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Effect of the planting date on the quality of pot chrysanthemums from the Time group in all-year-round culture

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ABSTRACT

The quality of the flowering plants 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. No supplementary light was used. The plants which attained the highest quality were those potted between February and September and flowering between April and November, respectively, when real insolation amounted to 200-250 hours per month. In the autumn-winter season when the amount of insolation fell by half, the quality of flowering plants declined dramatically. Hence, planting dates between October and January were judged unfit for the start of controlled cultivation of pot cultivars of chrysanthemums.

INTRODUCTION

Photoperiodic control of the growth and flowering of chrysanthemums makes it possible to cultivate them all-year-round. By lengthening a short day through supplementary illumination or shortening a long one through shading, one can keep the plants in the vegetative or the generative stage, and so delay or bring forward their blooming (Strojny 1989, Machin 1997).

In Europe, the centres of the controlled cultivation of pot cultivars of chrysanthemums are England, the Netherlands, and Denmark. Recently it has been gaining increasing popularity in Poland, too. Many growers have managed to achieve several harvests annually, from spring to autumn, through photoperiodic control. All-year-round culture with supplementary light in the autumn-winter period of insolation deficit is still rare (Jerzy and Borkowska 2003, Jerzy et al. 2004). The rich offer of new, highly attractive chrysanthemum cultivars from the Time group, whose common feature is a short photoperiodic response (7-8 weeks) and which display a rich variety of bloom colours and shapes, is likely to change this situation.

It is, however, necessary to identify those periods in the year when the controlled cultivation of pot chrysanthemums from the Time group yields the best results. This was the aim of the research reported in the present paper.

MATERIAL AND METHODS

The experiment was conducted in greenhouse conditions from 2 January 2002 to 9 March 2003. The material was four pot cultivars of the chrysanthemum *Dendranthema grandiflora* Tzvelev (syn. *Chrysanthemum* × *grandiflorum* /Ramat./ Kitam.) from the Time group, bred by the English firm Cleangro and differing in growth vigour, colour, structure of inflorescences, and photoperiodic response: ‘Esperanto Time’, ‘Icon Time’, ‘Jewel Time’, and ‘Solar Time’. The characteristics of the cultivars are listed in Table 1.

Table 1. Characteristics of chrysanthemum cultivars

Cultivar	Photoperiodic response (days)	Inflorescence		Growth vigour
		colour	type	
‘Esperanto Time’	53	white – pink	single, spoon	medium
‘Icon Time’	53	purple – cream	single	medium
‘Jewel Time’	49	cream	full, decorative	small
‘Solar Time’	60	golden	single	medium

Cuttings were obtained from stock plants previously regenerated *in vitro*. Starting with 2 January 2002, on the second day of each successive month of the year, cuttings of all cultivars were planted into pots 14 cm in diameter, 5 cuttings per pot. In each of the 12 production cycles, the number of pots (replications) was 20. 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 through shading. No supplementary illumination was used from November to mid-February (a photoperiod of under 10 hours) to improve light conditions in the period of insolation deficit. In summer, when the night temperature outside the greenhouse exceeded 15°C, the blackout covers opened 2 hours after sunset and closed 2 hours before sunrise to reduce the humidity and temperature inside. Real insolation over the research period is shown in Fig. 1, while Fig. 2 presents the temperatures of the greenhouse air.

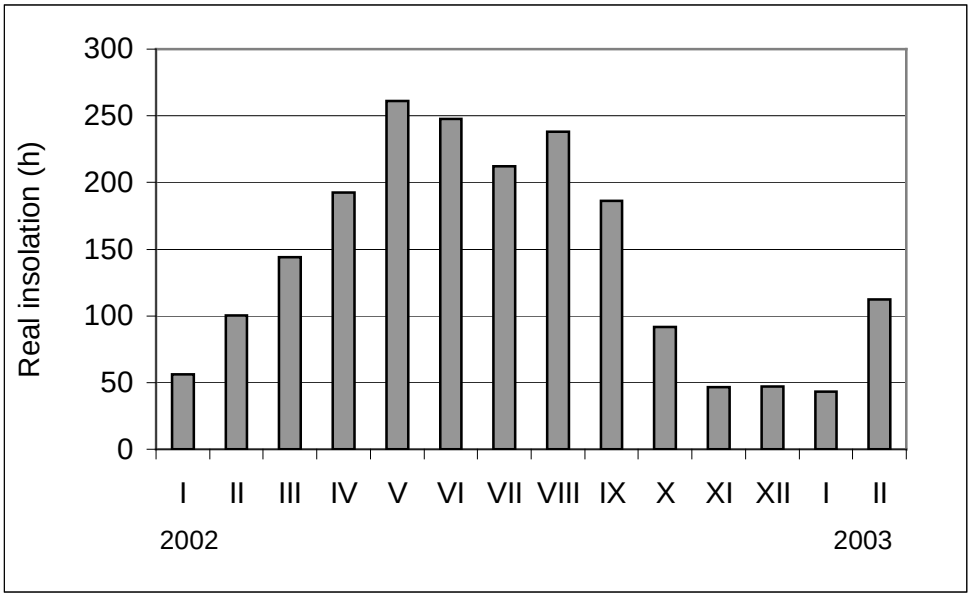

Figure 1. Real insolation from January 2002 to February 2003

The plants were grown in a peat substrate (80% white peat, 15% mixed peat, 5% clay by volume) mixed with PGMix and Radigen fertilisers. The pots with cuttings were placed in a soil bed at a 30 × 30 cm spacing in a diagonal pattern (9 pots m^{-2}). For the first few days after potting, the plants were sprinkled with water; later this practice was replaced with drip fertigation. The plants were fed once, usually with 160 cm^3 of the solution per pot, with the feeding frequency depending on weather conditions. The chrysanthemums were also fed with carbon

dioxide. The gas concentration was kept at 1.1-1.2 μl dm^{-3} with closed ventilators, and at 550-600 μl dm^{-3} with opened ones.

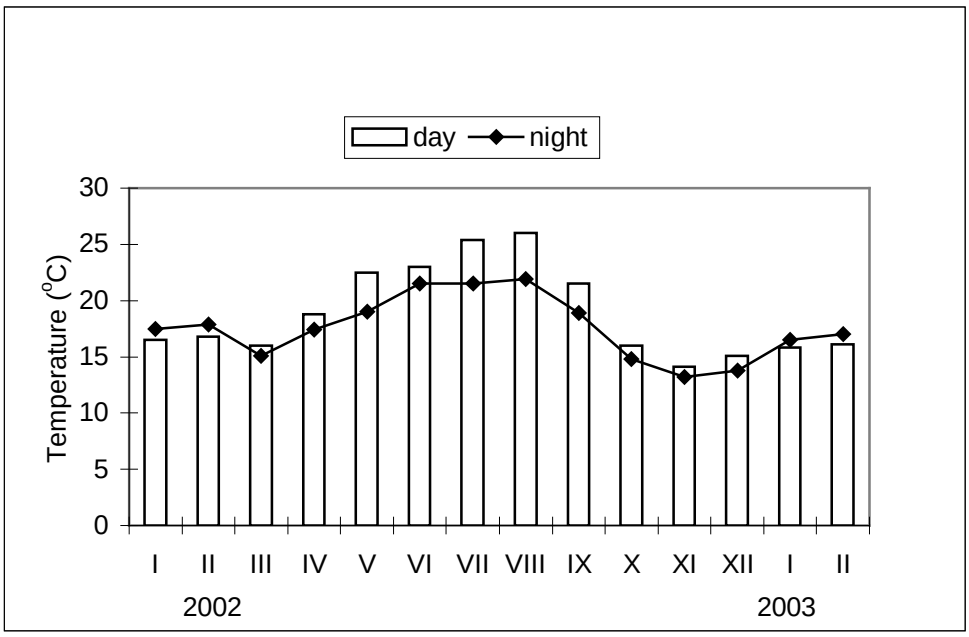

Figure 2. Air temperature in glasshouse from January 2002 to February 2003

Five days after potting, 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 at a concentration of 0.3%. The treatment was applied first when lateral shoots (after pinching the main stem) attained a length of 10-15 mm. Two further treatments were given every 7-10 days. Because of severe retardation and weakening of the plant growth, B-Nine was not applied in cycle 11 (planting on 2 November). For the same reason, all cultivars from cycle 12 (planted on 2 December) were only treated with B-Nine once, when flower buds appeared on lateral shoots 5-7 cm long.

In the experiment the following features were studied: number of inflorescences (developed and undeveloped), size of inflorescences assessed on the basis of measurement of the diameter of five biggest inflorescences in a pot, height of the above-ground parts of plants, flower colour, and plant habit. Measurements and observations were carried out when the plants were in full flower (half of all the inflorescences were fully opened). The terms of flowering are presented in Table 2.

Table 2. The terms of chrysanthemums flowering depending on cultivar and term of cultivation

Cultivar	Beginning of pot cultivation in shortday glasshouse (in 2002)											
	2 Jan.	2 Feb.	2 Mar.	2 Apr.	2 May	2 Jun.	2 Jul.	2 Aug.	2 Sept.	2 Oct.	2 Nov.	2 Dec.
'Esperanto Time'	5 Mar.	30 Mar.	26 Apr.	4 Jun.	6 Jul.	20 Aug.	7 Sep.	1 Oct.	29 Oct.	11 Dec.	23 Jan.	12 Feb.
'Icon Time'	18 Mar.	5 Apr.	9 May	11 Jun.	27 Jul.	11 Sep.	18 Sep.	5 Oct.	4 Nov.	7 Dec.	20 Feb.	28 Feb.
'Jewel Time'	9 Mar.	2 Apr.	30 Apr.	27 May	26 Jun.	14 Aug.	4 Sept.	25 Sep.	28 Oct.	10 Dec.	20 Feb.	28 Feb.
'Solar Time'	11 Mar.	2 Apr.	4 May	10 Jun.	15 Jul.	28 Aug.	12 Sep.	4 Oct.	31 Oct.	10 Dec.	31 Jan.	17 Feb.

The measurement results were processed statistically with the use of the univariate analysis of variance. To evaluate the significance of differences among means at the $p = 0.05$ significance level, Duncan's test was employed.

RESULTS

The quality of the four chrysanthemum cultivars from the Time group as expressed by the number and size of inflorescences is presented in Tables 3-5.

The highest quality was attained by plants potted between 2 February and 2 September and flowering after 2 months of cultivation, from April to the first days of November, respectively. Those plants developed the greatest number of inflorescences and stood out for their compact habit and a usually typical, cultivar-specific colour of the flower.

Table 3. Number of flowers depending on cultivar and term of cultivation

Cultivar	Beginning of pot cultivation in shortday glasshouse (in 2002)											
	2 Jan.	2 Feb.	2 Mar.	2 Apr.	2 May	2 Jun.	2.Jul.	2 Aug.	2 Sept.	2 Oct.	2 Nov.	2 Dec.
'Esperanto Time'	20.6 a	35.5 c	42.7 d	39.5 d	63.0 f	82.6 g	66.1 f	90.9 h	49.2 e	27.3 b	18.1 a	16.8 a
'Icon Time'	24.7 c	39.7 e	45.3 f	40.9 e	58.8 h	72.3 i	55.1 g	95.6 j	30.5 d	14.1 a	18.0 b	26.5 c
'Jewel Time'	17.1 a	20.5 b	27.7 c	29.7 c	33.7 d	37.9 e	56.9 f	57.9 f	35.1 de	20.9 b	19.5 ab	18.1 ab
'Solar Time'	21.9 a	41.5 c	40.6 c	57.2 e	69.5 f	87.1 g	86.0 g	103.4 h	48.9 d	23.3 ab	27.4 b	22.0 a

Means followed by the same letters do not differ significantly

Table 4. Diameter of inflorescences (cm) depending on cultivar and term of cultivation

Cultivar	Beginning of pot cultivation in shortday glasshouse (in 2002)											
	2 Jan.	2 Feb.	2 Mar.	2 Apr.	2 May	2 Jun.	2.Jul.	2 Aug.	2 Sept.	2 Oct.	2 Nov.	2 Dec.
'Esperanto Time'	7.6 d	8.4 f	7.6 d	7.5 cd	7.9 e	5.8 a	7.6 d	7.2 bc	8.3 f	7.3 bc	7.2 b	7.5 d
'Icon Time'	8.3 cd	8.5 d	8.4 d	7.1 a	8.0 bc	6.9 a	7.7 b	6.9 a	9.8 f	6.9 a	9.4 e	9.3 e
'Jewel Time'	9.3 bc	10.4 e	10.0 d	10.9 f	9.7 cd	8.8 a	9.0 ab	10.8 ef	9.8 d	9.0 ab	10.7 ef	10.9 ef
'Solar Time'	7.2 c	7.6 d	7.5 d	6.2 b	7.2 c	4.4 a	6.3 b	7.1 c	8.2 f	7.9 e	8.4 fg	8.6 g

Means followed by the same letters do not differ significantly

Table 5. Height of plants (cm) depending on cultivar and term of cultivation

Cultivar	Beginning of pot cultivation in shortday glasshouse (in 2002)											
	2 Jan.	2 Feb.	2 Mar.	2 Apr.	2 May	2 Jun.	2.Jul.	2 Aug.	2 Sept.	2 Oct.	2 Nov.	2 Dec.
'Esperanto Time'	14.8 a	20.2 bc	19.6 b	21.3 d	24.6 e	21.3 d	21.5 d	20.9 cd	26.3 f	27.4 g	30.3 h	21.2 cd
'Icon Time'	19.0 b	21.4 c	23.2 de	24.1 e	28.8 g	26.7 f	25.9 f	26.0 f	22.5 cd	13.9 a	26.3 f	22.3 cd
'Jewel Time'	14.6 a	18.1 b	19.3 c	21.8 f	22.9 gh	21.5 ef	21.9 fg	20.3 cd	20.5 de	20.4 d	31.7 i	23.3 h
'Solar Time'	15.6 a	19.1 bc	18.2 b	18.1 b	22.7 e	18.7 bc	16.5 a	19.5 cd	21.9 e	22.4 e	29.0 f	20.1 d

Means followed by the same letters do not differ significantly

The plants grown in the autumn-winter season, potted in the greenhouse in October, November, December and January, flowered after 3 months an average, producing inflorescences no smaller than those forming in the remaining periods of the year, and even bigger than those developing in the height of summer. Their number, however, was much smaller, and they crowned rather flaccid shoots which tended to spread sideways and sometimes even to break under the weight of flowers.

The ornamental quality of plants potted in November and December was also reduced by uneven flowering of the inflorescences. One plant could be observed to have inflorescences that were withered, in full flower, and still in closed buds. Inflorescences of the 'Icon Time' were also highly discoloured, and individual ray florets lost their bicoloration and tended to grow together into narrow tubes. 'Esperanto Time' inflorescences did not fade and kept their bicoloration, but their habit was very effuse, as was that of 'Jewel Time'. Only the 'Solar Time' did not lose its high ornamental quality. Plants potted in November and December developed large, typical-coloured inflorescences built of ray florets whose shape changed to an advantageous tubular one.

DISCUSSION

The results of the research on the effect of the planting date on the flowering of English cultivars of chrysanthemums from the Time group reported in this article turned out to be surprisingly similar to those obtained by Jerzy and Borkowska (2003) in their study of the rhythm of growth and flowering of American cultivars of chrysanthemums, of the Yoder Brothers Inc. breed, in all-year-round culture. In both experiments the quality of the flowering plants depended on the light conditions and temperature changes over the year.

Real insolation, or the time during which the sunshine reaches the surface of the earth directly, changes over the year in a wide range, from 200-250 hours per month in spring and summer to 50-120 hours per month in autumn and winter. In spring and summer the quality of the plants was therefore the best, while in autumn and winter, the worst. Planting dates between October and January were established to be of no use as the starting time for controlled cultivation of pot cultivars of chrysanthemums.

While the Time cultivars are recommended as fully fit for all-year-round cultivation, there is no mention that they require supplementary illumination from November to mid-February, i.e. in the period of insolation deficit in Poland. Such illumination, applied daily 2 hours before and 2 hours after sunset with a quantum irradiance intensity of 60 μmol $m^{-2}s^{-1}$, radically accelerates the flowering and substantially improves the quality of the American pot cultivars ‘Baton Rouge’, ‘Kodiak’, and ‘Springfield’ (Jerzy et al. 2004). It can be presumed, or perhaps even taken for granted, that supplementary lighting can produce the same effect for the English pot cultivars of the Time group.

The temperature is equally important for the growth and flowering of pot cultivars of chrysanthemums in all-year-round cultivation. Too high a temperature in a greenhouse can markedly arrest the development of chrysanthemums or completely prevent them from flowering (Lint and Heij 1987, Whealy et al. 1987). The detrimental effect of temperature can be felt in the height of summer when it exceeds 26^{o}C, and in the autumn-winter season when it drops below the optimum 16-18^{o}C.

CONCLUSIONS

1. In all-year-round culture the quality of the flowering chrysanthemums from the Time group depended on the light condition and temperature.
2. Planting dates between October and January were not suitable for controlled cultivation of tested cultivars of chrysanthemums.
3. The best quality was attained by plants potted between 2 February and 2 September and flowering after 2 months.

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WPŁYW TERMINU SADZENIA ROŚLIN NA JAKOŚĆ DONICZKOWYCH ODMIAN CHRYZANTEM Z GRUPY TIME W UPRAWIE CAŁOROCZNEJ

Streszczenie: Badano jakość kwitnących roślin czterech odmian chryzantem w 12 cyklach uprawowych rozpoczynających się drugiego dnia każdego miesiąca roku: od stycznia do grudnia. Nie stosowano doświetlania roślin. Najwyższą jakość osiągały rośliny sadzone w okresie od lutego do września, kwitnące odpowiednio od kwietnia do listopada. W tym okresie usłonecznienie rzeczywiste kształtowało się na poziomie 200-250 godzin na miesiąc. W porze jesienno-zimowej, gdy liczba usłonecznionych godzin była o połowę mniejsza, jakość kwitnących roślin ulegała drastycznemu pogorszeniu. W związku z tym, terminy sadzenia roślin przypadające na okres od października do stycznia, określono jako nieprzydatne do rozpoczynania sterowanej uprawy doniczkowych odmian chryzantem.

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