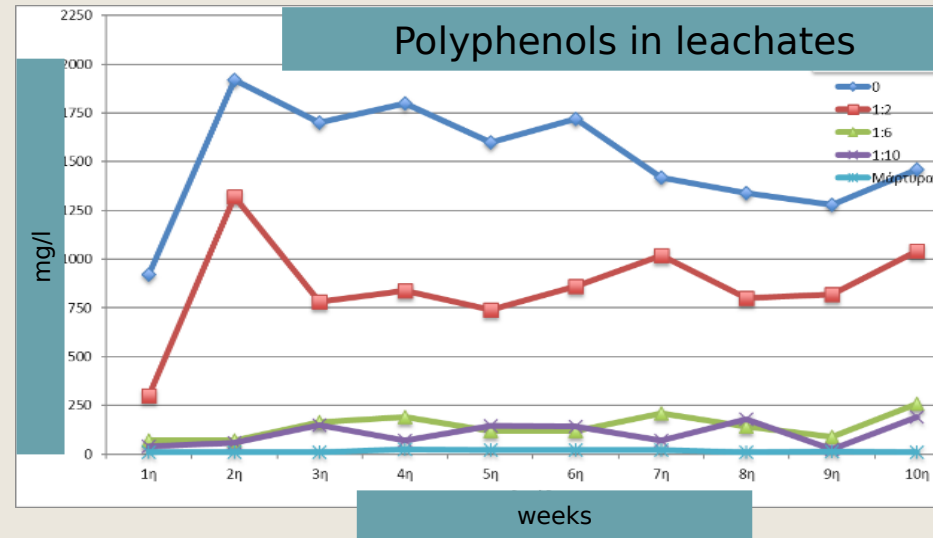


Leachates were further analyzed for electrical conductivity, pH, NO<sub>3</sub><sup>-</sup>, Cl<sup>-</sup>, Na, K, polyphenols, Cu, Zn, Mn, and Fe. After experiment completion, the substrates were collected and analyzed for pH, EC, OM, polyphenols, total N, available P, exchangeable cations (K, Na, Ca, Mg), B, and available metals in order to assess potential impacts on soil properties after

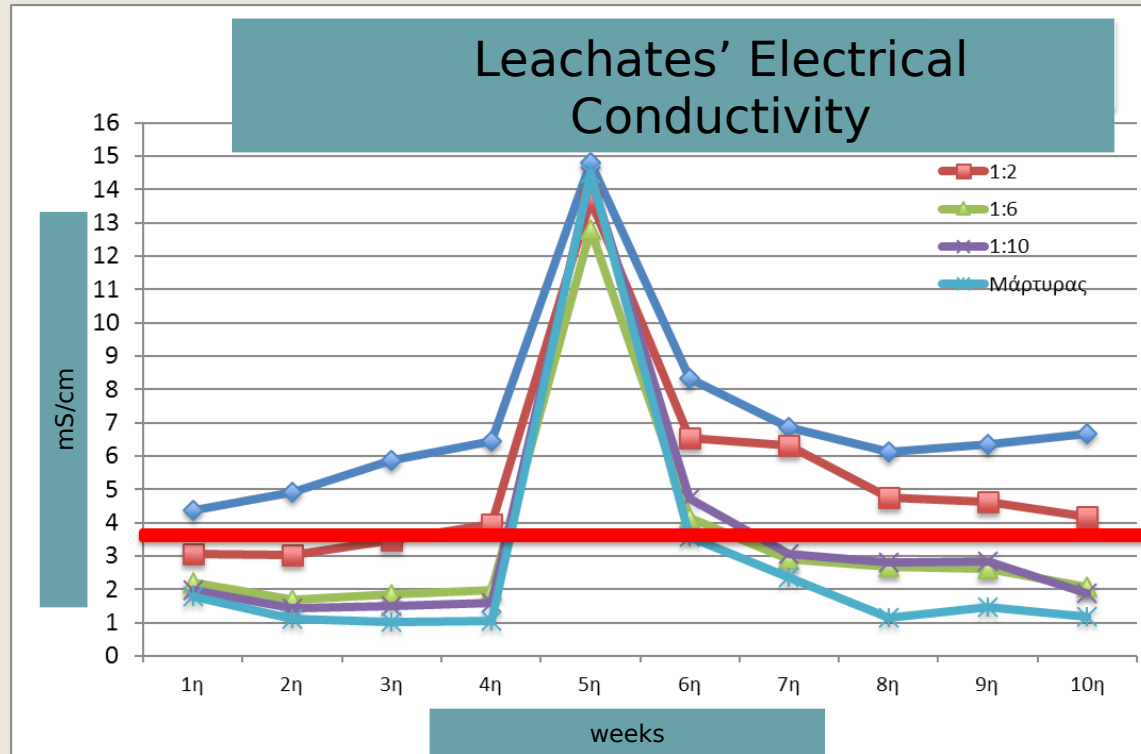
# Some important findings



The effect of dilution was recorded in yield parameters.

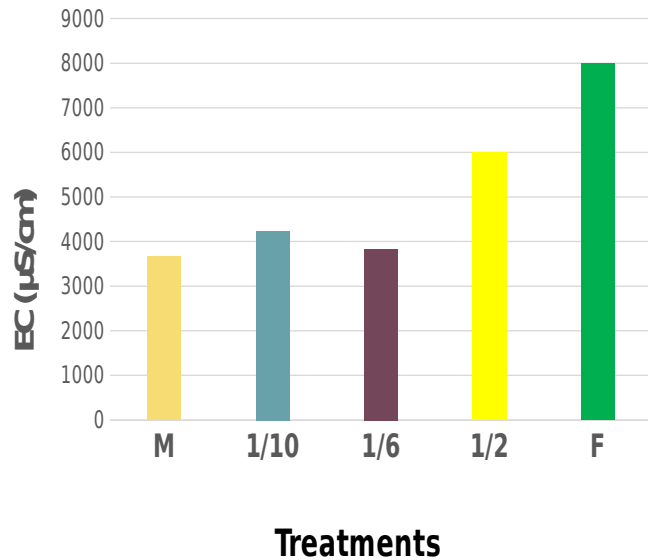


And more....

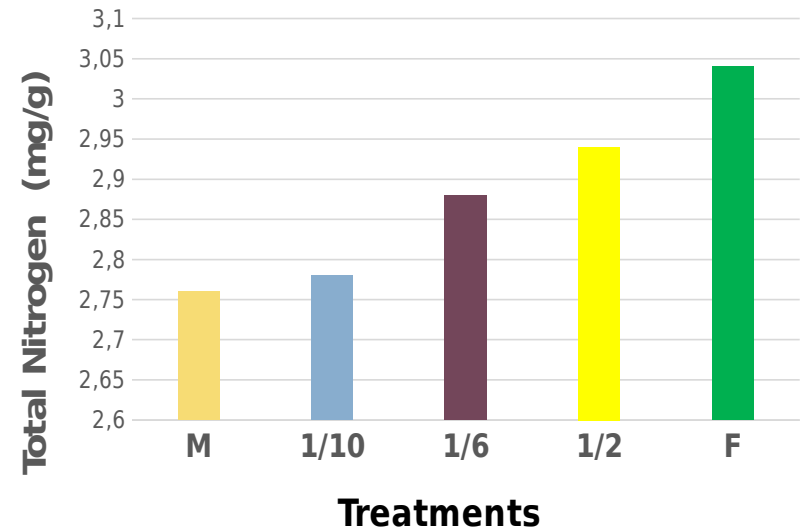




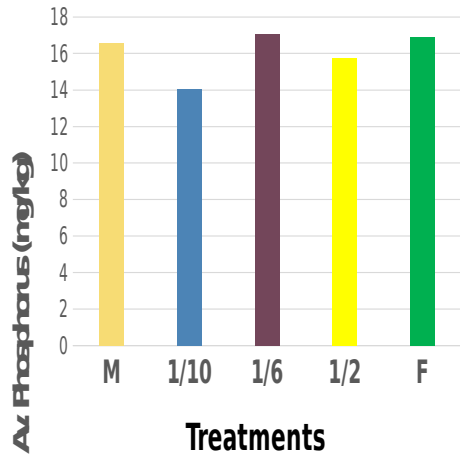
### Soils Electrical Conductivity after the end of the experiment



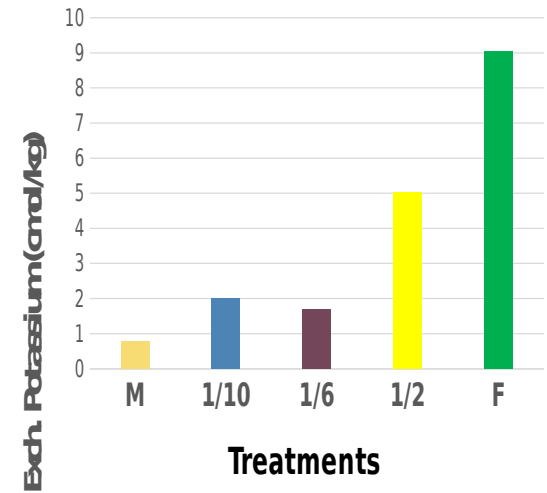
### Total Nitrogen in soils after the end of the experiment



Available Phosphorus in soils after the end of the experiment

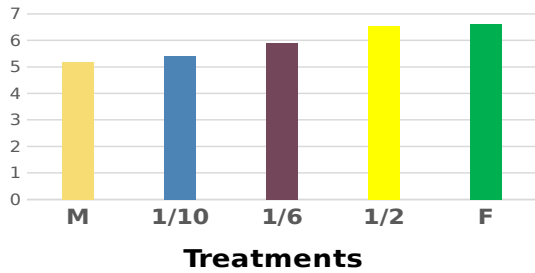


Exchangeable Potassium in soils after the end of the experiment

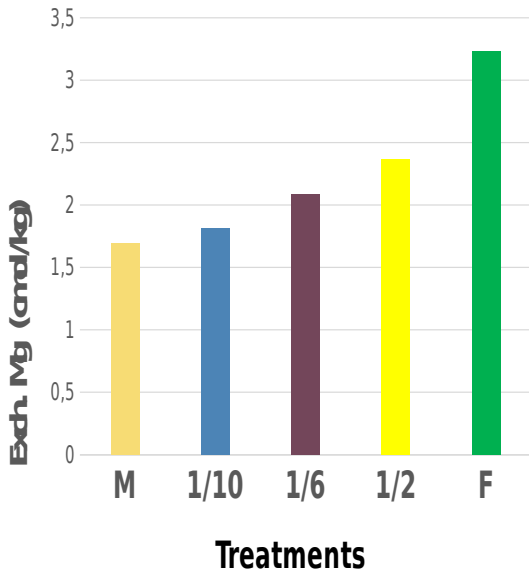


Soil Organic Matter after the end of the experiment

Soil Organic Matter after the end of the experiment

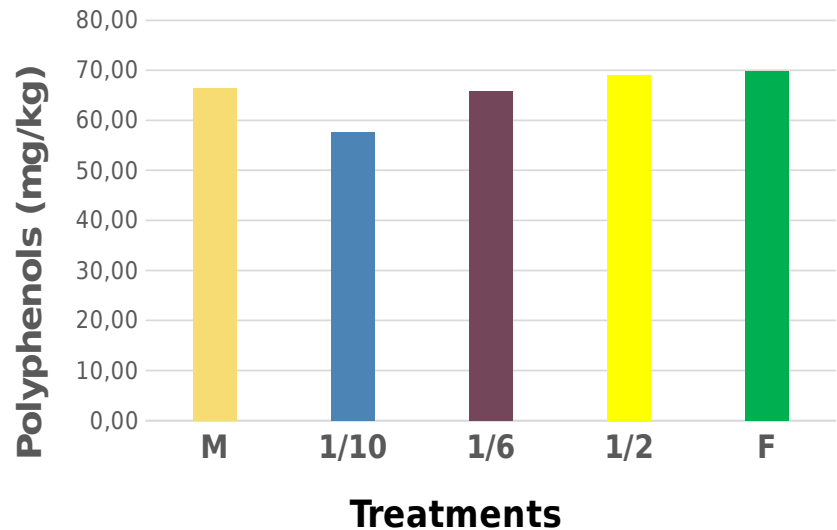


## Exchangeable Magnesium in soils after the end of the experiment



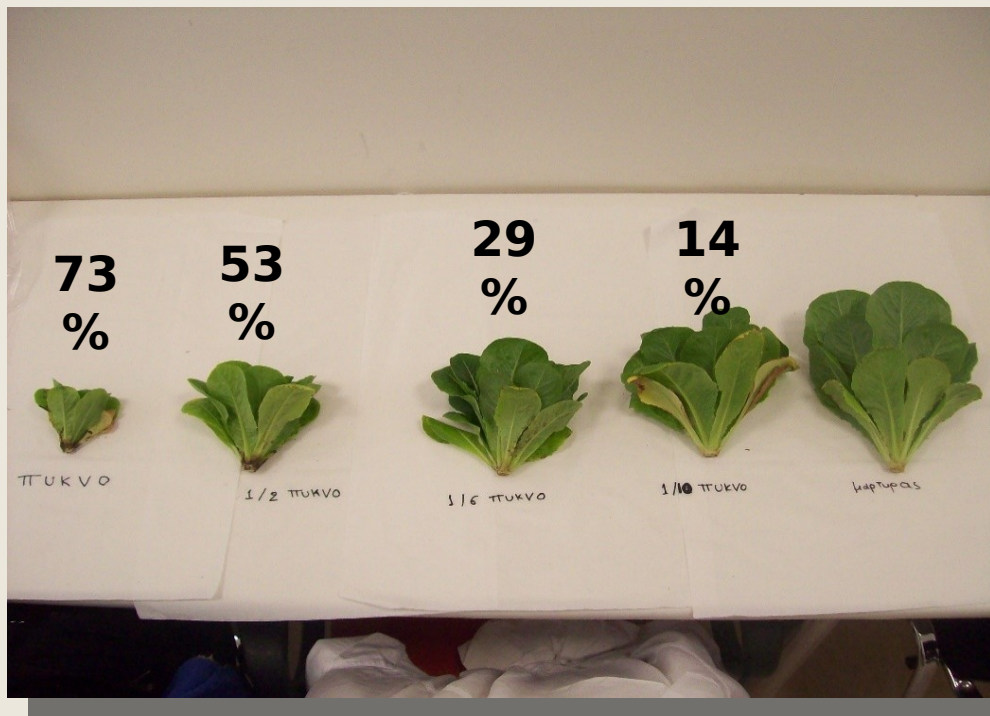
Considering soil parameters after experimentation and also soil quality thresholds (Doula et al., 2013), it can be proposed that the use of pistachio wastewater for irrigation after 1:10 (and also 1:6 after specific preconditions) could provide the anticipated and well known advantages of wastewater reusing on soils, while at the same time protects soils from overloading with salts and nutrients.

## Polyphenols in soils after the end of the experiment



**BUT...**





...the obtained yield suggests 1:10 dilution as the optimum one...

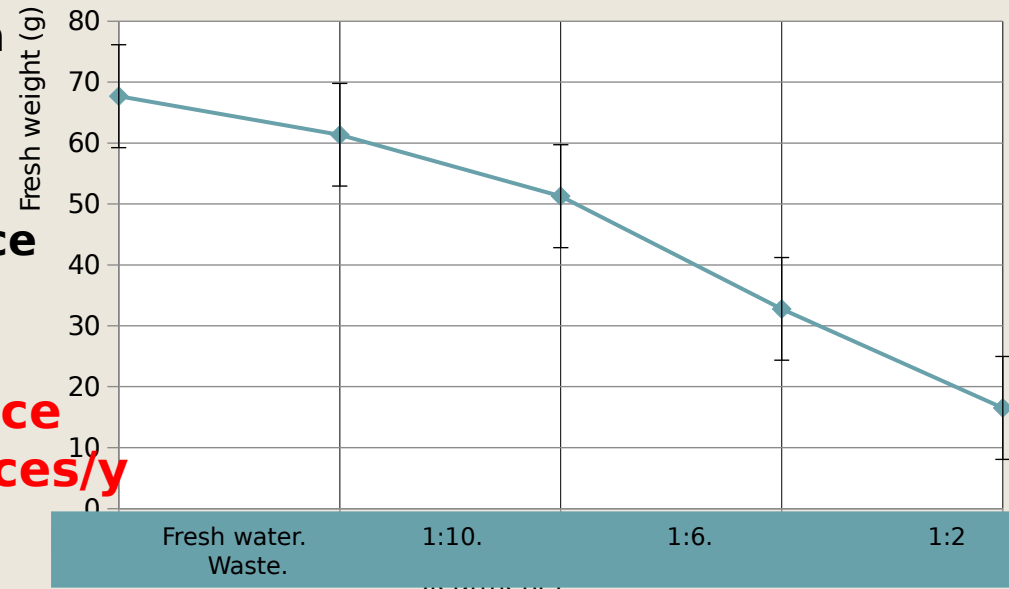
...still we are happy...

...for 10 weeks ...

- We irrigated 20 times each lettuce
- 2lt waste/water added to each lettuce
- 200ml waste to each lettuce and 10 lt waste for 50 lettuces

...and in Greece we produce almost 125.000.000 lettuces/y

Change in fresh weight of lettuce





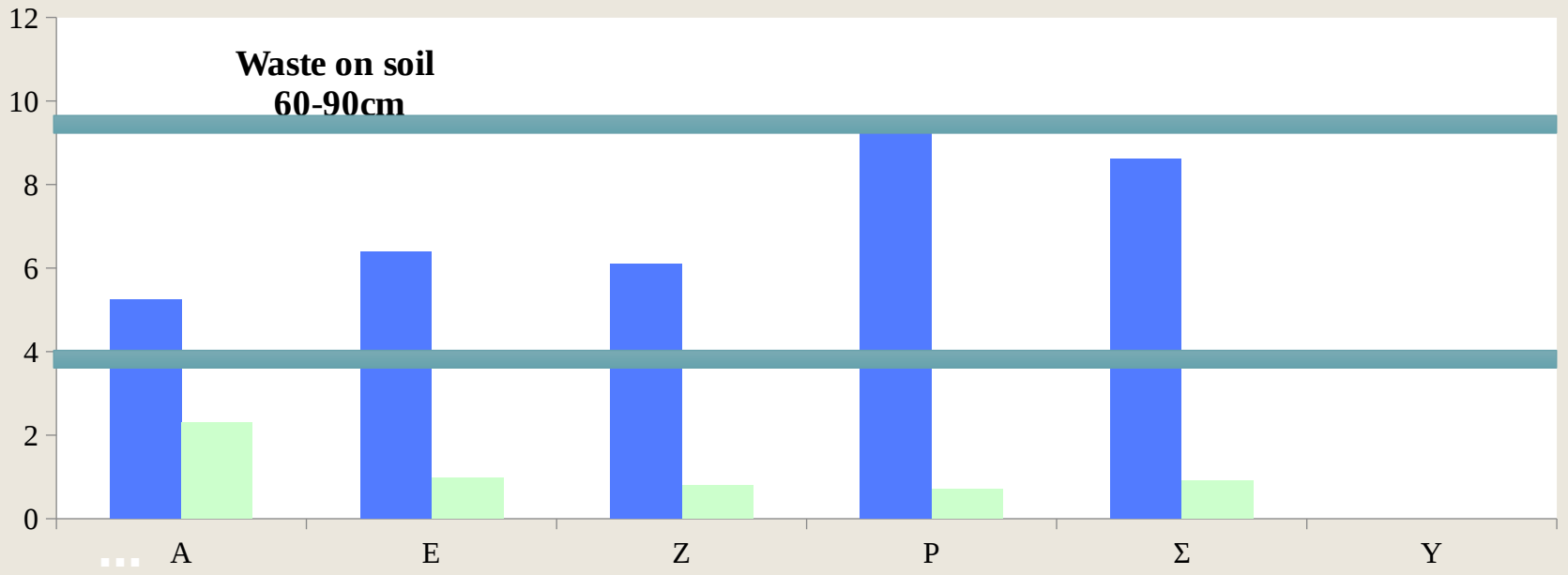
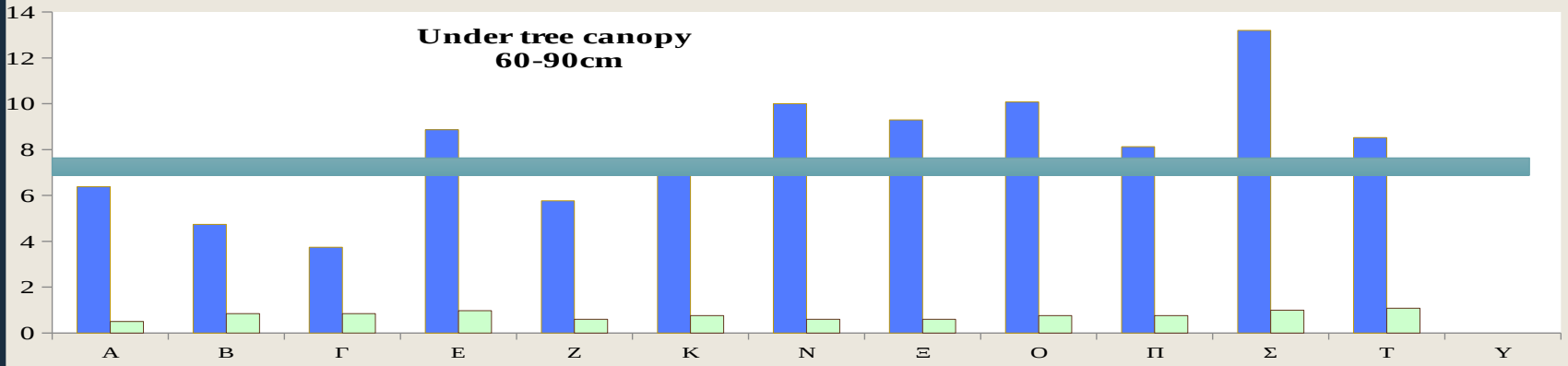
Thank you  
for your attention

Dr. Maria K. Doula

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Greece

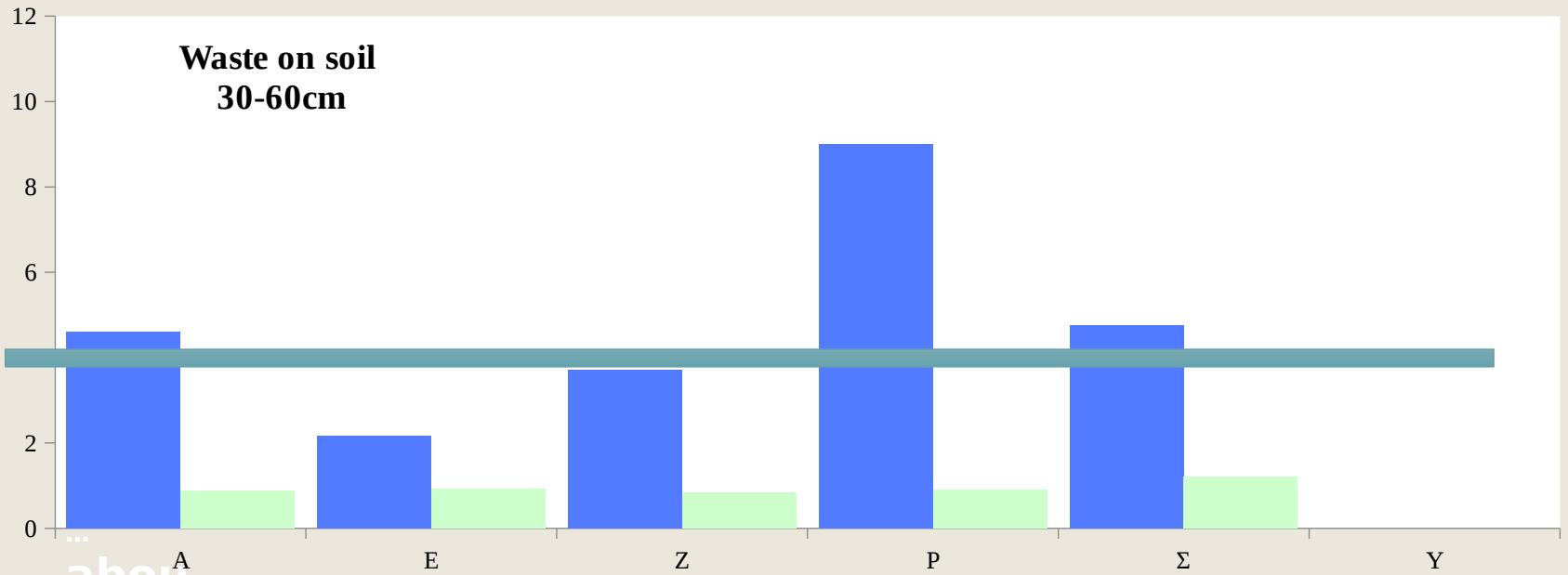
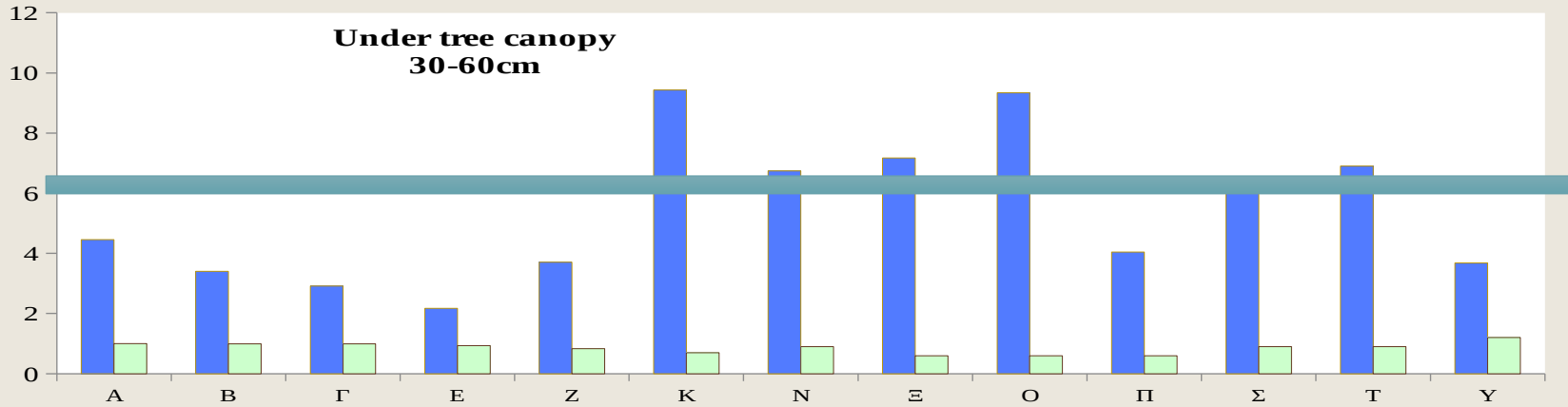


Electrical Conductivity,



about

Electrical Conductivity, m



about  
soil