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Effect of locality and cultivar on microelement concentrations in apple leaf

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Abstract: This paper presents the results relating to Fe, Mn, Cu, Zn and B availability in the apple leaf depending on the locality, cultivar, research year, and their interaction.

The localities and cultivars had a highly significant effect only on Mn concentration, while study years affected Fe concentration. Based on correlation between all the parameters, no significant effect on variations in Cu and B concentrations was revealed, whereas a marked effect on variations in Mn concentration was most expressed.

Key words: apple, concentration, leaf, locality, microelements, cultivar

Introduction

It is well-known that the same micronutrients are required by various fruit crops to enable them to perform metabolic processes. However, fruit requirements for individual elements are different and specific. They depend for the most part upon species, cultivar and rootstock genotype which is commonly limited and affected by environmental factors and the level of cultural and pomotechnical practices.

Therefore, in many countries with developed fruit culture, based on chemical analysis of leaf, the so-called boundary values have been assessed or standards, which have served for estimating the availability of ions to the plant, with respect to individual elements. When compared and related to the analysis of

soil and other parameters, such values may present the basis for determining both species and fetrilizer amounts needed for fruit fertilization. However, these standards, due to the effect of climatic and soil conditions on the availability of ions to apple leaf cannot be used in each country and its particular areas for the same fruit species.

All above stated has defined the objective of the paper, which is to ascertain to what extent apple leaf is provided with microelements, but from the aspect of simultaneous effect of locality, cultivar, year and their interaction, on the mentioned conditions.

In the available literature, no data have been encountered as a result of investigations carried out in the way done in the present paper, though the authors in their numerous works elaborated standards for the availability of microelements for apple. For comparing the obtained results, the data of B o u l d (1966), K e n w o r t h y (1967), S t i l e s (1968), G a u c h (1972), B e r g m a n n and N e u b e r t h 1976, cit. acc. to U b a v i ć et al., 1990), S t o i l o v (1977), W e s t w o o d (1978), F a u s t (1989) have been used, as Weel as of other workers.

Material and Methods

Locality - The seedlings tested are owned by PIK „Čačak", established in Trbušani, Mojsinje and Baluga, twenty years old. They were spaced 5 x 4m apart, and growing form was irregular palmette with oblique branches. In the present studies, the same growing technology was used.

Material - As a material, widely known American cultivars of apple were used - Jonathan, Golden Delicious and Starking. These cultivars were grafted on the seedlings of the wild apple (Malus sylvestris Mill).

Methods - The experiment was set up according to randomized block design with four replications, each involving 12 trees of one cultivar.

Leaf samples for chemical analyses were collected at the end of July from the middle part of the shoot. For each replication, 100 leaves were used of each cultivar.

After preparing samples in the laboratory, Fe, Mn, Cu Zn and B concentrations were determined according to well-known and generally adopted methods. All the concentrations, except for B concentration, were directly obtained from the concentrated solutions through atomic absorption on atomic absorber, Pye Unicam SP 191. For B concentration colorimetry procedure was used with coloured reaction with chinalizarin using the colorimeter „Zeiss"MK 6/6.

The data were processed by analysis of variance (F test), and Duncan multiple test was used to test the differences.

Environmental conditions

Soil conditions - Smonitza, inclining to brown forest soil of a mild acid reaction characterises the soil in Trbušani. It is moderately supplied with humus,

total nitrogen, phosphorus, and well supplied with potassium. Mojsinje has alluvium clayey soil. It is characterised by slightly acid to neutral reaction, an average humus and total nitrogen supply, and well supplied with P and K.

The planting in Baluga lies on alluvium clayey soil. Soil reaction ranges from a mild acid to neutral. It is moderately supplied with humus, total nitrogen and phosphorus and well supplied with potassium.

Climatic conditions - Over the study period, basic climatic factors were within the limits of the long-term average for Čačak and its surroundings, and no essential differences were revealed among them for all the three plantings which are located within the 10-km radius from Čačak. (Tab.1).

Tab. 1 Climatic factors in the research period

Climatic factors	Year		
	1983	1984	Ø1983/84
Mean annual air temperatures (°C)	9.2	10.4	9.8
Mean vegetation temperatures (°C)	17.3	16.8	17.1
Yearly precipitation sum (mm^2)	716	794	755
Vegetation precipitations sum (mm^2)	380	420	400

The analysis of the above factors showed them to favour apple as a species so that they had no signifirant effect on the results of the investigations.

Results and Discussion

From the obtained results of the microelement concentrations in apple leaf, 121.5 µg /g of dry matter was reported, followed by 172.1µg /g of Mn, 8.38 µg /g of Cu, 24.8 µg /g of Zn and 75.7 µg /g of B, respectively (Tab. 2).

Tab. 2. Average microelement concentration in apple leaf (µg /g of dry matter)

Variants Fe	Mean				
	Mn	Cu	Zn	B	
Locality (a):					
Trbušani	117.9 a	176.2 b	8.31 a	23.8 a	74.3 a
Mojsinje	117.7 a	143.7 c	8.35 a	24.6 a	74.0 a
Baluga	128.9 a	196.4	8.49 a	26.0 a	78.8 a
Cultivar (B):					
Jonathan	114.9 a	161.0 b	8.27 a	26.6 a	73.6 a
Golden Delicious	124.9 a	168.5 b	8.36 a	20.6 a	74.0 a
Starking	124.7 a	186.8 a	8.51 a	27.3 a	79.5 a

Year (C):					
1983.	113.9 b	170.2 a	8.27 a	23.7 a	77.3 a
1984.	129.1 a	174.1 a	8.49 a	25.9 a	74.1 a
Interaction:					
AB	ns	**	ns	**	ns
AC	**	**	ns	ns	ns
BC	ns	ns	ns	ns	ns
ABC	ns	**	ns	ns	ns
Average	121.5	172.1	8.38	24.8	75.7

Fe concentration - In respect of localities, Fe was for the most part present in apple leaf in planting area in Baluga, with about 128.9 µg /g of dry matter, whereas 117.9 µg /g of dry matter reported in Trbušani and 117.7 µg /g in Mojsinje well indicated the lower or perhaps equal Fe concentration.

In respect of cultivars, the Starking and Golden Delicious leaf contained similar Fe amounts, i.e. 124.7 and 124.9 µg /g, and the Jonathan leaf had about 114.9 µg /g dry matter. In 1984, the leaves of the cultivars studied in all the three localities had comparatively higher Fe amounts , i.e. 129.1 µg /g in relation to the preceding year, with about 113.9 µg /g.

Mn concentration - The greatest Mn levels amounting to 196.4 µg /g of dry matter were found in leaves in the planting in Baluga, while it was the least in Mojsinje, i.e. 143.7 µg /g. Among the cultivars, the Starking leaf was the richest in this element, i.e. 186.8 µg /g, and the the Jonathan leaf was the poorest, i.e. 161.0 (g /g, On a year-by-year basis, its higher amount was reported in 1984 174.1 µg /g, and somewhat lesser in 1983, i.e. 174.1 µg /g and 170.2 µg /g respectively.

Tab. 3. Optimum microelement concentrations in apple leaf according to different authors (µg /g)

Authors	Microelements				
	Fe	Mn	Cu	Zn	B
Bould, 1966	50-200	25-100	5-12	25-50	25-50
Kenworthy, 1967	220	98	23	-	42
Stiles, 1968	100-300	-	5-20	25-50	30-40
Gauch, 1972	-	-	5-6	-	25-34
Bergmenn & Neubert, 1976	40-280	35-100	5-12	22-50	25-50
Stoilov, 1977	50-400	25-200	5-20	22-50	20-50
Westwood, 1978	50	25	4	18	35
Faust, 1989	85	25	6	18	35

Cu concentration - The highest Cu amount was found in the cultivars in Baluga, and the least one in Trbušani, i.e.8.49 µg/g and 8.31 µg/g of dry matter, respectively. As regards the cultivars, Cu was mostly contained in the Starking leaf, and least in the Jonathan leaf, i.e. 8.51 µg/g and 8.27 µg/g respectively. Based on investigated years, Cu concentration ranged from 8.27 µg/g to 8.49 µg/g in 1983 and 1984, respectively.

Zinc concentration - In view of the localities, Zn concentration in the apple leaf ranged from 23.8 µg/g of dry matter in Trbušani to 26.0 µg/g in Baluga, and concerning the cultivars, from 20.6 µg /g in Golden Delicious to 27.3 µg /g in Starking. Concerning the studied years, Zn concentration ranged from 23.7 µg /g in 1983 to 25.9 µg/g in 1984.

B concentration - In the leaves of the cultivars, concerning the locality, it was proved the highest in Baluga, and somewhat lower and very much alike in Mojsinje and Trbušani, i.e. 78.8 µg/g, 74.0 µg/g and 74.3 µg/g of dry matter respectively. Pronounced variations were revealed in this concentration concerning the cultivars, i.e. 73.6 µg/g in Jonathan and 79.5 µg/g in Starking, and on a year-by year basis, from 74.1 µg/g to 77.3 µg /g in 1984 and 1983, respectively.

After the analysis of overall microelement concentrations in apple leaf, the cultivars in Baluga were found to be the richest in these substances, which is attributed to slightly better soil properties. Among cultivars, the Starking leaf possessed the highest Mn, Cu, Zn and B content, while Fe content was the lowest in Golden Deliciouss. Based on the research years, only B content prevailed in 1983, while the other elements were noticeable in 1984.

Through analysis of variance and Duncan test on the mean microelement concentrations in apple leaf, highly significantly high differences were observed between the localities in respect of Mn concentration, followed by those between the cultivars in Mn and Zn concentrations, and between the years Fe concentration varied. Other differences could be neglected.

The analysis of variance also indicated that the interaction between the locality and the cultivar significantly affected the differences in the average Mn and Zn concentrations, followed by the interaction between the locality and the year, largely affecting the differences in Fe and Mn cncentrations, while locality x cultivar x year interaction considerably affected differences in Fe concentration. The effect of other ratios was statistically insignificant.

Comparing the results obtained in the present study with those of the authors named in the Tab. 3, it could be stated that, if the similar conditions were provided, the optimum availability of Fe, Mn, Cu and Zn would be represented in the apple seedlings in all the three localities, and B concentration would even be above the optimum. K a s t o r i (1983) reports that B surplus, depending on the plant species may exhibit toxic effect ranging from 100 to 1000 ppm. The mentioned concentration cannot be considered harmful and is most probably the result of the drought period which occurred in July and August in both 1983 and 1984.

Conclusion

On the basis of the objective of this paper and the results obtained, the following may be concluded:

The highest microelement concentration in the leaves of the three apple cultivars was noticeable in the planting in Baluga. Concerning the cultivars, the Starking leaf was found out to be the richest in Mn , Cu, Zn and B amounts, and Golden Delicious was the richest in Fe amounts. Based on the study years, Fe, Mn, Cu and Zn contents prevailed in 1984, and B content was prevalent in 1983;

The localities significantly affected only the differences in Mn concentration, while the cultivars affected both the differences in Mn and Zn concentrations. The years alone affected the differences in Fe content.

The cultivars in the plantings were provided with all the microelements to the greatest extent, with the exception of excess B content.

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UTICAJ LOKALITETA SORTE NA KONCENTRACIJU MIKROELEMENATA U LISTU JABUKE

- originalni naučni rad -

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Rezime

U radu su prikazani rezultati, koji se odnose na obezbeđenost lista jabuke gvožđem, manganom, bakrom, cinkom i borom zavisno od lokaliteta i godine ispitivanja, kao i njihovih međusobnih interakcija.

Utvrđeno je da su lokaliteti i sorte ispoljili pojedinačno visoko opravdan uticaj jedino na koncentraciju mangana, a godine ispitivanja na koncentraciju gvožđa. Interakcije parametara nisu značajno uticale na razlike u koncentraciji bakra i bora, dok je uticaj na razlike u koncentraciji mangana najviše izražen.