

Modulation of copper uptake and toxicity by salinity stress in *Mentha spicata* plants

Antonios Chrysargyris*, Eleftheria Papakuriakou, Panayiota Xylia, Nikos Tzortzakos

¹Department of Agricultural Sciences, Biotechnology and Food Science, Cyprus University of Technology, Limassol, 3603 Cyprus.

Abstract

Copper (Cu), although it is an essential element for plant growth, when found in excess, causes adverse effects on the growth and physiology of plants. Toxic effects are also caused by the continuous exposure of the plants to high concentrations of sodium chloride (NaCl) in the nutrient solution. The impact of salinity (Sal) on copper (Cu) uptake and changes to metabolism were studied in the combined treatments (control, Sal, Cu, Sal+Cu) in hydroponics. Spearmint (*Mentha spicata* L.) were grown for 30 days and then subjected for additional 10 days stress to 150 mM NaCl and/or 60 μ M Cu. Not only Sal and Cu, but also their combination suppressed plant growth in response to decreased plant biomass, root fresh weight and plant height. Leaf chlorophylls (Chl a, Chl b, total Chls) content decreased mainly through the combined treatment (Sal+Cu). Total soluble phenols and antioxidants (FRAP, DPPH, ABTS) were accumulated in both Sal and Cu, but decreased in the combination of Sal+Cu. It seems that moderate salinity stress along with Cu application changed the primary metabolites pathways in favor of major volatile oil components biosynthesis, with effects of essential oil yield and composition. Selected minerals in leaves and roots were reduced after stress treatment while the role of damage index and/or enzyme antioxidant activities are discussed too.

Keywords: NaCl, oxidative stress, heavy metals, essential oils, mineral uptake, spearmint

***Author of correspondence: Dr Antonios Chrysargyris**

Mailing address: Department of Agricultural Science, Biotechnology and Food Science, Faculty of Geotechnical Sciences and Environmental Management, Cyprus University of Technology, 3603, Limassol, Cyprus. E-mail: a.chrysargyris@cut.ac.cy

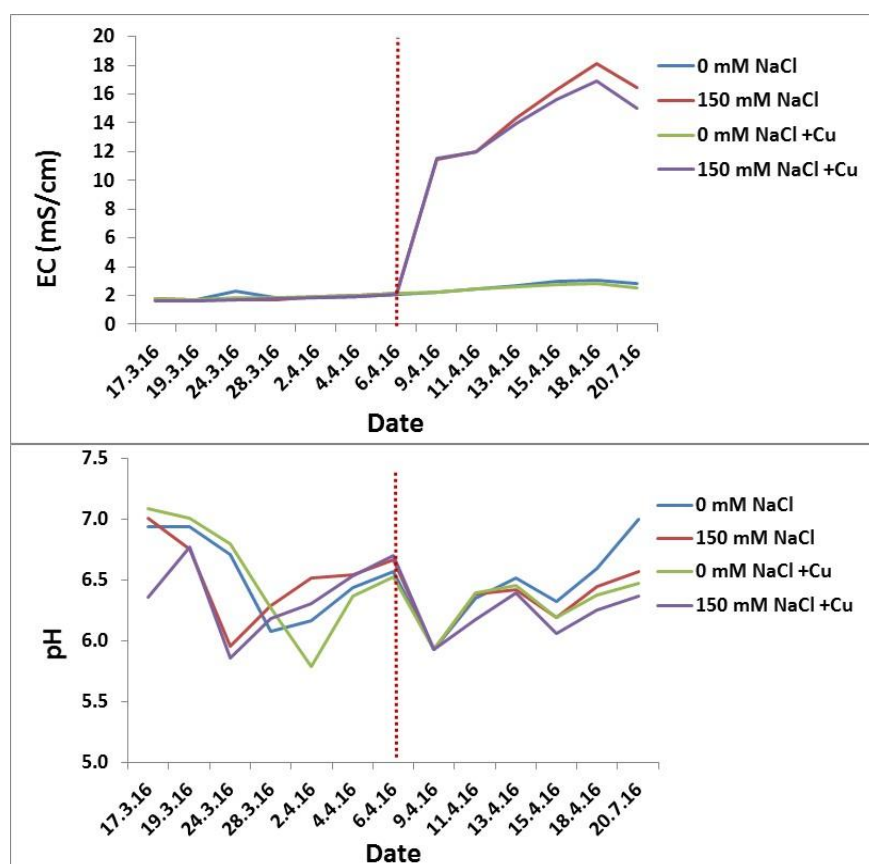


Figure 1. Distribution of pH and EC in the nutrient solution in spearmint plants exposed to different treatments of Copper (Cu) and salinity (NaCl), in hydroponics.

Table 1. Selected plant growth related parameters in spearmint plants exposed to different treatments over 10 days. Copper (Cu) was applied in 60 μ M and salinity (NaCl) in 150 mM concentrations. Data are means \pm SEs.

Parameters	Control	NaCl	Cu	NaCl + Cu
Plant height (cm)	(27.66 \pm 1.45) 52.83 \pm 1.53 ^{a,Y}	37.33 \pm 1.56 ^b	38.00 \pm 1.06 ^b	36.66 \pm 1.38 ^b
Biomass fresh weight (g)	(25.13 \pm 2.09) 62.74 \pm 4.02 ^a	40.16 \pm 3.30 ^b	38.86 \pm 3.58 ^b	39.40 \pm 3.76 ^b
Biomass dry matter (%)	(15.09 \pm 1.64) 17.48 \pm 0.31 ^c	20.63 \pm 0.19 ^{ab}	21.92 \pm 0.89 ^a	20.01 \pm 0.44 ^b
Root length	(45.33 \pm 0.66) 51.50 \pm 3.59 ^a	46.83 \pm 1.75 ^{ab}	41.33 \pm 3.54 ^b	44.16 \pm 2.44 ^{ab}
Root fresh weight (g)	(16.33 \pm 1.23) 26.79 \pm 1.51 ^a	19.66 \pm 1.36 ^b	17.60 \pm 1.78 ^b	18.44 \pm 1.80 ^b
Root dry matter (%)	(6.98 \pm 0.04) 7.99 \pm 0.20 ^b	8.89 \pm 0.18 ^a	9.55 \pm 0.29 ^a	9.15 \pm 0.17 ^a

^Y values (n=6) in rows followed by the same small letter are not significantly different, $P \leq 0.05$. Values in parenthesis are related to day 0 (before NaCl and/or Cu stress).