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EVALUATION OF MICRONUTRITIONAL STATUS OF CHRYSANTHEMUM STOCK PLANTS

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Introduction

Fertilization recommendations for chrysanthemum stock plants grown according to the principles of fertigation have not been fully elaborated so far. There are also no data referring to the critical content of microelements permitting to define their ranges in reference to chrysanthemum leaves. This problem is essential for the correct diagnostics of chrysanthemum growth disturbances. The objective of this work was the evaluation of:

- microelement nutrition of chrysanthemum motherplants grown in a greenhouse with the use of fertigation,
- usefulness of the parameters actually used in diagnostics for the characterization of chrysanthemum nutritional status.

Results of studies referring to macroelements were presented by BREŚ et al. [2002].

Material and methods

The studies were carried out in the years 2000–2001 in a productive trial. Chrysanthemum stock plants were grown in light medium sand. Frequency of fertigation was regulated on the basis of soil moisture measurement. For the preparation of the proper nutrient, the following components were used: calcium nitrate, potassium nitrate and multicomponent fertilizer Hydroflex T containing 7.4% N; 3.8% P; 30% K; 8% S; 2% Mg; 0,07% Fe; 0.045% Mn; 0.028% Zn; 0.07% B; 0.004% Cu and 0.004% Mo. After mixing in a computerized nutrient-mixer of the above mentioned solutions in 2.5 : 2.5 : 1 volumetric proportion with rain water, a nutrient of pH 5.5 and EC 2 $mS \cdot cm^{-1}$ was obtained. The plants were irrigated using a drip irrigation. Every month, from February to May, random samples of chrysanthemum leaves and soil were taken for chemical analyses. In 2000, samples of 16 and in 2001 samples of 13 cultivars were examined. A detailed sampling timetable is presented in Table 1. In mean samples of plant material, after drying at 50°C and mineralization in strong mineral acids the total content of Fe, Zn and Cu was determined [BREŚ et al. 1997]. Lindsey's extract was used for the soil analysis [NOWOSIELSKI et al. 1984]. Also the pH in H_2O was measured.

Table 1; Tabela 1

Sampling terms of chrysanthemum leaves and soil
Terminy pobierania prób liści chryzantem i gleby

Term Termin	Year; Rok	
	2000	2001
1	28 II	28 II
2	27 III	26 III
3	28 IV	26 IV
4	29 V	26 V

For the particular components in the leaves of each chrysanthemum cultivar defined at 4 terms standard deviation were calculated. For the whole population in the given year of studies, on the basis of standard deviation of the population and the mean value of element content, the coefficient of variation was calculated.

Results end discussion

The results of soil analysis are shown in Table 2. For comparison, the range of microelements recommended for ornamental plants by KACPERSKA et al. [1990] for cultures fertilized in the traditional way are presented as well. With the exception of copper, the contents of microelements in the soil were contained within the recommended ranges. However, the deficit of copper is only apparent because throughout the whole period of motherplant growing, the plants were irrigated with a full nutrient containing all macro- and microelements necessary for growth. Furthermore, no characteristic symptoms of this component deficit were recorded on the plants. Also no signs of zinc deficit was observed in spite of the fact that the content of this element in the soil did not exceed one half of the recommended range. According to CHAUDHRY et al. [1973], higher concentrations of zinc in the soil can cause copper deficit. That author explains this phenomenon by ionic antagonism of elements. The obtained results indicate that the recommendations elaborated for traditional fertilization methods cannot be directly adopted for cultures where fertigation is applied. Similar conclusions referring to the evaluation of macroelement content in chrysanthemum motherplarats were formulated by BREŚ et al. [2002].

Table 2; Tabela 2

Content of iron, zinc, copper in the soil and pH of the soil
Zawartość żelaza, cynku i miedzi w glebie oraz pH gleby

Element Pierwiastek	Range of content; Zakres zawartości ($mg \cdot dm^{-3}$)		Recommended value * Zawartości zalecane*
	2000	2001	
Fe	66.9–112.9	81.6–95.4	5–100
Zn	11.7–14.4	9.5–14.8	5–50
Cu	1.1–1.2	1.0–1.1	3–10
pH_{H_2O}	5.36–6.68	5.72–6.74	5.5–7.0

* acc. KACPERSKA et al. [1990]; wg KACPERSKIEJ i in. [1990]

Results of leaf analysis are graphically presented on the example of copper in Fig. 1 and 2. The figures show results of analyses for all cultivars at 4 terms of sampling (mean values from 3 measurements). In 2000, Cu content was within the range of 4.4–11.4, while in 2001, the range was from 3.7 to 9.1 mg·kg^{-1} of leaf dry matter. However, the ranges for the remaining studied elements determined in a similar way are too wide because they are created by extreme values departing from the average values. For this reason, in order to define the standard ranges, Table 3 based on statistical analysis were created. Statistical calculations carried out on the basis of those data show that the variability of the investigated characteristic features (component content) within the studied chrysanthemum cultivar is not great. Both in the year 2000 and 2001, the least diversity of results within the population of all tested cultivars (the least coefficient of variation) was obtained for iron and copper. Slightly higher but also satisfactory values of this coefficient were obtained for zinc.

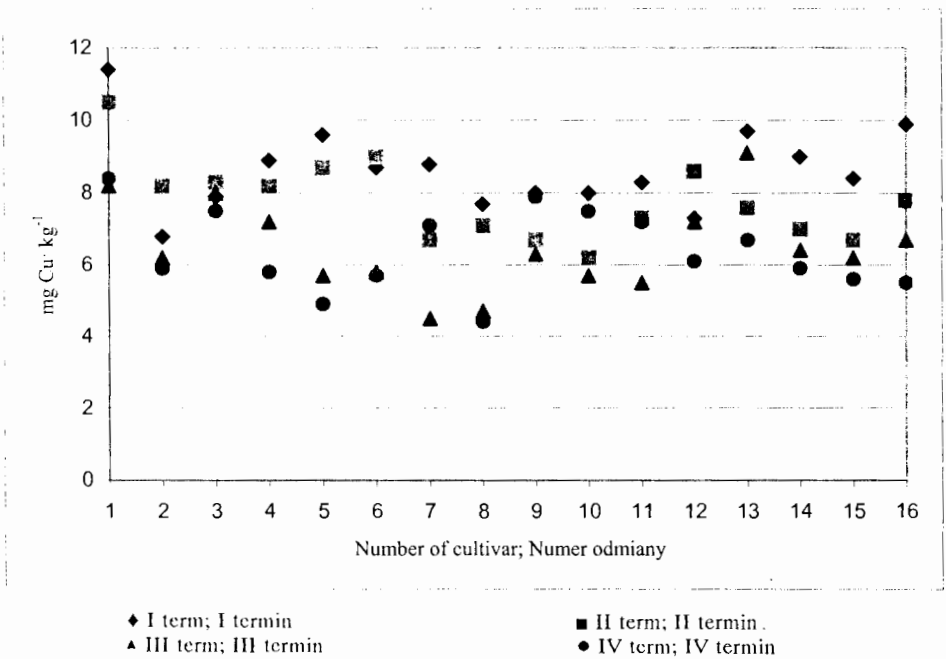

Fig. 1. Content of copper in healthy leaves of chrysanthemum stock plants – year 2000 (number of cultivar – see Table 3)

Rys. 1. Zawartość miedzi w zdrowych liściach roślin matecznych chryzantem – rok 2000 (numer odmiany – patrz tab. 3)

Since there are no numerical parameters permitting to define the nutrition status of chrysanthemum motherplants fertilized together with irrigation, the obtained results of analyses were compared with the values elaborated for plants grown for cut flowers in rockwool [DE KREIJ et al. 1990] in sand [LUNT et al. 1964] or sand and peat medium [ADAMS et al. 1975] but additionally fed with solutions. An illustrating comparison is shown in Table 4.

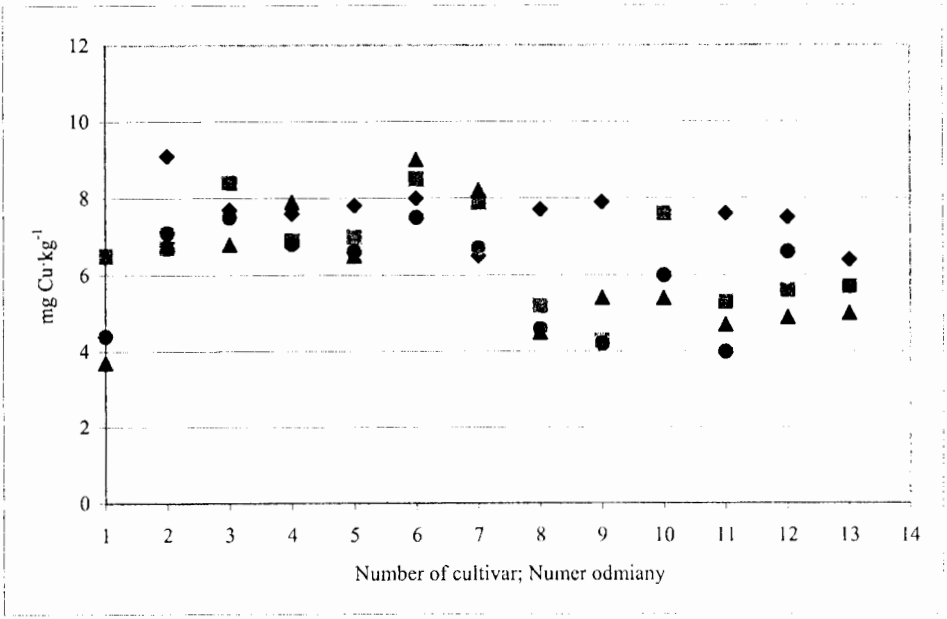

Fig. 2. Content of copper in healthy leaves of chrysanthemum stock plants – year 2001 (number of cultivar – see Table 3)

Rys. 2. Zawartość miedzi w zdrowych liściach roślin matecznych chryzantem – rok 2001 (numer odmiany – patrz tab. 3)

Table 3; Tabela 3

Total content of iron, zinc and copper in the leaves of chrysanthemum stock plants (mg·kg^{-1} of dry matter)

Całkowita zawartość żelaza, cynku i miedzi w liściach roślin matecznych chryzantem (mg·kg^{-1} suchej masy)

Cultivar Odmiana	2000			2001		
	mg·kg^{-1}	standard deviation odchylenie standardowe	coefficient of variation współczynnik zmienności (%)	mg·kg^{-1}	standard deviation odchylenie standardowe	coefficient of variation współczynnik zmienności (%)
	Fe content; zawartość Fe					
1	2	3	4	5	6	7
Super White (1)	138.98	21.71	5.45	96.30	23.99	7.36
Sheena select (2)	117.70	8.87		76.23	14.69	
Reagan White (3)	127.01	16.53		94.30	9.40	
Reagan Sunny (4)	126.54	24.05		97.05	24.50	
Reagan Splendid Dark (5)	135.04	25.70		–	–	
Fiji White (6)	132.95	26.81		–	–	

1	2	3	4	5	6	7
Fiji Yellow Improved (7)	118.82	25.04		–	–	
Eleonora White (8)	115.25	18.68		93.09	13.19	
Eleonora Yellow (9)	125.38	20.39		73.40	0.92	
Eleonora Lilac (10)	114.07	6.74		104.43	13.40	
Miral (11)	119.44	10.44		95.03	10.73	
Royalys (12)	132.53	23.05		77.88	11.50	
Passionement (13)	127.10	26.43		67.60	11.62	
Ibera (14)	138.90	20.53		73.28	14.16	
Kermit (15)	147.86	24.64		99.65	23.30	
Aztec (16)	127.85	26.05		72.33	4.49	
Zn content; Zawartość Zn						
Super White	61.73	9.30		54.05	14.18	
Sheena select	62.10	13.02		46.93	12.83	
Reagan White	64.53	2.24		40.20	18.42	
Reagan Sunny	59.83	15.50		60.63	17.52	
Reagan Splendid Dark	63.42	11.11		–	–	
Fiji White	47.90	7.80		–	–	
Fiji Yellow Improved	56.28	6.76		–	–	
Eleonora White	49.95	12.99	7.45	51.83	7.52	11.10
Eleonora Yellow	74.70	12.19		83.05	6.22	
Eleonora Lilac	59.53	15.92		65.40	10.86	
Miral	55.08	12.64		39.48	16.04	
Royalys	43.55	11.60		60.67	16.55	
Passionement	43.83	13.04		59.38	13.50	
Ibera	68.80	11.93		45.83	12.92	
Kermit	49.93	13.99		42.00	11.74	
Aztec	52.17	8.70		73.93	15.01	
Cu content; Zawartość Cu						
Super White	9.63	1.58		4.75	1.21	
Sheena select	6.78	1.02		7.43	1.13	
Reagan White	7.93	0.33		7.60	0.66	
Reagan Sunny	7.53	1.35		7.30	0.54	
Reagan Splendid Dark	7.23	2.28		–	–	
Fiji White	7.30	1.79		–	–	
Fiji Yellow Improved	6.78	1.77		–	–	
Eleonora White	5.98	1.67	5.52	6.98	0.59	8.07
Eleonora Yellow	7.23	0.85		8.25	0.65	
Eleonora Lilac	6.85	1.08		7.33	0.85	
Miral	7.08	1.16		5.50	1.50	
Royalys	7.30	1.02		5.45	1.72	
Passionement	8.28	1.37		6.65	1.12	
Ibera	7.08	1.36		5.40	1.56	
Kermit	6.73	1.20		6.15	1.14	
Aztec	7.48	1.87		5.70	0.58	

The values suggested by the mentioned authors differ distinctly between each other. Also the results of here presented studies depart from these recommendations. It means that for chrysanthemum stock plants cultivated using fertigation system, the ranges elaborated by the above cited authors are not usable. Therefore, it is necessary to elaborate new critical contents for chrysanthemums grown in systems where fertigation is applied. At the same time, in the diagnostics for the evaluation of micronutritional status of chrysanthemum motherplants temporarily one can utilize the standard ranges obtained on the basis of the presented experiments. For chrysanthemums grown in this technology for cut flowers, new critical contents were proposed by BREŚ [1998].

Table 4; Tabela 4

Recommended content for microelements in healthy leaves of chrysanthemum (mg·kg^{-1}of dry matter – total value)

Zawartości zalecane dla mikroelementów w zdrowych liściach chryzantem (mg·kg^{-1} suchej masy – zawartości całkowite)

Element Pierwiastek	Values for plants grown for flowers Wartości dla roślin uprawianych na kwiat				Values for stock plants Wartości dla roślin matecznych Results of investigations Wyniki badań
	LUNT et al. [1964]	ADAMS et al. [1975]	RORDA VAN EYSINGA, SONNEVELD [1980]	DE KREIJ et al. [1990]	
Fe	100–173	97–130	>140	279.5	67.6–147.9
Zn	7–26		92	13–98	39.5–74.7
Cu	20.5	5–14			4.8–9.6

According to SONNEVELD [1991] chemical status of plant tissue depends on cultivar, relation between nutrients in root zone, pH of solution or medium (soil), buffer capacity of medium (soil), edge of plant, part of plant. On other hand, constant level of nutrients in the solution caused rather stable content of macroelements (besides phosphorus) from the juvenile to mature growth in the leaves of hydroponically grown chrysanthemum [BOODLEY, MEYER 1965]. Also during the growing period small variability of nutrients in the leaves of cut chrysanthemum grown in rockwool was observed by BREŚ [1998]. Cuttings are taken from motherplants at the vegetative stage of growth. Therefore, it is not necessary to elaborate any critical values depending on the developmental stage for chrysanthemum motherplant.

Conclusions

1. Application of fertigation in growing chrysanthemum stock plants causes the necessity to amend the critical contents of microelements in the leaves determined so far.
2. For the standard ranges of component content in the leaves of chrysanthemum stock plants grown in systems with fertigation, one can accept the following values (mg·kg^{-1} of dry matter): Fe 67.6–147.93; Zn 39.5–74.7; Cu 4.8–9.6.

3. The use of fertigation makes inadequate the guide values elaborated for traditional methods of chrysanthemum growing. It is purposeful to elaborate new standard ranges for chrysanthemum motherplants characterizing optimal content of elements in the soil.
4. Values shown in Table 2 can be used as temporal recommended contents of microelements in the soil.

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Key words: chrysanthemum stock plants, microelements, nutritional status of plant

Summary

Up till now, no critical contents have been elaborated which permit to evaluate the correct microelement nutrition on the basis of chrysanthemum stock plant leaves analysis. Experiments were carried out to determine the content of iron, zinc and copper in the leaves of chrysanthemum motherplants by studying 16 cultivars in 2000 and 13 cultivars in 2001. Analyses were carried out at 4 terms (from: February to May). The values characterizing the content of the particular components in the leaves of each cultivar of chrysanthemum were statistically elaborated. Standard deviation for the cultivars and variation coefficient for the whole population in the given year were calculated. The usability of guide values utilized for traditional methods of chrysanthemum growing in diagnostics of plant nutrition were critically evaluated. New standard ranges of the content of iron, zinc and copper in chrysanthemum motherplant leaves were elaborated.

OCENA ODŻYWIENIA MIKROELEMENTAMI ROŚLIN MATECZNYCH CHRYZANTEM

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Słowa kluczowe: rośliny mateczne chryzantem, mikroelementy, ocena odżywienia roślin

Streszczenie

Dotychczas nie opracowano zawartości krytycznych pozwalających ocenić prawidłowość odżywienia mikroskładnikami na podstawie analizy liści roślin matecznych chryzantem. Doświadczenia, których celem było określenie całkowitej zawartość żelaza, cynku, miedzi w liściach przeprowadzono w roku 2000 wykorzystując 16, a w roku 2001 – 13 odmian roślin matecznych chryzantem. Analizy wykonano w 4 terminach (od lutego do maja). Wartości charakteryzujące zawartości poszczególnych składników w liściach każdej z odmian chryzantem opracowano statystycznie: obliczono odchylenie standardowe dla odmian oraz współczynnik zmienności dla całej populacji w danym roku. Krytycznie oceniono przydatność dotychczas stosowanych w diagnostyce parametrów charakteryzujących stan odżywienia roślin. Opracowano nowe, standardowe zakresy zawartości dla żelaza, cynku i miedzi w liściach roślin matecznych chryzantem.

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