ENPI CBCMED
CROSS-BORDER COOPERATION IN THE MEDITERRANEAN

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MEDOLICO
MEDITERRANEAN COOPERATION IN THE TREATMENT AND VALORISATION OF OLIVE MILL WASTEWATER

Application of diluted olive mill wastewater enhances plant growth & changes soil fertility parameters

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This study is part of the activities of the EU funded project “MEDOLICO”
MEDOLICO = Mediterranean Cooperation in the Treatment and Valorization of Olive Mill Wastewater **(OMW)**

Goal & Objectives of MEDOLICO

- The goal of MEDOLICO is to Prevent/reduce the environmental risk presented by OMW on the Mediterranean Sea Basin

- The specific objectives of MEDOLICO are to:

1. Evaluate advanced techniques of OMW treatment

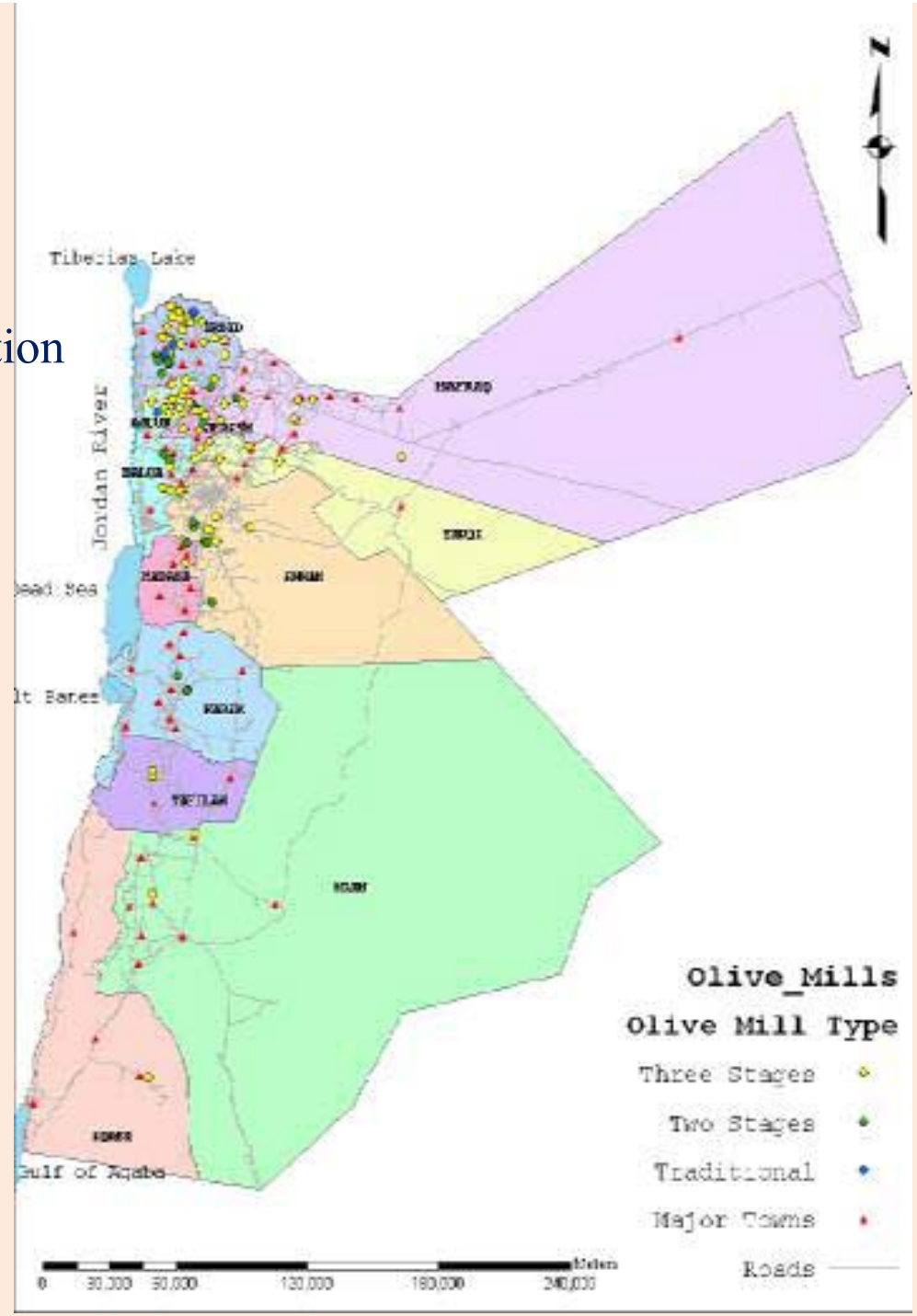
2. Valorize the by-products recovered from the OMW

OMW in the Mediterranean Sea Basin:

- 30 MCM of OMW generated annually in the Mediterranean region.
- It is either evaporated or disposed in the areas surrounding olive Mills
- These methods of disposal are not appropriate and therefore,
  - → There is real potential for contamination
  - → Proper OMW management is crucial for sustainability of MED environment

OMW in Jordan

- There are 130 olive mills under operation
- They generate 200,000 m^3OMW/year
- It is prohibited to discharge OMW to sewage system due to its nature
- Disposed to dumping sites or to the surrounding areas without



Pollution power of OMW:

- OMW is a liquid industrial ww from olive oil extraction process
- Composed of large amounts of organic load that is mainly non-biodegradable & phytotoxic due to phenolic compounds
- imposes a great deal of impact on environment & public health
- Pollution power of OMW is > 200 times that of MWW

- **What are the Challenges of OMW treatment**
  - Complexity & costs of treatment options at commercial level
  - Can not be treated in municipal ww treatment plants
  - Most common and cheapest treatment option is lagooning (natural evaporation), widely used in most Mediterranean countries

- **Objective:**
  - The Objective of this study was to determine whether the dilution of OMW, as non-expensive technique, will eliminate its phytotoxicity and be used as an Irrigation water and enhances soil fertility

Materials & Methods

Treatments	Code
Tap water → 0% OMW	0% OMW
Diluted OMW → 25% OMW & 75% tap water	25% OMW
Diluted OMW → 50% OMW & 50% tap water	50% OMW
Diluted OMW → 75% OMW & 25% tap water	75% OMW
Undiluted OMW → 100% OMW	100% OMW

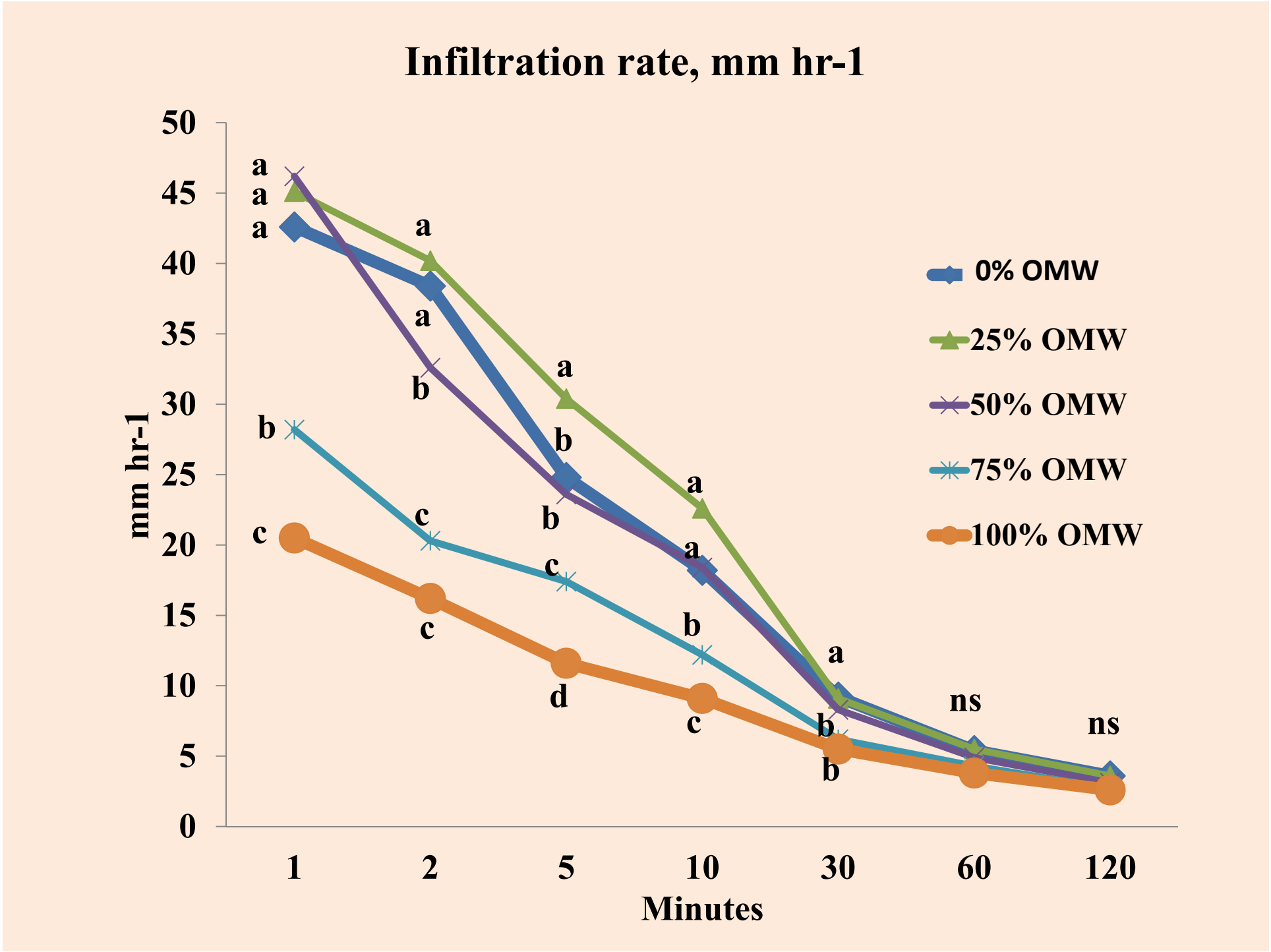
Characteristics of water & OMW	W	OMW*
pH initial	7.8	4.7
EC, dS m^{-1}	0.56	7.6
TSS, mg 1^{-1}	10	1236
TP, mg l^{-1}	0.98	1666
COD, g l^{-1}	ND	118
N, mg l^{-1}	11.7	96
P_2O_5, mg l^{-1}	34.3	369
K_2O, mg l^{-1}	10.9	2441
Total bacterial count, CFU ml^{-1}	-	2.13 X 10^{-6}

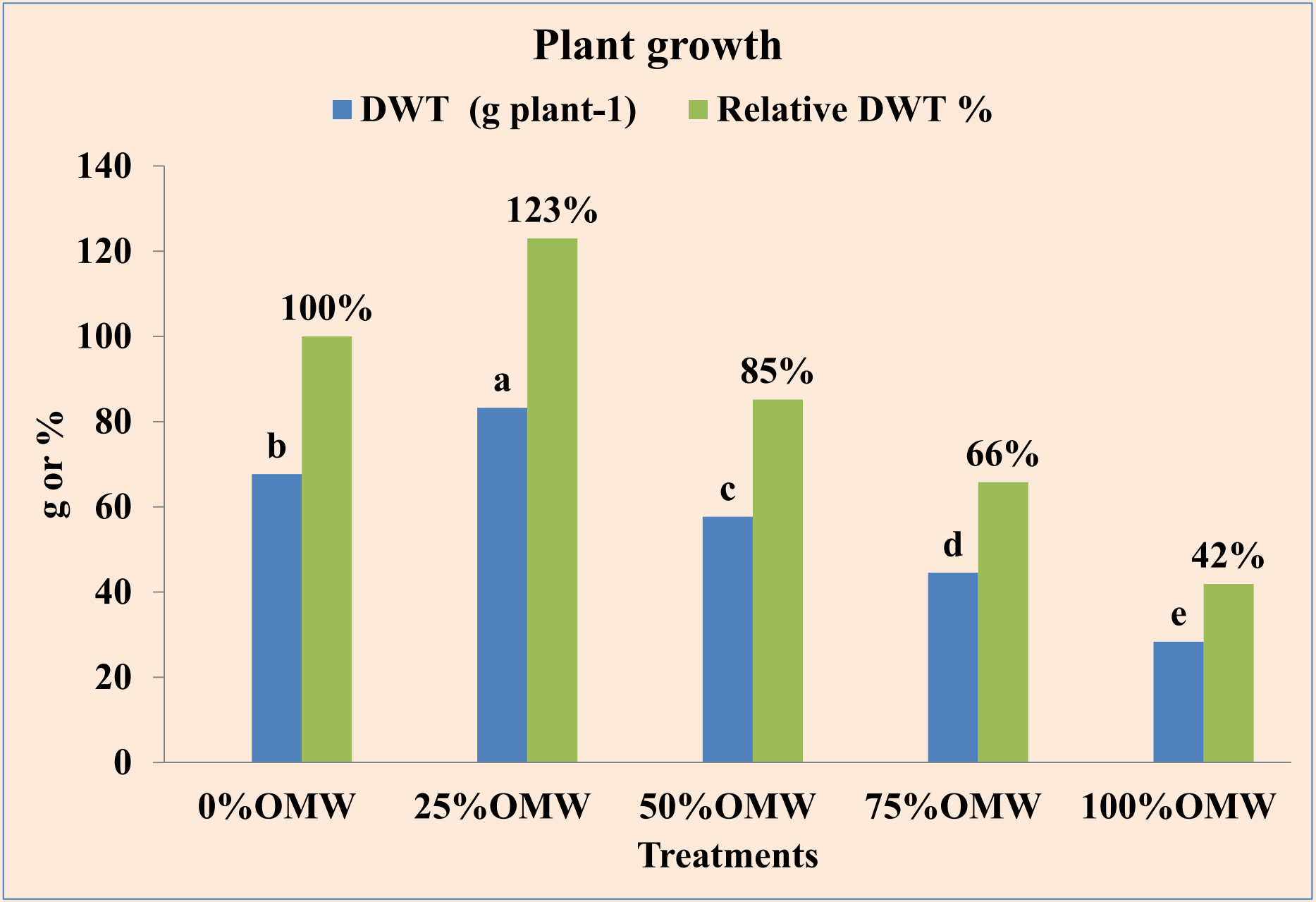
EC= Electrical conductivity; TP= Total polyphenols; COD = Chemical oxygen demand; TSS = Total suspended solids.

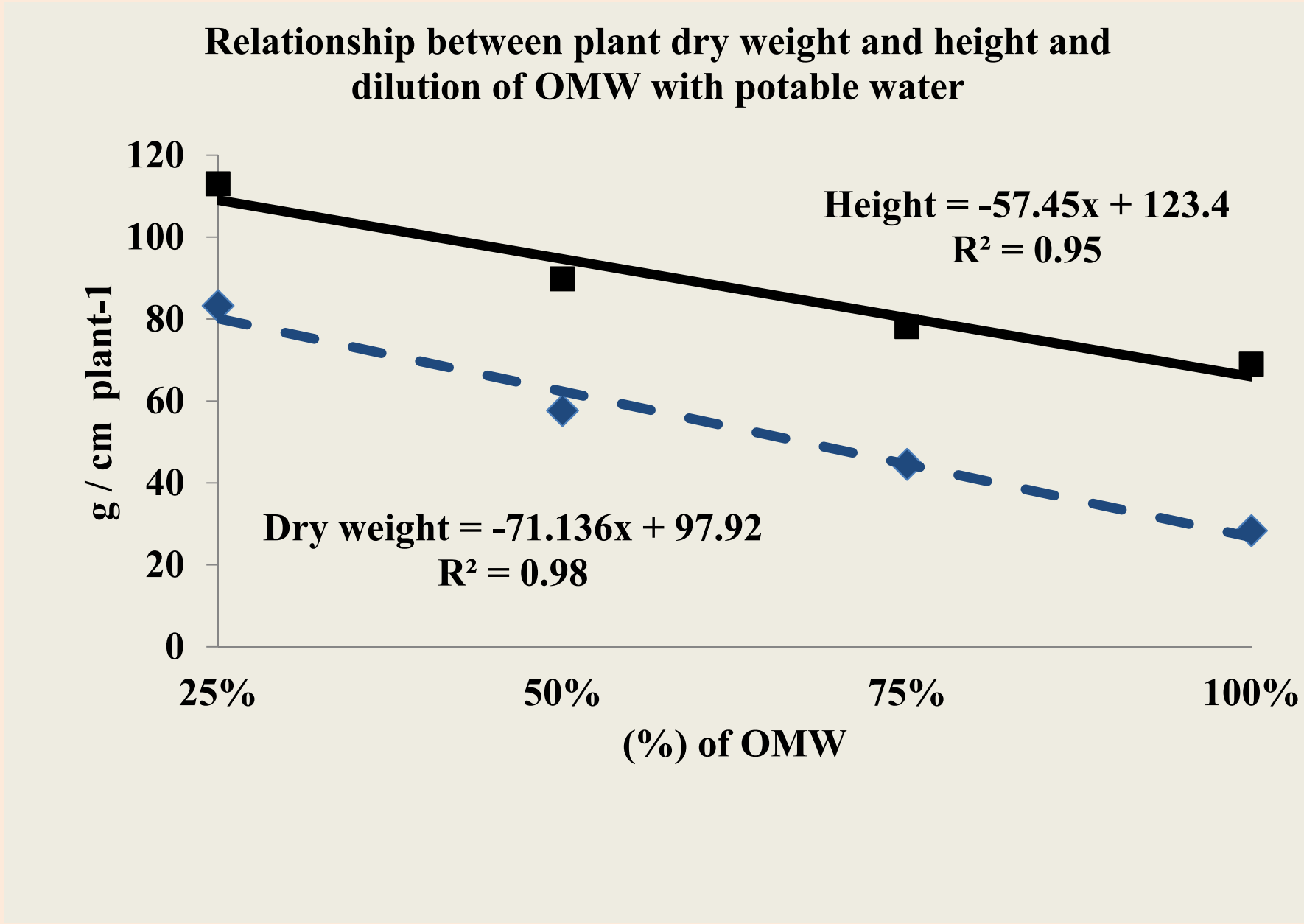
Greenhouse pot exp. = Five Kgs soil / pot
Soil characteristics = Basic, alkaline low in OM, N, P and micronutrients
Crop = Hybrid maize (*Zea mays*)
Irrigation = Periodic irrigation to maintain field capacity soil moisture
After harvest, plant & soil samples were analyzed for physical and chemical properties

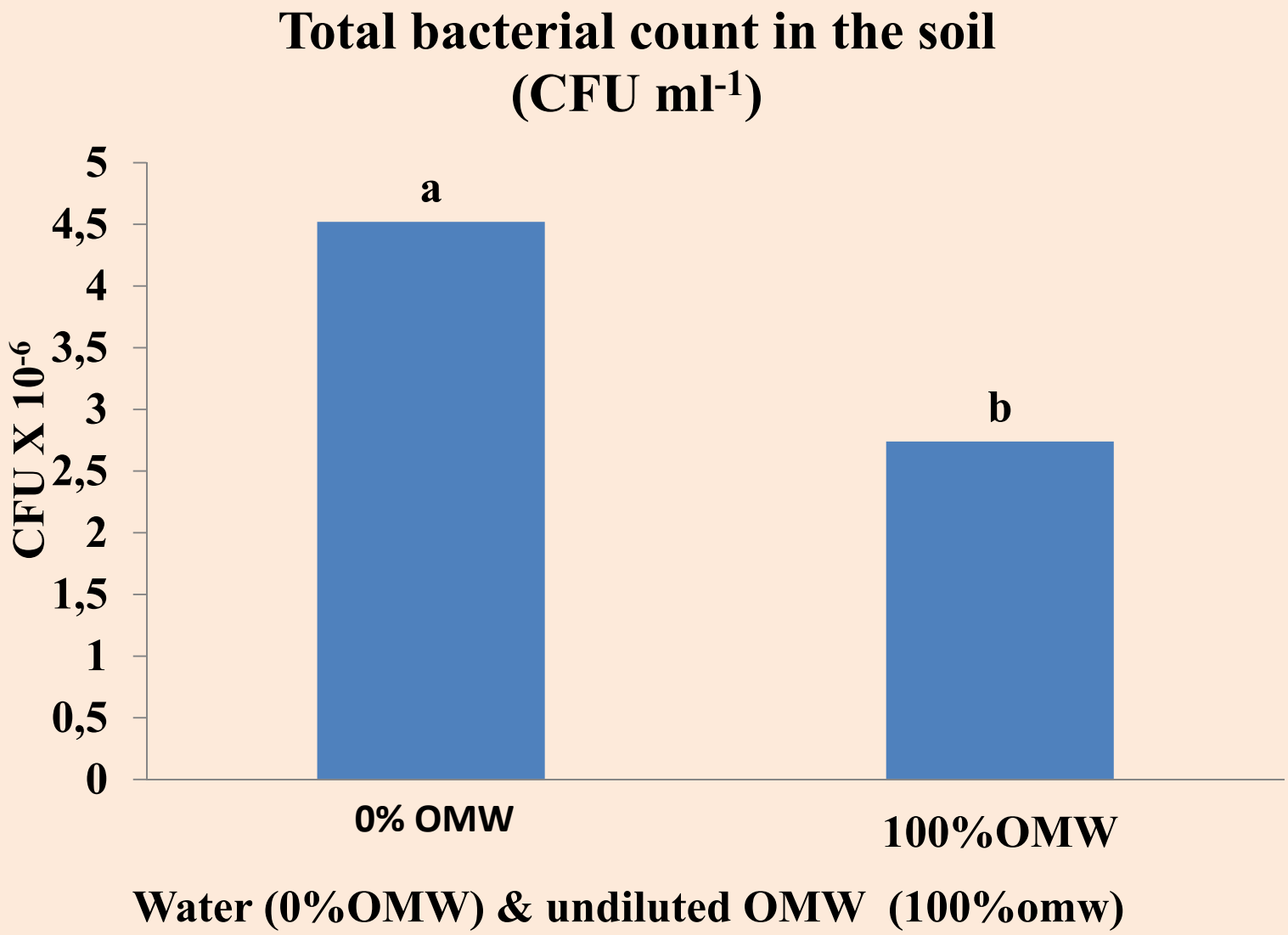
Soil pH (1:1 soil:water suspension)	8.18
EC (1:1 soil:water extract (dS m^{-1})	0.61
CEC (cmol kg^{-1})	34.32
O.M (%)	0.72
N (%)	0.01
P (mg kg^{-1})	7.11
K (mg kg^{-1})	452
$CaCO_3$ (%)	13.3
Fe (mg kg^{-1})	3.56
Mn (mg kg^{-1})	5.58
Zn (mg kg^{-1})	1.88
Cu (mg kg^{-1})	1.22
Pb (mg kg^{-1})	0.68
Cd (mg kg-1)	0.06
Bulk density (g cm^3)	1.38
Texture Class	Silty clay loam

results


Infiltration rate, mm hr-1
mm hr-1
50
45
40
35
30
25
20
15
10
5
0
1
2
5
10
30
60
120
Minutes
0% OMW
25% OMW
50% OMW
75% OMW
100% OMW
a
a
a
a
b
b
a
b
b
c
c
c
a
a
b
b
a
ns
b
b
ns

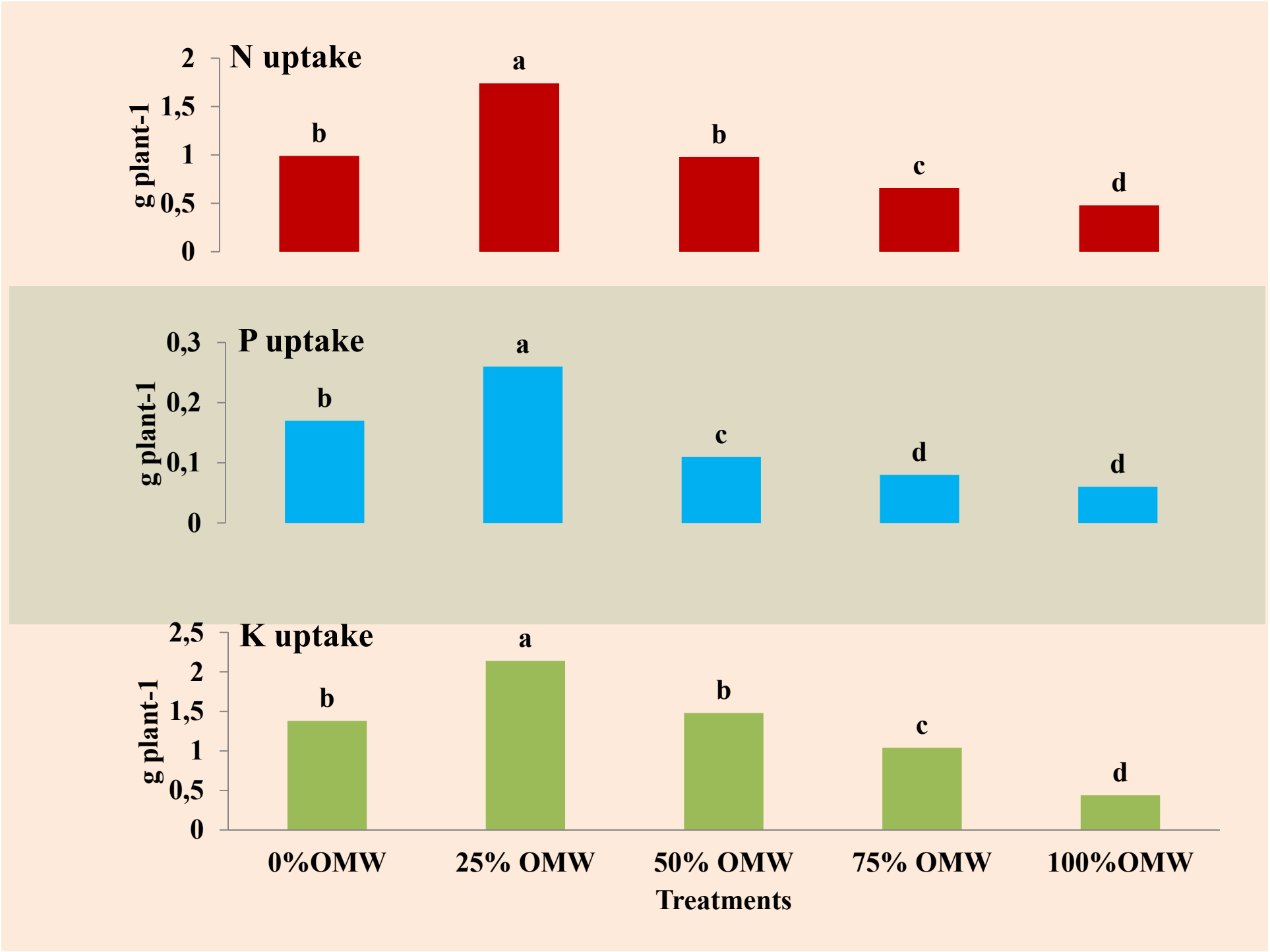

Plant growth
DWT (g plant-1)
Relative DWT %
g or %
140
120
100
80
60
40
20
0
100%
123%
85%
66%
42%
b
a
c
d
e
0%OMW
25%OMW
50%OMW
75%OMW
100%OMW
Treatments


Relationship between plant dry weight and height and dilution of OMW with potable water
120
100
80
60
40
20
0
g / cm plant-1
Height = -57.45x + 123.4
R² = 0.95
Dry weight = -71.136x + 97.92
R² = 0.98
25%
50%
75%
100%
(%) of OMW


Total bacterial count in the soil
(CFU ml-1)
CFU X 10-6
5
4,5
4
3,5
3
2,5
2
1,5
1
0,5
0
a
b
0% OMW
100%OMW
Water (0%OMW) & undiluted OMW (100%omw)

Plant uptake of macronutrients

	N	P	K
Trts	gm Plant^{-1}		
$0\%_{OMW}$ (water)	0.99 b	0.17 b	1.38 b
$100\%_{OMW}$	0.48 d	0.06 d	0.44 d
$75\%_{OMW}$	0.66 c	0.08 d	1.04 c
$50\%_{OMW}$	0.98 b	0.11 c	1.48 b
$25\%_{OMW}$	1.74 a	0.26 a	2.14 a


N uptake
g plant-1
2
1,5
1
0,5
0
b
a
b
c
d
P uptake
g plant-1
0,3
0,2
0,1
0
b
a
c
d
d
K uptake
g plant-1
2,5
2
1,5
1
0,5
0
b
a
b
c
d
0%OMW
25% OMW
50% OMW
75% OMW
100%OMW
Treatments

Plant uptake of micronutrients and heavy metals

Trts	Fe	Mn	Zn	Cu	Cd	Pb
	mg Plant^{-1}					
0%$_{OMW}$ (water)	3.68	1.86	0.39	0.02	0.05	0.17
100%$_{OMW}$	1.74	1.61	0.27	0.03	0.02	0.08
75% $_{OMW}$	1.72	1.64	0.21	0.03	0.07	0.08
50% $_{OMW}$	1.95	1.72	0.22	0.02	0.14	0.09
25% $_{OMW}$	1.81	1.92	0.25	0.02	0.16	0.11
$LSD_{.05}$	NS	NS	NS	NS	NS	NS

Soil characteristics after plants harvest

Treatments	PH	EC	OM	TP	BD
		dS/m	%	%	g/cm3
0%$_{OMW}$ (water)	7.87 a	0.98 d	1.21 d	0.11 e	1.22 a
100%$_{OMW}$	7.70 b	5.88 a	2.10 a	20.67 a	1.09 b
75% $_{OMW}$	7.87 a	4.88 b	1.96 a	15.95 b	1.09 b
50% $_{OMW}$	7.90 a	3.22 c	1.83 ab	10.31 c	1.2 a
25% $_{OMW}$	7.87 a	2.83 c	1.65 bc	5.09 d	1.2 a

Soil macronutrients and secondary nutrients after plants harvest

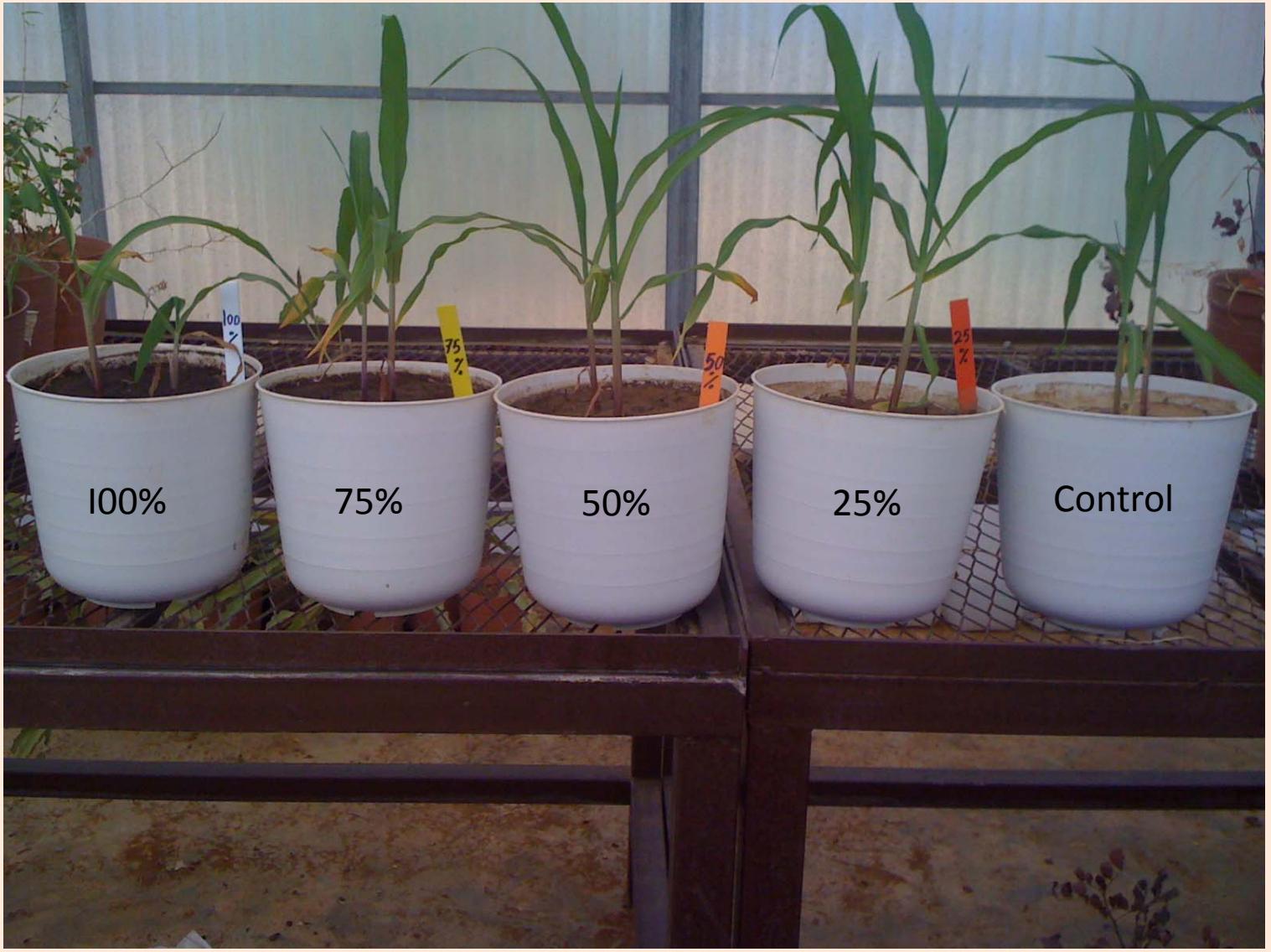
Treatments	N	Olsen-P	K	Ca	Mg	Na
	%	mg kg^{-1}	mg kg^{-1}	meq L^{-1}	meq L^{-1}	meq L^{-1}
$0\%_{OMW}$ (water)	0.09 b	8.83 d	631 d	3.47 e	3.13 e	2.96 d
$100\%_{OMW}$	0.12 a	82.50 a	2926 a	23.73 a	22.70 a	8.10 a
$75\%_{OMW}$	0.12 a	64.23 b	2558 b	17.70 b	16.73 b	7.59 a
$50\%_{OMW}$	0.11 a	54.53 bc	2290 b	11.23 d	13.10 c	6.31 b
$25\%_{OMW}$	0.12 a	28.23 c	1664 c	12.77 cd	8.27 d	5.03 c

Soil DTPA-extractable micronutrients after plants harvest

	DTPA Fe	DTPA Mn	DTPA Zn	DTPA Cu
Trts	mg kg^{-1}			
0%$_{OMW}$ (water)	**1.50 b**	**3.10 d**	**0.88 c**	1.49 a
100% $_{OMW}$	**3.12 a**	**83.40 a**	**2.45 a**	1.30 a
75% $_{OMW}$	**3.69 a**	**65.27 b**	**2.40 a**	2.10 a
50% $_{OMW}$	**4.34 a**	**27.70 c**	**2.50 a**	1.87 a
25% $_{OMW}$	**2.86 a**	**22.77 c**	**1.93 b**	1.56 a

Conclusions

- **Soil application of undiluted OMW had phytotoxic and prohibiting effect on plant growth and soil microorganisms**
- **On the other hand, soil application of OMW improved soil fertility thru increasing levels of OM & nutrients in the soil**
- **Dilution of OMW with potable water at water to OMW ratio of 3:1 (25%OMW) is recommended before soil application to eliminate its phytotoxicty and to enhance plant growth**
- **Such dilution can be adopted without any further treatment as an inexpensive technique before application**
- **Finally, the enhancement of soil OM, N, P and K and improving soil fertility is of particular importance for the poor soils of the arid and semi-arid region.**


I00%
75%
50%
25%
Control

Thank you