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Evaluation the effect of rootstock type on mineral elements concentration in shoot of budded sweet orange (*Citrus sinensis* var. Valencia)

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ABSTRACT

In this study, have been evaluated the effect of four citrus rootstocks [(Sour orange (Citrus aurantium), Bakraei (C. reticulate × C. limmetta), Mexican lime (C. aurantifolia) and Volkamer lemon (C. volkameriana)] Valencia orange leaf chlorophyll content and mineral elements concentration (N, P, K, Ca, Na, Mg, Fe, Zn, Mn, Cl, Cu, and B) in completely randomized design with four replications. Budded Valencia orange on rootstocks were grown in pots containing calcareous soil (pH=8.2) in greenhouse. Results showed that rootstocks had significant effect on leaf chlorophyll content. Highest chlorophyll content was on Sour orange rootstock. Rootstock types had significant effect on leaf mineral concentrations except of Cl and Na. Leaf N concentration on Mexican lime and Sour orange rootstocks was lower than optimum range. Leaf Cu concentration on all rootstocks except of Sour orange and Cl concentration on all rootstocks were higher than optimum range. Scions on Volkamer lemon rootstock had highest Cl and lowest Na concentrations.

Keywords: Citrus, Rootstocks, Valencia orange, Chlorophyll, Mineral elements

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INTRODUCTION

Rootstock type has important role in quantity and quality of growth and development and crop production in citrus. Citrus rootstocks differ in compatibility to kinds of soils, manner of root dispersion and affiliation to micorhyza. This object lead to difference in leaf mineral elements concentration or leaf of budded cultivars on them and finally affect vegetative growth and fruit quantity and quality [3]. In a budded tree, rootstock type affects many scion properties such as chlorophyll content [5] and leaf mineral elements [8, 14]. Georgiou [6] in evaluation of mineral elements content in Clementine mandarin leaf on 12 rootstocks reported that there was significant difference between rootstocks in viewpoint of Mg, Cu and B in leaf of scion. Iqbal *et al*. [7] reported that rootstock type had significant influence on leaf mineral elements of Kinnow mandarin scion. Pestana *et al*. [12] reported that citrus rootstocks perform various in iron absorption and had significant difference together. Similar citrus also in pistachio [13] and apple [4] reported that rootstock type has significant difference on leaf scion mineral elements concentration. Valencia orange is the most important late ripening sweet orange in the world, which has good compatibility with warm region. This cultivar is commercial and its fruit has good marketable and fruit permanency on tree is excellent. Somewhat is resistant to cold and drought and in due to proper compatibility developing in Jahrom township. Attentive to budding propagation and using of different rootstocks for this cultivar and nonexistence of sufficient information on interaction between it and rootstock type, aim of this investigation was evaluation the effect of rootstock type on chlorophyll and mineral elements content in leaf of Frost Valencia orange in calcareous soil condition.

MATERIALS AND METHODS

In order to examination the effect of rootstock type on mineral elements concentration in budded Valencia orange, an experiment was performed in greenhouse in completely randomized design in Jahrom township at Iran. For this purpose, annual seedlings from 4 rootstocks consist Sour orange, Mexican lime, Bakraei and Volkamer lemon was cultured in 5 liters pots containing dominant soil of region (Calcareous soil with pH=8.5 and silt texture) with 4 replications and until budding stage, was performed necessary attentions. Five months after transplanting, seedlings were budded by Frost Valencia orange scion (from a single 7 years old tree) by T-budding method. Twenty days after budding, plastic band opened around the graft place. After scion growth, rootstocks cut from 5 cm above budding place. After 6 months was measured chlorophyll in scion leaves by SPAD set then shoots cut from budding place. For measurement of mineral elements, scion shoot put in oven with 75 °C for 48 hours and then was powdered [2]. Total nitrogen measured by 0.3 g plant powder by using of Micro-kejeldahl set [6]. For measurement of other elements, at first was supplied extract. For this purpose, 0.5 g plant powder was ash in oven with 550 °C for 5 hours until obtained white color ash and then was added 2 ml HCl 2N to ashes. Thereafter, was filtrated by boiling double distilled water in 50 ml volumetric by Vatman paper No. 2. Filtration repeated some times and finally volumetric filled by double distilled water [2]. By using of the extract was measured K and Na content by Flame photometer model Sherwood 410, Ca, Mg, Fe, Zn, Cu and Mn by Atomic absorption model Pekrin Elmer 1100 and P and B content by Spectrophotometer model ShimadzuUV-120-02. For measurement of Cl, 0.5 g plant powder mixed in 50 ml distilled water and shake for 30 min. Then was filtrated by Vatman paper No. 2 and read by chloride meter model Jenway PCLM3 (2). For convert of obtained data from SPAD, 10 leaves selected and its chlorophyll measured by SPAD. Then was measured its chlorophyll content by Moran and Porath method [9] and finally by regression method, SPAD data was converted to mg chlorophyll in gram leaf fresh weight. Obtained data analyzed by MSTAT-C software and means compared by Duncan's multiple range test.

RESULTS

Analysis of variance table showed significant influence of rootstock type on chlorophyll, N, P, K, Zn, B and Mn content in Valencia orange leaf in 1% level and Fe in 5% level. Rootstocks had no significant influence on Na and Cl content (Table 1 and 2). Highest chlorophyll content was observed on sour orange and lowest on Volkamer lemon rootstocks (Fig. 1).

Table 1- Analysis of variance in relative to chlorophyll and macro elements

Source of Variation	d.f	Mean Square (MS) of Data							
		Chlorophyll	N	P	K	Ca	Mg	Na	Cl
Rootstock	3	1.671**	0.035**	0.023**	0.421**	1.517**	0.104**	0.00064^{ns}	0.004^{ns}
Error	12	0.001	0.001	0.0025	0.002	0.004	0.006	0.0003	0.004
C.V.		9.5	11.4	11.7	11.5	11.5	8.4	18.2	10.2

^{ns}, *, **: Non significant, significant in 5 and 1% respectively

Table 2- Analysis of variance in relative to trace elements

Source of Variation	d.f	Mean Square (MS) of Data				
		Fe	Cu	Zn	Mn	B
Rootstock	3	118.333*	417**	606.333**	1944**	1505**
Error	12	25.667	14	42.833	30.333	10.167
C.V.		7.26	13.01	6.59	9.03	6.16

^{ns}, *, **: Non significant, significant in 5 and 1% respectively

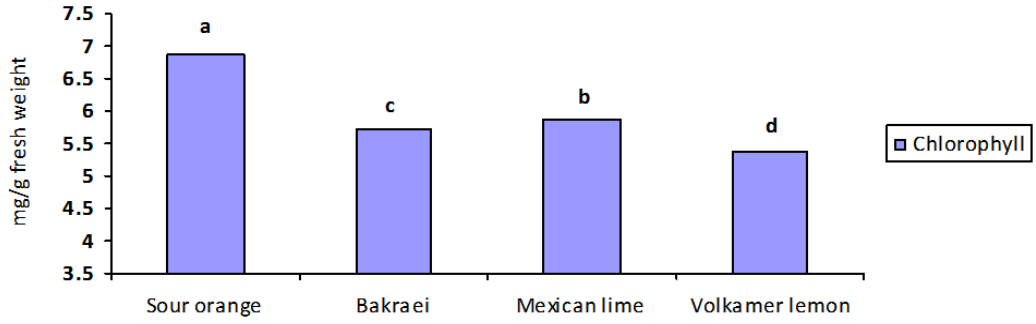

Fig 1- Mean comparison of Valencia orange leaf chlorophyll content on different rootstocks

Effect of rootstock type on macro elements and Na concentration in Valencia orange leaf

Means comparison showed that rootstock type had influence on macro elements and Na concentration that this effect in some cases was significant. There was highest N level (2.65 dry matters %) in scion leaf on Bakraei rootstock and lowest (2.44 dry matter %) on Mexican lime rootstock. Mexican lime and Sour orange were in one statistical level. Highest P content (0.5 dry matter %) was in leaf of scion on Bakraei rootstock that had not significant difference with Sour orange. There was highest K concentration (2.18 dry matters %) in leaf scion on Bakraei rootstock and lowest (1.44 dry matter %) on Sour orange rootstock. Rootstock type had significant influence on leaf scion Ca concentration. Highest Ca concentration was in Sour orange rootstock. Lowest Na concentration (0.012 dry matter %) observed in leaf scion on Volkamer lemon rootstock and there was not significant difference between all rootstocks (Table 3).

Table 3- Mean comparison of Valencia orange leaf macro elements on different rootstocks

Rootstocks	Macro elements					
	N	P	K	Ca	Mg	Na
	% Dry matter					
Sour orange	2.47^{c}	0.48^{a}	1.60^{c}	4.85^{a}	0.82^{b}	0.020^{a}
Bakraei	2.65^{a}	0.50^{a}	2.18^{a}	3.48^{d}	0.86^{b}	0.020^{a}
Mexican lime	2.44^{c}	0.42^{b}	1.42^{d}	3.62^{c}	0.93^{b}	0.020^{a}
Volkamer lemon	2.55^{b}	0.33^{c}	1.74^{b}	4.02^{b}	1.18^{a}	0.012^{a}

Means with same letter in each column have not significant difference in 1% level of DMRT test

Effect of rootstock type on trace elements concentration in Valencia orange leaf

On basis of obtained results, rootstocks had significant influence on Fe, Zn, Mn, Cu and B concentration. There was highest Fe concentration (77 mg/kg) in leaf scion on Sour orange and lowest (64 mg/kg) on Volkamer lemon rootstock. Highest Zn, Cu, B and Mn concentration observed in leaf scion on Bakraei rootstock. Leaf scion on Volkamer lemon rootstock had Cl concentration more than other rootstocks whereas all rootstocks were in same statistical class (Table 4).

Table 4- Mean comparison of Valencia orange leaf trace elements on different rootstocks

Rootstocks	Trace elements					
	Fe	Cu	Zn	Mn	B	Cl
	% Dry matter					
Sour orange	77^{a}	16^{c}	104^{ab}	52^{b}	40^{c}	0.32^{a}
Bakraei	68^{ab}	41^{a}	113^{a}	79^{a}	72^{a}	0.28^{a}
Mexican lime	70^{ab}	29^{b}	84^{c}	34^{c}	64^{b}	0.29^{a}
Volkamer lemon	64^{b}	29^{b}	96^{bc}	79^{a}	31^{d}	0.35^{a}

DISCUSSION

Attentive to total results, rootstock type had influence on concentration of some mineral elements and chlorophyll content of Valencia orange leaf. Difference in leaf scion chlorophyll content on rootstocks attribute to ability rootstocks to absorption and transfer of mineral elements to shoot. Other researchers [5, 6, 15] in other citrus scion and rootstock combinations also had reported this subject. Exception of rootstock type, different citrus cultivars also have difference together in chlorophyll content [5]. On basis of Table 3 results, rootstock type had been influence on mineral elements concentration that this subject also had reported by other researchers [3, 6, 7, 8, 14]. In comparison of obtained mineral elements contents and optimum concentrations [11] showed N content in Valencia orange leaf on Mexican lime and Sour orange rootstocks was less than optimum range. In relation to trace elements, Cu concentration in leaf scion on all rootstocks except Sour orange and Cl on all rootstocks was more than optimum range. Under condition of this experiment, in stage of budded plant production of Valencia orange except N for Mexican lime and sour orange rootstocks and Cu only for sour orange is not need to consumption of other mineral elements. In condition of existence of high level of Cl in soil or irrigation water there is probability the accumulation of this element and incidence of toxicity symptoms in scion leas of Valencia orange on all rootstocks. Thus in existence of high level of Na probably Volkamer lemon rootstock had little trend to accumulation Na in leaf scion than other rootstocks.

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