Екол. Заšт. Живот. Сред.	Том 7	Број 1-2	стр. 61-66	Скопје 2000/1
Ekol. Zašt. Život. Sred.	Vol.	No.	p-p	Skopje

оригинален научен труд

EFFECT OF VARIOUS ZINC CONCENTRATIONS ON SOME MORPHOLOGICAL PARAMETERS AT TOMATO (*Lycopersicon esculentum* Mill.)

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ABSTRACT

Cvetanovska, L., Spasenoski, M. (2000/1). Effect of various zinc concentrations on some morphological parameters at tomato (*Lycopersicon esculentum* Mill.). Ekol. Zašt. Život. Sred., Vol. 7, No.1-2, 61-66, Skopje.

The investigations have been carried out with tomato plants cv.Saint Pierre grown in hydroponics on modified Hogland's nutrient solution with different Zn concentrations. In the course of these investigations has been established that the optimal Zn concentrations of treatment which had a favorable effect on the biometric indices, on macro and microelement content, varied within a range od 0,67-3,34 mM. Concentrations of 13,40 as well as 1339,42 mM zinc were toxic and inchibited greatly growth, sugar and chloroplast pigments production in abovegrounds parts.

Key words: tomato, mineral solution, different zinc concentrations, chloroplast pigments, total and soluble sugars.

ИЗВОД

Цветановска, Л., Спасеноски, М. (2000/1). Ефектите од различните концентрации на цинк врз некои морфолошки параметри кај домат (*Lycopersicon esculentum* Mill.). Екол. Зашт. Живот. Сред. Том 7, Бр. 1/2, 61-66, Скопје.

Истражувањата беа извршени на водени култури кај домат, сорта Saint Pierre одгледувани на модифициран Hogland-ов раствор во присуство на различни концентрации на цинк. Притоа, беше утврдено дека оптималната концентрација на цинк која има стимулативно влијание на акумулацијата на биомасата, содржината на одредени макро и микроелементи варира во границите од 0,67-3,34 mM . Концентрациите на цинк од 13,40 mM како и 1339,42 mM се токсични и влијаат инхибиторно на растот, содржината на вкупни и растворливи јаглехидрати во надземните делови на растенијата како и на содржината на хлоропластните пигменти.

Клучни зборови: домат, минерален раствор, различни концентрации на цинк, хлоропластни пигменти, вкупни и растворливи шеќери.

INTRODUCTION

A highly intensive production of agriculture crops depends on a balanced nutrition whereas except macroelements an important role have microelements and their distribution within the plant. also. Excess of almost all heavy metals in a nutrient medium inchibits plant growth and causes leaf chlorosis. Well known is that one of important microelements in plant nutrition is a zinc, which as a

trace element is directly related with hormonal regulation as well as pigment synthesis. The problem of zinc uptaking by the plants has been studied by many authors (De Filippis et al. 1981a; Stojanova and Vasileva 1993). The aim of present study has been to explain the effect of various Zn concentrations on biomass accumulation, distribution of certain macro and microelement, chloroplast pigments as well as total and soluble sugar content in tomato plants.

MATERIAL AND METHODS

In this experiment 10 days old (I group) and 20 days old (II group) tomato plants, cv.Saint Pierre were used. Plants were grown in water culture on Hogland's nutrient solution. Fe was given as Fe-EDTA and per each five individulas have been taken for analysing. All variants have been grown on full strenght nutrient solution and Zn concentrations were changed only: control; 0,67; 1,67; 6,70; 669,71 mM L(I group) and control; 0,67; 3,34; 13,40 and 1339,42 mM L (II group). The content of plastid pigments mass have been determinated by extraction with 85% acetone and calculated by the equation of Röbbelen (1957), some elements by atomic absorption spectrophotometerVarian BQ-10 and sugar content by Dubois & al. (1956).

RESULTS AND DISCUSSION

The metal toxicity in plants appeares after icreasing of heavy metals content in plants. Zn is included in the list of elelments, which physiological role and necessity for plant live is proved. In first group of performed experiment the effect of high Zn concentrations in relation to the control isn't so visible especially in root whereas have been registered data which pointed out to the weak stimulative influence in the course of three passages (Tab.1). But, in case when the used Zn concentrations were double higher, a toxic effect has been visible at root especially at aboveground part what confirmed the fact that root cells are not so sensitive on high Zn concentrations difference of stem cells (Tab.2).

The suppressing of growth and decreasing of dry weight of different plant organs may be confirmed with literature data according which growth reduction of navy beans due to excessive Zn concentrations as high as 777 mg g^{-1} in the leaf (Polson and Adams 1970). On a dry weight basis toxic symptoms were associated with 1700 mg g^{-1} in oat leaves (Hunter and Vergnano 1953) while Polson and Adams (1970) indicated that the 200 mg g^{-1} is reasonable estimated of the upper critical level for cotton.

Stripe chlorosis has been appeared on tomato leaves 15-30 days after Zn treatments (II group), tab.4, while at first group whereas the Zn concentrations of treatments are lower hasn't been considered the Zn toxic effect on chlorophyll biosynthesis and carotenoid content expressed through the leaf chlorosis (Tab.3).

Tab.1 Influence of Zn concentrations on the fresh and dry biomass in tomato organs (g).
Таб.1 Влијанието на концентрациите на цинк на свежата и сува биомаса на органите кај домат (g).

Variants Варијанти	Root Корен		Stem Стебло		Leaf Лист	
Zn (μM)	fresh weight свежа маса	dry weight сува маса	fresh weight свежа маса	dry weight сува маса	fresh weight свежа маса	dry weight сува маса
0	2,071	0,108	11,271	0,446	6,063	0,532
0,67	2,385	0,098	8,556	0,303	4,695	0,344
1,67	1,828	0,093	6,269	0,229	3,915	0,309
6,70	1,291	0,088	4,230	0,152	3,147	0,235
669,71	1,127	0,063	3,364	0,120	2,541	0,179

Tab. 2 Influence of Zn concentrations on the fresh and dry biomass in tomato organs (g).
Таб. 2 Влијанието на концентрациите на цинк на свежата и сува биомаса кај органите на домат (g).

Variants Варијанти	Root Корен		Aboveground part Надземен дел	
Zn (μM)	fresh weight свежа маса	dry weight сува маса	fresh weight свежа маса	dry weight сува маса
0	1,141	0,046	5,481	0,249
0,67	0,855	0,039	3,990	0,187
3,34	0,498	0,029	1,889	0,100
13,40	0,295	0,018	0,664	0,026
1339,42	0,180	0,014	0,525	0,019

Tab. 3 Influence of Zn concentrations on plàstid pigments in fresh tomato leaves (I group).
Таб. 3 Влијанието на концентрациите на цинк врз хлоропластните пигменти кај свежи листови од домат (I група).

The content of chloroplast pigments in fresh tomato leaves (after 15 days) Содржина на хлоропластни пигменти во свежи листови (после 15 дена)				
Zn (μM)	Chlorophyll a Хлорофил а $mg\ g^{-1}$	Chlorophyll b Хлорофил б $mg\ g^{-1}$	Carotenoides Каротеноиди $mg\ g^{-1}$	Chlorophyll a/b Хлорофил а/б
0	2,5907	2,4392	0,4009	1,062
0,67	3,0420	3,4730	0,5897	0,875
1,67	1,9320	2,2505	0,2170	0,858
6,70	2,5285	2,6927	0,5845	0,939
669,71	1,4597	1,4390	0,2913	1,014
The content of chloroplast pigments in fresh tomato leaves (after 30 days) Содржина на хлоропластни пигменти во свежи листови (после 30 дена)				
Zn (μM)	Chlorophyll a Хлорофил а $mg\ g^{-1}$	Chlorophyll b Хлорофил б $mg\ g^{-1}$	Carotenoides Каротеноиди $mg\ g^{-1}$	Chlorophyll a/b Хлорофил а/б
0	5,8182	5,8405	1,3005	0,996
0,67	5,3245	5,5267	1,4111	0,963
1,67	4,9950	5,5012	1,3773	0,907
6,70	3,7202	4,2660	1,1580	0,872
669,71	6,1645	7,9855	1,3957	0,771
The content of chloroplast pigments in fresh tomato leaves (after 45 days) Содржина на хлоропластни пигменти во свежи листови (после 45 дена)				
Zn (μM)	Chlorophyll a Хлорофил а $mg\ g^{-1}$	Chlorophyll b Хлорофил б $mg\ g^{-1}$	Carotenoides Каротеноиди $mg\ g^{-1}$	Chlorophyll a/b Хлорофил а/б
0	8,6555	8,6432	2,5122	1,001
0,67	8,3467	8,5332	2,3308	0,978
1,67	6,2705	6,3232	1,7873	0,991
6,70	6,4965	6,6335	1,9392	0,979
669,71	6,4337	6,6115	1,8445	0,973

However, according to the literature data treatment of maize plants with high concentrations of heavy metals (Hg and Co) caused a reduction of chrophyll a as well as chlorophyll b content and resulted with necrotic stripes at older maize leaves (Kamenova et al. 1984) while at young leaves reduction of chlorophyll and carotenoid content occured of lower Hg concentrations (0,10-0,75 mg/L). The similar effect on chlorophyll content caused Cd (Baszynski et al. 1980; Callegari and Lannoye 1981; De Filippis et al. 1981a).

Through these investigations is considered that increased Zn concentrations in nutrient media caused the most increasing of microelements content in root than in stem and the little in leaves, Tab.5 and 6.

Tab.4. Influence of Zn concentrations on plastid pigments in fresh tomato leaves (II group).
Tab.4. Влијанието на концентрациите на цинк врз хлоропластните пигменти кај свежи листови од домат (II група).

after 15 days после 15 дена	Zn (μM)	Chlorophyll a Хлорофил а mg g^{-1}	Chlorophyll b Хлорофил б mg g^{-1}	Carotenoides Каротеноиди mg g^{-1}	Chlorophyll a/b Хлорофил а/б
	0	2,7132	3,0342	0,6428	0,894
	0,67	2,2202	2,3072	0,6294	0,962
	3,34	1,9732	2,2192	0,5783	0,889
	13,40	1,2950	1,4262	0,4209	0,907
	1339,42	1,3977	1,5547	0,3355	0,899
after 30 days после 30 дена	Zn (μM)	Chlorophyll a Хлорофил а mg g^{-1}	Chlorophyll b Хлорофил б mg g^{-1}	Carotenoides Каротеноиди mg g^{-1}	Chlorophyll a/b Хлорофил а/б
	0	3,5355	3,9245	1,1228	0,900
	0,67	4,2952	5,2070	1,2328	0,824
	3,34	3,4927	4,7822	0,9983	0,730
	13,40	1,8287	2,3975	1,1326	0,762
	1339,42	1,2530	1,8707	0,4422	0,669

Tab. 5 Influence of Zn concentrations on the content of some biogene elements in tomato.
Таб. 5 Влијанието на концентрациите на цинк врз содржината на некои биогени елементи кај домат.

I group – I група					
Zn (μM)	Organs Органи	Zn	Cu	Fe	Mg
0	Root-Корен	1,207	0,984	1,814	4,344
	Stem-Стебло	0,021	0,014	0,025	0,566
	Leaf-Лист	0,009	0,017	0,034	0,051
0,67	Root-Корен	1,679	0,469	1,006	1,775
	Stem-Стебло	0,095	0,040	0,058	0,645
	Leaf-Лист	0,021	0,032	0,092	0,078
1,67	Root-Корен	3,491	3,061	3,698	6,656
	Stem-Стебло	0,150	0,084	0,054	1,083
	Leaf-Лист	0,028	0,195	0,080	0,166
6,70	Root-Корен	4,648	1,000	0,612	4,535
	Stem-Стебло	1,292	0,373	0,811	0,698
	Leaf-Лист	0,103	0,202	0,626	3,723
669,71	Root-Корен	2,207	0,888	1,629	1,284
	Stem-Стебло	1,110	0,157	0,463	1,200
	Leaf-Лист	0,100	0,070	0,126	1,959

Tab. 6 Influence of Zn concentrations on the content of some biogene elements in tomato.
Таб.6 Влијанието на концентрациите на цинк врз содржината на некои биогени елементи кај домат.

II group- II група					
Zn (μM)	Organs Органи	Zn	Cu	Fe	Mg
0	Root-Корен Ab.ground part Надземен дел	5,619 0,090	2,883 0,045	4,591 0,107	19,835 0,287
0,67	Root- Корен Ab.groundpart Надземен дел	6,733 0,202	3,466 0,068	4,411 0,390	10,333 3,613
3,34	Root- Корен Ab.ground part Надземен дел	25,246 0,929	8,580 0,188	13,858 0,289	6,790 4.017
13,40	Root- Корен Ab.groundpart Надземен дел	48,500 9,475	17,300 3,575	17,400 2,875	24,000 7,750
1339,42	Root- Корен Ab.ground part Надземен дел	44,814 19,250	27,037 8,816	11,111 6,213	27,160 17,159

Tab. 7 The content of total and soluble sugars in tomato (% / dry weight).
Таб. 7 Содржина на вкупни и растворливи шеќери кај доматот (%/сува маса).

Zn (μM)	Total sugars (%) Вкупни шеќери (%)			Soluble sugars (%) Растворливи шеќери (%)		
	Root Корен	Stem Стебло	Leaves Листови	Root Корен	Stem Стебло	Leaves Листови
0	22,176	16,128	22,568	1,960	3,248	13,048
0,67	20,216	15,512	24,584	0,840	4,014	4,928
1,67	20,944	18,928	23,688	2,800	4,256	7,224
6,70	15,120	17,248	20,216	1,728	2,688	8,848
669,71	13,608	17,136	18,816	0,728	1,736	6,440

Dynamic of total and soluble sugars in different tomato organs pointed out that values of total carbohydrates content have been higher in tomato leaves in comparision to those in stems and roots. Average value of soluble sugars content in the stems and leaves has been somewhat higher than in roots, Tab.7.

CONCLUSIONS

Performed investigations in which have been included hydroponics by tomato (Lycopersicon esculentum Mill.) treated with different zinc concentrations lead down to these conclusions:

Optimal Zn concentrations which had a favorable effect on the biometric indices as well as on content of some macro and microelements varied within a range od 0,67-3,34 mM. Concentrations of 13,40 as well as 1339,42 mM zinc were toxic and also have a inchibited influence on plant growth, content of total and soluble sugars and chloroplast pigments in aboveground part of plants.

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ЕФЕКТИТЕ ОД РАЗЛИЧНИТЕ КОНЦЕНТРАЦИИ НА ЦИНК ВРЗ НЕКОИ МОРФОЛОШКИ ПАРАМЕТРИ КАЈ ДОМАТ (*Lycopersicon esculentum* Mill.)

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РЕЗИМЕ

Различните концентрации на цинк кај водени култури од домат (Lycopersicon esculentum Mill., сорта Saint Pierre) одгледувани на Hogland-ов раствор влијаат стимулативно врз акумулацијата на биомасата на истражуваните органи кај доматот, содржината на одредени макро и микроелементи и тоа во границите од 0,67-3,34 mM. Повисоките концентрации на цинк од 13,40 mM како и 1339,42 mM се доста токсични и покажуваат инхибиторно влијание на растот на органите изразено преку нивните биометрички вредности, содржината на вкупни и растворливи јаглехидрати во надземните делови на растенијата како и на содржината на хлоропластните пигменти.