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CONTENT OF SULPHUR IN LEAVES OF CHRYSANTHEMUMS FROM THE TIME GROUP IN THE ALL YEAR-ROUND CULTURE

Włodzimierz Breś, Jerzy Roszyk

Department of Horticultural Plant Nutrition, Agricultural University, Poznań

Introduction

The diagnostics of the nutritional status of chrysanthemum *(Dendranthema grandiflora* TZVELEV, *syn. Chrysanthemum x grandiflorum* /RAMAT./ KITAM.) is based on the knowledge of the basic micro- and macroelements in leaves. Publications referring to the critical nutrients content for chrysanthemum are rather numerous, however, they usually refer to the basic macroelements. There are very few papers dealing with the sulphur content in the plant. The reason for this may be the difficulties in sulphur determination. Symptoms of the deficiency of this element, although seldom, are misinterpreted as symptoms of nitrogen deficiency or sulphur shortage. A great effect on the appearance of the plant may be also exerted by the deficiency of light. The objective of this work was the determination of the range of changes in sulphur content in the leaves of chrysanthemum from the Time group in the all year-round culture.

Material and methods

The experiment with eleven chrysanthemum cultivars from the Time group (Tab. 1) included 12 growing cycles. The first cycle started on January 2, 2002. The successive cycles started on the 2nd of February, 2nd of March and so on. Plants were cultivated in peat medium with the use of fertigation system. In pots of 14 cm diameter 5 seedlings were planted. From the day of potting, the plants were treated with a short day regime. In the periods of a natural long day, a 10,5-hour day was obtained by plant shading. In periods of light deficiency, no supplementary assimilation light was used. The chrysanthemum plants were nourished by the following nutritional solution ($mg \cdot dm^{-3}$): $N\text{-}NO_3$ 211.8; P 5.7; K 291.2; Ca 87.8; Mg 53.0; $S\text{-}SO_4$ 93.5; Fe 2.711; Mn 0.875; Zn 0.489; Cu 0.070; B 0.295; pH 5.5; EC 2.2 $mS \cdot cm^{-1}$. In summer, the EC value of the nutrition was decreased to 1.8 $mS \cdot cm^{-1}$. Solutions were prepared using rain water. The chrysanthemums were retarded using the preparation B-Nine 85 SP at a concentration of 0.3%. For chemical analyses, samples were taken from fully developed

leaves when 30% of inflorescences were developed. After mineralization of plant material in acids, sulphur content was determined using the nephelometric method. On the basis of the results of chemical analyses of leaves, a regression equation was made and regression coefficients as well as coefficients of variants were calculated.

Results and discussion

Critical contents of sulphur in chrysanthemum leaves recommended by different authors show a wide range. The widest range is recommended by LUNT et al. [1964]: 0.3–0.75% S (DM). In the here presented experiments, during all year-round culture, the mean sulphur content in chrysanthemum leaves from Time group ranged between 0.25 and 0.45% S (Table 1). Similar results were obtained by MACZ et al. [2001a], who defined the leaf S concentration of 0.3–0.5% as acceptable levels of the produced commercial quality pot chrysanthemums. According to the quoted authors, in controlled cultivation such range is proper for the plants during the whole period of growth and development of chrysanthemums cultivated in pots. However, this statement is a far going simplification. Figure 1 shows that sulphur concentration in chrysanthemum leaves changes during the year. The highest sulphur contents (0.35–0.45% S) were found in the periods of natural light deficiency, i.e. in November-February. In months with better light conditions, the S content ranged from 0.25 to 0.35%. The obtained results are a confirmation of the observations made by HUANG et al. [1997], who argued that sulphur deficiency symptoms can appear below 0,17% S in spring and

Table 1; Tabela 1

Content od sulphur in the chrysanthemum leaves (% DM)
Zawartość siarki w liściach chryzantem (% s.m.)

Cultivar Odmiana	Beginning of cultivation in 2002: Początek uprawy w roku 2002											
	2 I	2 II	2 III	2 IV	2 V	2 VI	2 VII	2 VIII	2 IX	2 X	2 XI	2 XII
Brill Time	0.553	0.416	0.443	0.394	0.419	0.275	0.306	0.248	0.316	0.318	0.510	0.400
Cool Time	0.374	0.503	0.418	0.316	0.300	0.245	0.244	0.260	0.231	0.264	0.343	0.366
Deram Time	0.338	0.435	0.478	0.484	0.245	0.212	0.244	0.226	0.304	0.311	0.445	0.396
Energy Time	0.467	0.377	0.455	0.414	0,288	0.211	0.249	0,267	0.301	0.355	0.335	0.464
Esperanto Time	0.486	0.436	0.443	0,414	0.302	0.255	0.278	0,314	0.316	0.326	0.323	0.377
Icon Time	0.420	0.416	0.459	0,487	0.297	0,312	0.225	0.491	0.282	0.300	0.328	0.285
Jewel Time	0.391	0.392	0.453	0,464	0,291	0.238	0.296	0.299	0.273	0.286	0.245	0.342
Solar Time	0.362	0.304	0.407	0.400	0.244	0.250	0.234	0.216	0.242	0.233	0.365	0.342
Tatoo Time	0.367	0.409	0.421	0.476	0,275	0.281	0.232	0.285	0.286	0.263	0.280	0.277
Tea Time	0.434	0.329	0.452	0.293	0.276	0.228	0.241	0.280	0.202	0.240	0.321	0.289
Quarz Time	0.582	0,523	0,443	0.414	0.332	0.307	0.241	0.292	0,251	0.331	0.293	0.414
Mean value Zawartość średnia	0.434	0.413	0.443	0.414	0.297	0.256	0.253	0.289	0.273	0.293	0.344	0.359
Variation coefficients (%): Współczynnik zmienności (%)	9.45	15,01	11.96	18.35	15.49	14.06	10.28	24.22	13.55	13.99	20.63	16.16

below 0.27% S in fall. Variation coefficients calculated for the whole population in the particular growing cycles indicate that sulphur content in the studied chrysanthemum cultivars did not differ significantly from each other (coefficients from 9 to 20%). A slight deviation recorded in August in case of Icon Time cultivar caused an increase of the coefficient value to 24%.

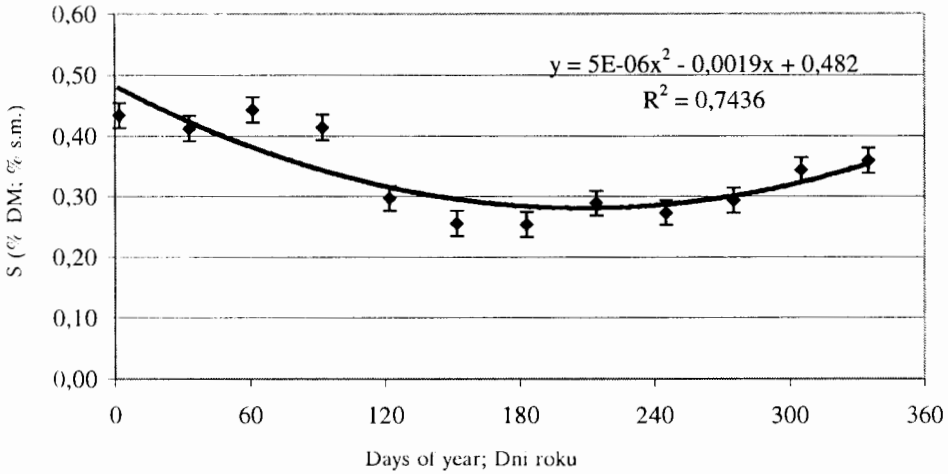

Fig. 1. Content of sulphur in chrysanthemum leaves in 12 growing cycles (% DM – mean values for 12 cultivars)

Rys. 1. Zawartość siarki w liściach chryzantem w 12 cyklach uprawy (% s.m. – wartości średnie z 11 odmian)

Changes in sulphur content during the year are best illustrated by the multinomial statistical trend line determinate on the basis of leaf analysis of the studied chrysanthemum cultivars in 12 production cycles (Fig. 1). The course of the line is similar to multinomial trend lines representing the content of nitrogen, potassium and calcium in chrysanthemum leaves, reversely to the multinomial trend line of real insolation [BREŚ, JERZY 2004]. Interdependence between the cultivation term (independent variable = day of the year) and sulphur content in chrysanthemum leaves is represented by the curvilinear regression equation (Fig. 1). The high regression coefficient (r = 0.7436) is a confirmation of these dependences.

Some publications referring to sulphur in chrysanthemums focus on the interdependence of the fertilization with nitrogen and sulphur. According to MACZ et al. [2001b], S application in soilless peat-based medium should be included in the fertilization program of pot chrysanthemums. Regardless of N amount applied, lack of sulphur produced a very low leaf N and S concentration, yellowish foliage, stunted plants, minimal leaf area, delayed bud set and late first flower colour. The experimental results of HUANG et al. [1997] and MACZ et al. [2001b] indicate that N application can be reduced when adequate S levels are incorporated in the fertilization program of chrysanthemums. Similar conclusions are presented by ADAMS et al. [1998] and DALE et al. [1991] in their publications referring to poinsettia. The studies of HUANG et al. [1997] and MACZ et al. [2001a] also referred to changes of sulphur during one production cycle after short day

initiation (SDI). The highest leaf S concentration recorded 5–6 weeks after SDI initiation. The lowest – 3 weeks after SDI, when flower buds were in the setting stage.

Conclusions

1. The light conditions effect the content of sulphur in chrysanthemum leaves.
2. Values in the range of 0.25–0.45% S DM can be accepted as guide values in the leaves of chrysanthemums from the Time group in all year-round culture.
3. Investigated chrysanthemum cultivars from the Time group do not differ in the sulphur content of their leaves.

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Key words: chrysanthemum, sulphur, guide values, all-year-round culture

Summary

The determination of the range of changes in the sulphur content in chrysanthemum (*Dendranthema grandiflora* TZVELEV, *syn. Chrysanthemum x grandiflorum* /RAMAT./ KITAM.) leaves of Time group in the all year-round culture was studied. The studies were carried out in 2002. The experiment included 12 gro-

wing cycles with 11 chrysanthemum cultivars. The first cycle was initiated on January 2, 2002. The successive cycles were started on February 2, March 2, and so on. Plants were grown in peat medium using fertigation system. From the day of potting, chrysanthemums were treated with a short day regime. In periods of natural long days, a 10.5-hour day was obtained by applying shading. In the period of light deficiency no supplementary assimilation light was used. In chrysanthemum leaves, after mineralization in strong acids, the total content of sulphur was determined by nephelometric method. The content of the studied element oscillated in the range of 0.25–0.45% S DM. Sulphur content depended on light conditions. The highest content was found in periods of natural light deficiency (November-February), while the lowest content was identified in months with better light conditions.

ZAWARTOŚĆ SIARKI W LIŚCIACH CHRYZANTEM Z GRUPY TIME W UPRAWIE CAŁOROCZNEJ

Włodzimierz Breś, Jerzy Roszyk
Katedra Nawożenia Roślin Ogrodniczych,
Akademia Rolnicza im. A. Cieszkowskiego w Poznaniu

Słowa kluczowe: chryzantema, siarka, zawartości wskaźnikowe, uprawa całoroczna

Streszczenie

Określono zakres zmian zawartości siarki w liściach chryzantem (*Dendranthema grandiflora* TZVELEV, *syn. Chrysanthemum x grandiflorum* /RAMAT./ KITAM.) z grupy Time w całorocznej uprawie. Badania przeprowadzono w roku 2002. Doświadczenie obejmowało 12 cykli uprawowych z 11 odmianami chryzantem. Pierwszy cykl zapoczątkowano 2 stycznia 2002 roku. Kolejne cykle rozpoczynano 2 lutego, 2 marca itd. Rośliny uprawiano w substracie torfowym z wykorzystaniem fertygacji. Od momentu posadzenia chryzantemy traktowane były dniem krótkim. W okresach naturalnego długiego dnia, stosując zaciemnianie, uzyskiwano dzień 10,5 godzinny. Nie stosowano doświetlania asymilacyjnego w okresie niedoboru światła. W liściach chryzantem po mineralizacji materiału w silnych kwasach oznaczono całkowitą zawartość siarki metodą nefelometryczną. Zawartość badanego pierwiastka mieściła się w zakresie 0,25–0,45% S (s.m.). Zawartość siarki zależała od warunków świetlnych. Najwyższe zawartości stwierdzono w okresach naturalnego deficytu światła (listopad – luty), natomiast najniższe w miesiącach, w których panują lepsze warunki świetlne.

Dr hab. Włodzimierz **Breś**, prof. AR
Katedra Nawożenia Roślin Ogrodniczych
Akademia Rolnicza im. A. Cieszkowskiego
ul. Zgorzelecka 4
60–198 POZNAŃ