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RESPONSE OF CHRYSANTHEMUMS FROM TIME GROUP TO DIFFERENTIATED NITROGEN AND POTASSIUM FERTILIZATION IN CONTROLLED CULTIVATION

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Abstract. Studies were carried out in the years 2003–2004 in a greenhouse. Three nutrient solutions with differing contents of nitrogen and potassium for chrysanthemum fertigation were used. Influence of used fertilization on growth and development of plants data was very limited. No effect of the studied nutrient solutions on plant flowering term was found. For the fertigation of chrysanthemums from Time group grown from April till October in peat substrate nutrient solution containing 150–180 mg $N\text{-}NO_3 \cdot dm^{-3} \cdot$and 210–252 mg $K \cdot dm^{-3} \cdot$is recommended.

Key words: chrysanthemum, nutrient solution, nitrogen, potassium

INTRODUCTION

Chrysanthemums (*Chrysanthemum* × *grandiflorum* /Ramat./ Kitam.) form Time group can be grown all year round. One cycle of controlled cultivation lasts 60–80 days. In a comparatively short period, the chrysanthemums should be given adequate amount of nutritive components. Different authors have published compositions of nutrient solution elaborated for classic, hydroponic or thin-layer flow cultures. However, there is no information concerning the fertilization specificity of chrysanthemums from 'Time' group. The objective of the presented work was the evaluation whether three proposed nutrients differing by their content of nitrogen and potassium are useful for the fertigation of the mentioned chrysanthemum group.

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MATERIAL AND METHODS

Studies were carried out in the years 2003–2004 in a greenhouse equipped with a computer system control of day length. Day length was shortened to 10 hours (from 7:00 to 17:00) from the moment of cultivation start. For darkening purposes, material of OBSCURA A/B+B type was used. In the experiments 3 cultivars of chrysanthemum from the Time group were used: 'Doing Time', 'Jewel Time White', 'Swing Time Improved'. Plants were fertilized using individual drop irrigation system. Frequency of nutrient supply was controlled with Soltimer energy meter. Each year, two experimental cycles were carried out – the first one (conventionally called the spring season cycle) lasted from mid-April till the end of June, the second one (summer-autumn season) lasted from mid-August till the end of October. The plants were retarded using the preparation B-Nine 85 SP. Exact terms of the particular experiments duration and a detailed schedule of treatments is shown in table 1. Chrysanthemums were grown in a mixture of limed raised peat and coconut fibre (v/v = 9:1), in pots with 14 cm diameter filled with 0.71 dm^3 substrate. In each pot 5 plants were grown. Three nutrient solutions with differing contents of nitrogen and potassium were used (tab. 2).

Table 1. Timetable of experiments
Tabela 1. Harmonogram doświadczeń

Treatment Traktowanie	Growing season Termin uprawy			
	2003		2004	
	spring wiosna	summer-autumn lato-jesień	spring wiosna	summer-autumn lato-jesień
Beginning of pot cultivation Sadzenie do doniczek	14:04	20:08	22:04	16.08
Topping Uszczykiwanie	19:04	25:08	27:04	21.08
I Retardation I Skarlanie	05:05	03:09	06:05	02:09
II Retardation II Skarlanie	19:05	-	24:05	-
Beginning of florescence Początek kwitnienia	23–25:06	15–17:10	28–30.06	20–23:10

The usefulness of nutrients was determined on the basis of 4 features, when the plant fully developed 5 flower buds: flower height, flower width (maximal diameter of 5 plants growing in the pot and measured according to vertical projection), number of inflorescences (fully developed and also in the stage of coloured, half open flower bud), the diameter of five fully developed inflorescences). For statistical assessment, Tuckey mean separation test was used. Calculations were made only for nutrient solutions and for season of growing without differentiation of chrysanthemum cultivars.

Table 2. Content of components in nutrient solution used in experiments (mg·dm^{-3})
Tabela 2. Zawartość składników w pożywce zastosowanej w doświadczeniach (mg·dm^{-3})

Nutrient Składnik	Nutrient solution mg·dm^{-3} Pożywka mg·dm^{-3}		
	I	II	III
N- NH_4	>10	>10	>10
N –NO_3	150	180	210
P	40	40	40
K	210	252	294
Ca	100	100	100
Mg	40	40	40
Fe	2.5	2.5	2.5
Mn	1	1	1
Zn	0.4	0.4	0.4
Cu	0.1	0.1	0.1
B	0.3	0.3	0.3
Mo	0.048	0.048	0.048
pH	5.5	5.5	5.5
EC (mS·cm^{-3})	1.5	1.8	2.2

RESULTS AND DISCUSSION

Fertilization is one of the factors conditioning the growth and flowering of chrysanthemums. In consequence, it exerts an effect also on plant quality. Nutrient solutions for chrysanthemums used by different authors differ amount others by the contents of nitrogen and potassium (tab. 3) – for N-NO_3 from 91 to 200 and for K from 176 to 500 mg·dm^{-3}.

In the presented work, nutrient solutions containing from 150 to 210 mg N-NO_3 and 210 to 294 mg K·dm^{-3} were studied. Their influence on the growth and development of plants is presented in tables 4 and 5. No differences in plant height and width were found. The number of inflorescences and diameter of inflorescences did not depend on the applied nutrient, or more favourable parameters were recorded in plants fertilized with nutrient solution I and II. Furthermore, no effect of nutrient solutions on the term of plant flowering was recorded (tab. 1).

Table 3. Content of N-NO_3 and K recommended by the different authors
Tabela 3. Zawartości N-NO_3 i K w pożywce zalecane przez różnych autorów

Authors Autorzy	Growing system Sposób uprawy	N-NO_3	K
		mg·dm^{-3}	
Barabosa et al. 2000	hydroponic in expanded clay	200	500
Bouwalda et al. 1995	ebb and flow	91	176
Breś 1998	hydroponic, soilless culture	160	220
Hicklenton et al. 1987	hydroponic	154	196
Sakamoto et al. 2001	sheet culture and deep flow technique	116	149
Sonneveld and Straver 1994	hydroponic, recirculation system	147	195
Wilson and Finley 1995	hydroponic, sand	150	250

Table 4. Influence of nutrient solutions on growth and development of chrysanthemums cultivated in year 2003
Tabela 4. Wpływ pożywek na wzrost i rozwój chryzantem uprawianych w roku 2003

Season Pora roku	Cultivar Odmiana	Nutrient solution Pożywka	Hight of plants Wysokość roślin cm	Width of plants Szerokość roślin cm	Number of inflorescences Liczba koszyczków kwiatostanowych	Diameter of inflorescences Średnica koszyczka cm
Spring 2003 Wiosna 2003	'Doing Time'	I	16.85	27.08	24.62	5.60
		II	19.35	29.31	26.68	5.82
		III	19.55	28.60	24.18	5.32
	'Jewel Time White'	I	20.0	31.43	23.93	5.56
		II	20.45	29.93	25.12	5.90
		III	18.4	30.43	30.17	5.57
	'Swing Time Improved'	I	21.5	30.19	24.63	5.60
		II	20.55	31.62	25.56	5.77
		III	20.3	31.43	23.81	5.94
	Mean value Średnia	I	19.45a	29.57a	24.39a	5.59a
		II	20.12a	30.29a	25.79a	5.83a
		III	19.42a	30.15a	26.05a	5.61a
Autumn 2003 Jesień 2003	'Doing Time'	I	16.85	27.93	20.5	5.59
		II	19.35	27.93	21.87	5.39
		III	18.65	26.25	16.5	5.71
	'Jewel Time White'	I	20.0	24.68	19.18	6.41
		II	20.45	24.81	18.56	6.42
		III	18.4	23.68	17.25	6.86
	'Swing Time Improved'	I	21.15	22.5	17.87	5.39
		II	20.55	26.12	19.75	5.06
		III	20.3	24.93	15.0	5.17
	Mean value Średnia	I	19.33a	25.04a	19.18a	5.80a
		II	20.12a	26.29a	20.06a	5.62a
		III	19.12a	24.95a	16.25b	5.91a

Values marked with the same letter no differ
Wartości oznaczone tymi samymi literami nie różnią się istotnie

Table 5. Influence of nutrient solutions on growth and development of chrysanthemums cultivated in year 2004
Tabela 5. Wpływ pożywek na wzrost i rozwój chryzantem uprawianych w roku 2004

Season Pora roku	Cultivar Odmiana	Nutrient solution Pożywka	Hight of plants Wysokość roślin cm	Width of plants Szerokość roślin cm	Number of inflorescences Liczba koszyczków kwiatostanowych	Diameter of inflorescences Średnica koszyczka cm
Spring 2004 Wiosna 2004	'Doing Time'	I	18.93	31.25	37.11	7.23
		II	18.87	30.12	37.69	6.5
		III	19.31	32.0	35.37	6.48
	'Jewel Time White'	I	18.31	30.37	31.18	7.38
		II	18.31	30.37	30.12	7.32
		III	18.50	30.68	26.12	6.63
	'Swing Time Improved'	I	19.68	27.93	27.31	6.25
		II	19.43	28.12	24.46	5.17
		III	19.50	26.75	25.18	5.83
	Mean value Średnia	I	18.97a	29.85a	31.87a	6.95a
		II	18.87a	29.54a	30.75a	6.33a
		III	19.10a	29.81a	28.89a	6.31a
Autumn 2004 Jesień 2004	'Doing Time'	I	18.25	25.81	20.81	5.77
		II	18.25	26.25	23.12	7.23
		III	18.00	29.56	22.68	5.93
	'Jewel Time White'	I	15.31	21.37	14.87	5.51
		II	15.37	23.68	16.0	6.27
		III	16.00	23.43	14.18	5.48
	'Swing Time Improved'	I	18.12	25.00	18.81	5.85
		II	18.56	25.12	21.87	6.62
		III	20.68	25.25	18.87	5.62
	Mean value Średnia	I	17.23a	24.06a	18.16a	5.71b
		II	17.39a	25.02a	20.33a	6.71a
		III	18.23a	26.08a	18.58a	5.68b

Values marked with the same letter no differ
Wartości oznaczone tymi samymi literami nie różnią się istotnie

On the other hand, the cultivation term (tab. 6) had an effect on plant height (year 2004), on plant diameter (2003 and 2004), on the number of inflorescences (2003 and 2004) and on the diameter of inflorescences (2004) – collected data usually were more favourable for chrysanthemums when grown in spring. The results of plant height and inflorescence diameter are not explicit. Most probably it follows from the fact that the vegetative growth and the generative development of chrysanthemums depends on many factors including temperature and the amount and quality of light [Heuvelink et al. 2002, Jerzy and Borkowska 2004, Lee et al. 2002, LePage et al. 1984, Nothnagl et al. 2004]. For example, in year 2004 solar radiation measured from 7:00 A.M. to 5:00 P.M. during the whole growing cycle showed in spring 955 $MJ \cdot m^{-2}$ and in autumn 645 $MJ \cdot m^{-2}$.

Table 6. Effect of growing season on growth and development of chrysanthemums
Tabela 6. Wpływ terminu uprawy na wzrost i rozwój chryzantem

Growing season Termin uprawy	Height of plants (cm) Wysokość roślin (cm)	Width of plants (cm) Szerokość roślin (cm)	Number of inflorescences Liczba koszyczków kwiatostanowych	Diameter of inflorescences (cm) Średnica koszyczka kwiatowego (cm)
Spring 2003 Wiosna 2003	19.66a	30.00a	25.41a	5.68a
Autumn 2003 Jesień 2003	19.52a	25.43b	18.50b	5.78a
Spring 2004 Wiosna 2004	18.98a	29.73a	30.50a	6.53a
Autumn 2004 Jesień 2004	17.62b	25.05b	19.02b	6.03b

In the subjective literature, there is no explicit information about the optimal composition of the nutrient for chrysanthemums from Time group grown in organic substrates. The difficulty in the definition of an optimum results among others from the specificity of the culture: day length shortened to 10 hours, small amount of substrate in pots, several plants in one pot, short period of culture. On the basis of studies, the authors of this work recommend for chrysanthemums from Time group grown in the period from April to October (controlled cultivation) in organic substrate the following contents of nitrogen and potassium in nutrient solution: 150–180 mg $N\text{-}NO_3$ and 210–252 mg $K \cdot dm^{-3}$. The application of nutrient with the highest content of $N\text{-}NO_3$ and K has been found unjustified and not agreeing with the principles of ecology. Watering of plants using low concentration solutions is the basis advantage of fertigation. For practical horticultural purposes, the maintaining of N and K contents in the determined range is easier than to observe rigid recommendations. It is connected with the possibility of making a choice among the available multicomponent fertilizers.

Moreover, excessive nitrogen fertility can increase insect populations. According to Davies et al. [2004] aphid abundance of chrysanthemum leaves was greatest at high nitrogen doses. Fertility affected also the vertical distribution of aphids: a higher population was observed in physiologically mature and older leaves at low fertility, whereas at high fertility young leaves had 33% more insects than the older, basal leaves [Chau et al. 2005]. Correct fertilization with potassium exerts an effect also on plant health. Soy-

bean plants with potassium deficiency symptoms had a higher density of aphids than plants without deficiency symptoms. A possible mechanism for this relationship is that potassium deficiency improves the nitrogen nutrition of these N-limited insects. By releasing these herbivores from N limitation, host plant potassium deficiency may allow soybean aphid populations to reach higher levels more rapidly in the field [Walter and Difonzo 2007]. In the presented experiments no intensification of aphids occurrence was recorded.

CONCLUSIONS

1. For the fertigation of chrysanthemums from Time group grown from April till October in peat substrate nutrient solution containing 150–180 mg $N\text{-}NO_3$ and 210–252 mg K dm^{-3} should be recommended.

2. No effect of the studied nutrient solutions on plant flowering term was found.

3. Nitrogen and potassium in examinated ranges of ions concentrations had no effect on height and width of plants, number and diameter of inflorescences. Growth and development of chrysanthemum from Time group depended first of all from the term of plants growing.

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REAKCJA CHRYZANTEM Z GRUPY 'TIME' NA ZRÓŻNICOWANE NAWOŻENIA AZOTEM I POTASEM W UPRAWIE STEROWANEJ

Streszczenie. Badania prowadzono w latach 2003–2004 w warunkach szklarniowych. Do fertygacji chryzantem zastosowano trzy pożywki różniące się zawartością azotu i potasu. Wpływ zastosowanego nawożenia na wzrost i rozwój roślin był bardzo ograniczony. Nie odnotowano także wpływu badanych pożywek na termin kwitnienia roślin. Dla chryzantem uprawianych w okresie od kwietnia do października (uprawa sterowana) w podłożu organicznym zaleca się stosowanie pożywki zawierającej od 150 do 180 mg $N\text{-}NO_3$ i od 210 do 252 mg K dm^{-3}.

Słowa kluczowe: chryzantemy, pożywka, azot, potas

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