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EFFECT OF THE PLANTING DATE ON MICRONUTRITIONAL STATUS OF POT CHRYSANTHEMUMS FROM THE TIME GROUP IN ALL-YEAR-ROUND CULTURE

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Abstract. The content of total iron, cuprum and boron in leaves of four chrysanthemum cultivars was studied in 12 growth cycles starting on the second day of each month throughout the year, from January to December. From the moment of potting, the plants were treated with a short day. In periods of naturally long days, the day was shortened to 10.5 hours using a black-out cover. No supplementary light was used. The time of culture associated with real insolation had a significant influence on micronutrients content. Maximum contents of cuprum and boron were recorded in the leaves of chrysanthemums grown in periods of light deficit. The reverse regularity in case of iron was observed.

Key words: Dendranthema grandiflora, fertigation, microelements, all-year-round culture

INTRODUCTION

The chemical composition of plants depends on many factors: fertilisation, proportion of ions in the root environment, properties of the medium [Sonneveld 1991], cultivar of plants [Breś 1998, Jerzy et al. 2004], the plant development stage [Waters 1967], system of culture [Breś 1998]. An additional factor affecting plants' macroelement balance is the time of culture, and hence insolation [Breś and Jerzy 2004b].

The aims of the research were the assessment of planting date on micronutritional status of pot chrysanthemums, and evaluation of usefulness of critical levels of microelements recommended for a conventional method of culture for diagnosing the micronutritional status of Time group chrysanthemums in all-year-round culture.

MATERIAL AND METHODS

Pot cultivars of the chrysanthemum *Dendranthema grandiflora* Tzvelev (syn. *Chrysanthemum* × *grandiflorum* /Ramat./ Kitam) grown in sprays were selected for the ex-

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periment: 'Esperanto Time', 'Icon Time', 'Jewel Time', and 'Solar Time'. The research embraced 12 growth cycles. Starting with 2 January 2002, on the second day of each successive month of the year rooted cuttings of the chrysanthemums were planted into pots 14 cm in diameter, 5 cuttings per pot. From the day of potting, the plants were treated with a short day. In periods of naturally long days, the day was shortened to 10.5 hours by shading. From November till mid-February (a day under 10 hours), no supplementary assimilation light was used to improve the light conditions in the period of insolation deficit. The plants were grown in a peat substrate. For the first few days after potting, the plants were sprinkled with water; later this practice was replaced with drip fertigation. To prepare the nutrient solution the rainwater was used. The composition of the nutritional solution prepared in a fertiliser mixer is presented in Table 1. The plants were fertigated usually with 160 cm^3 per pot, with the feeding frequency depending on weather conditions. Depending on those conditions, the electrolitical conductivity of the nutrient solution varied between 1.8 (in summer) and 2.2 $mS \cdot cm^{-1}$ (in winter). The results of a chemical analysis of the medium prepared for chrysanthemum culture and fertigation are presented in publication of Breś and Jerzy [2004b]. Five days after planting, stem tips were pinched above the fifth leaf, counting from the base of the stem. The chrysanthemums were retarded using the preparation B-Nine 85 SP (daminozide 85%) at a concentration of 0.3%. Details of the cultivars under study, method and time of culture, photoperiod, and yield are included in publication of Breś and Jerzy [2004a].

Table 1. Content of components in nutrient solution used in experiments
Tabela 1. Zawartość składników w pożywce stosowanej w doświadczeniu

Nutrient Składnik	$mg \cdot dm^{-3}$	Nutrient Składnik	$mg \cdot dm^{-3}$
$N\text{-}NH_4$	1.1	Cl	2.5
$N\text{-}NO_3$	211.8	$S\text{-}SO_4$	93.5
P	53.7	Fe	2.711
K	291.2	Mn	0.875
Ca	87.8	Zn	0.489
Mg	53.0	Cu	0.070
Na	4.3	B	0.295
pH	5.5	EC	$2.2\ mS \cdot cm^{-1}$

The material used for chemical analyses was well-developed leaves from plants, when 30% of inflorescences were in bloom. Total contents of Fe, Cu and B were determined in dried plant material after its mineralisation in strong acids [Nowosielski 1974]. Analysis of variance was applied to the results of the analyses and the LSD was calculated at the $p = 0.05$ significance level.

RESULTS AND DISCUSSION

A statistical evaluation of the results of the chemical analysis of chrysanthemum leaves is presented in table 2. The time of growing had a significant effect on the micronutritional status of the plants. The highest content of iron was found in the leaves of plants grown in cycles 5–11 (beginning from May to November 2002). The highest

Table 2. Influence of growing term on micronutrients content in chrysanthemum leaves, $mg \cdot kg^{-1}$ d.w.
Tabela 2. Wpływ terminu uprawy na zawartość mikroskładników w liściach chryzantem, $mg \cdot kg^{-1}$ s.m.

Beginning of cultivation Początek uprawy	Photoperiodic response, days Reakcja fotoperiodyczna, dni	Fe	Cu	B
'Esperanto Time'				
02.01.2002	62	94.80	7.10	70.77
02.02.2002	56	109.60	7.40	59.00
02.03.2002	55	171.60	5.70	54.70
02.04.2002	63	152.65	6.50	52.07
02.05.2002	65	133.70	6.20	70.67
02.06.2002	79	145.47	4.30	51.67
02.07.2002	67	147.27	7.37	63.50
02.08.2002	60	159.47	7.57	48.57
02.09.2002	57	171.67	6.57	68.40
02.10.2002	70	151.70	8.00	97.17
02.11.2002	82	125.57	8.00	83.07
02.12.2002	72	96.70	10.13	102.07
$LSD_{0.05}$ $NIR_{0,05}$		12.53	0.36	2.76
'Icon Time'				
02.01.2002	75	71.63	8.97	100.57
02.02.2002	62	113.90	8.10	91.70
02.03.2002	68	138.90	6.40	79.50
02.04.2002	70	154.59	6.67	85.17
02.05.2002	86	119.13	7.58	68.05
02.06.2002	101	170.27	5.57	68.70
02.07.2002	78	119.97	7.10	62.13
02.08.2002	64	180.30	7.62	65.57
02.09.2002	63	107.10	6.67	93.40
02.10.2002	66	123.97	8.14	109.50
02.11.2002	110	120.60	9.60	125.60
02.12.2002	88	89.70	10.41	125.77
$LSD_{0.05}$ $NIR_{0,05}$		11.03	1.92	4.97
'Jewel Time'				
02.01.2002	66	69.17	9.10	71.30
02.02.2002	59	89.67	7.77	66.10
02.03.2002	59	117.67	5.07	53.80
02.04.2002	55	119.30	6.97	53.37
02.05.2002	55	163.67	4.50	62.87
02.06.2002	73	161.90	5.60	48.20
02.07.2002	64	161.77	6.37	60.60
02.08.2002	54	159.87	6.77	47.27
02.09.2002	56	157.97	7.17	57.80
02.10.2002	69	123.40	8.37	73.20
02.11.2002	110	193.07	9.77	78.90
02.12.2002	88	144.57	10.50	82.37
$LSD_{0.05}$ $NIR_{0,05}$		6.14	0.31	1.85
'Solar Time'				
02.01.2002	68	79.20	7.00	68.70
02.02.2002	59	103.90	6.97	60.00
02.03.2002	63	144.37	5.40	53.90
02.04.2002	69	114.10	7.10	50.17
02.05.2002	74	122.00	5.47	68.70
02.06.2002	87	122.30	6.67	56.77
02.07.2002	72	135.60	7.70	61.37
02.08.2002	63	144.60	8.59	49.47
02.09.2002	59	153.60	6.47	57.77
02.10.2002	69	191.10	9.47	82.47
02.11.2002	90	126.80	8.47	86.47
02.12.2002	77	122.37	10.60	88.87
$LSD_{0.05}$ $NIR_{0,05}$		7.67	0.28	2.57

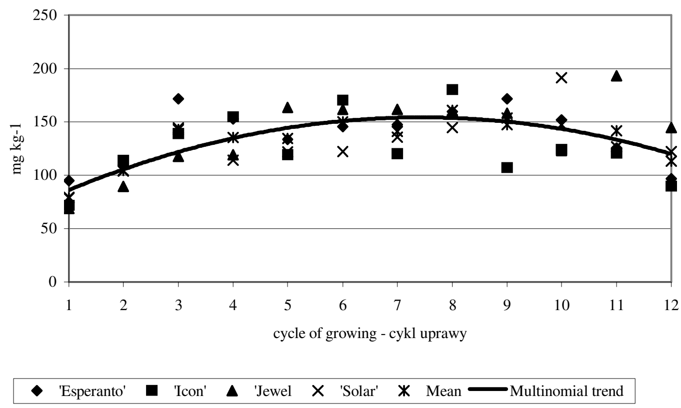

Figure 1. Content of iron in the chrysanthemums leaves and its multinomial trend
Rycina 1. Zawartość żelaza w liściach chryzantem oraz wielomianowa linia trendu zawartości

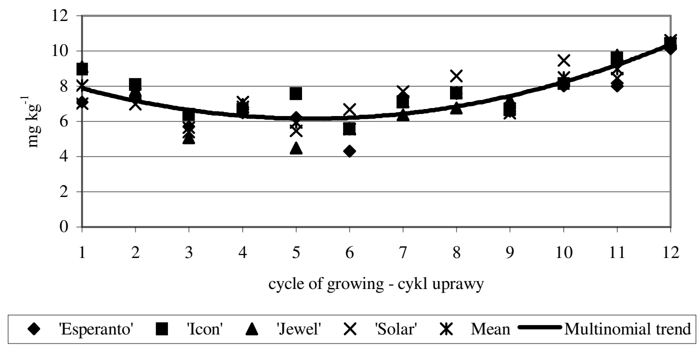

Figure 2. Content of cuprum in the chrysanthemums leaves and its multinomial trend
Rycina 2. Zawartość miedzi w liściach chryzantem oraz wielomianowa linia trendu zawartości

concentrations of cuprum and boron were recorded in the leaves of plants grown in cycles 1 and 10–12 (beginning, respectively in May and from October to December 2002). The lowest content of iron was usually found in the leaves of plants grown in cycles 1–3 and 12, however the lowest concentration of cuprum and boron was in plants from cycles 4–7.

The above findings are corroborated by figures 1–3 presenting the dependence between the time of culture and the nutritional status of the chrysanthemums in the form of multinomial statistical trend lines. Their shapes for cuprum and boron, are the reverse of the multinomial trend lines of real insolation. However, much the same form to a real insolation trend line has multinomial trend line for iron (fig. 4). Maximum contents of cuprum and boron were recorded in the leaves of chrysanthemums grown in periods of light deficit. Similar results obtained Breś and Jerzy [2004b] in case of nitrogen, potassium and calcium. Inverse dependence for iron was observed: in the months of the highest insolation, the content of iron was also higher.

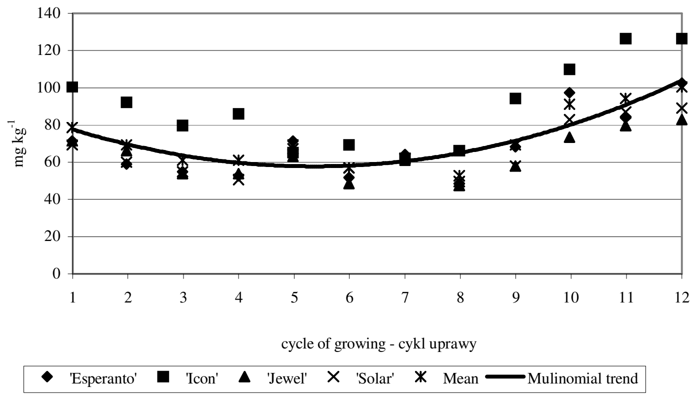

Figure 3. Content of boron in the chrysanthemums leaves and its multinomial trend
Rycina 3. Zawartość boru w liściach chryzantem oraz wielomianowa linia trendu

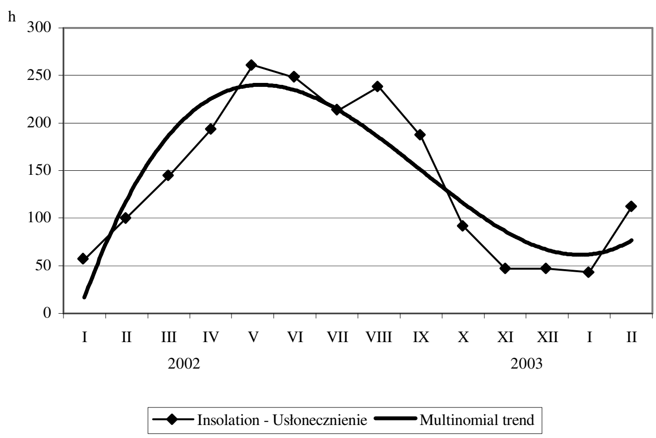

Figure 4. Real insolation from January 2002 to February 2003
Rycina 4. Usłonecznienie rzeczywiste od stycznia 2002 do lutego 2002 r.

There is no specific quide or critical values for chrysanthemums from Time group cultivated all-year-round. For this reason the results of the analyses of the chrysanthemum leaves were compared with recommendations by various authors worked out for traditional and hydroponic methods of culture (tab. 3). Different recommendations of authors cause that the evaluation of nutrient content in the leaves of chrysanthemums is also varied. According to Adams et al. [1975] and Lunt et al. [1964], the plants were well fed with boron, however according to Smilde [1975] boron concentration in leaves shall be classified as insufficient. Content of cuprum was sufficient [Adams et al. 1975] but according to Sapetto [1971] the plants were underfed. The chrysanthemums leaves contained insufficient amount of iron [Sapetto 1971] and simultaneously were well fed with that nutrient [Lunt et al. 1964].

Table 3. Comparison of results of chemical leaves analysis to the range of micronutrient levels recommended by the selected authors

Tabela 3. Porównanie wyników analizy chemicznej liści z zawartościami mikroelementów zalecanymi przez wybranych autorów

Nutrient Składnik	Recommended values $mg \cdot kg^{-1}$ d.m. Zalecane zawartości $mg \cdot kg^{-1}$ s.m.	Percentage part of samples included in the recommended range Procentowy udział prób mieszczących się w zalecanym zakresie	Authors Autorzy
Fe	97-130	33	Adams et al. 1975
Cu	5-14	96	
B	>20	100	
B	25-80	78	Kreij et al. 1990
Fe	100-173	73	Lunt et al. 1964
Cu	8.5-10	28	
B	25-200	100	
Fe	500-1000	0	Sapetto 1971
Cu	25-75	0	
B	50-100	86	
Fe	154-432	27	Smilde 1975
Cu	6-10	78	
B	20-30	0	

The wide discrepancies among recommendations of the particular authors prove that it is necessary to work out new guide values or critical nutrient levels for diagnostic purposes in the culture of chrysanthemums of the Time group. They have to accommodate the time of culture (insolation) and the specific system of fertilisation combined with irrigation.

CONCLUSIONS

1. The content of iron, cuprum and boron in the leaves of pot chrysanthemums from the Time group depend on the time of culture and the real insolation: maximum contents of cuprum and boron were in periods of light deficit; inverse dependence occurred in case of iron.

2. The critical levels of microelements recommended for conventional and hydroponic methods of culture are of little use for diagnosing the nutritional status of the Time group chrysanthemums in all-year-round culture.

3. It is necessary to work out new micronutrient guide values for the Time group chrysanthemum in all-year-round culture.

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WPŁYW TERMINU SADZENIA ROŚLIN NA STAN ODŻYWIENIA MIKROSKŁADNIKAMI DONICZKOWYCH ODMIAN CHRYZANTEM Z GRUPY TIME W UPRAWIE CAŁOROCZNEJ

Streszczenie. Badano całkowitą zawartość żelaza, miedzi i boru w liściach czterech odmian chryzantem w 12 cyklach uprawowych rozpoczynających się drugiego dnia każdego miesiąca roku: od stycznia do grudnia. Od momentu posadzenia, rośliny traktowano dniem krótkim. W okresach naturalnego długiego dnia stosowano zaciemnianie, uzyskując dzień 10,5-godzinny. Nie stosowano doświetlania roślin. Termin uprawy i związane z tym usłonecznienie istotnie wpłynęły na zawartość mikroskładników. Największą zawartość miedzi i boru stwierdzono w liściach chryzantem uprawianych w okresie niedoboru światła. Odwrotną zależność stwierdzono w przypadku żelaza.

Słowa kluczowe: *Dendranthema grandiflora*, fertygacja, mikroelementy, uprawa całoroczna

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