Comparison of eight dill cultivars grown in containers in different light conditions

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S u m m a r y

Experiments were carried out in the experimental station "Marcelin" of Poznań University of Life Sciences in 2006. The objective of this study was to compare eight dill cultivars in order to determine their usefulness for cultivation in containers in different lighting conditions (PPFD -100 and 75 $\mu mol \cdot m^{-2} \cdot s^{-1}$). The following cultivars 'Amat', 'Ambrozja', 'Herkules', 'Krezus', 'Kronos', 'Lukullus', 'Skaner' and 'Szmaragd' were compared. In the first week of cultivation, higher plants and greater biomass were obtained in the cultivation at 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ in comparison with plants growing at 75 $\mu mol \cdot m^{-2} \cdot s^{-1}$. After four weeks of growth, no differences in the parametric assessment of plants growing at 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and at 75 $\mu mol \cdot m^{-2} \cdot s^{-1}$ were observed. 'Ambrozja' cultivar was characterized by the highest growth dynamics and value of LAI index, while 'Skaner' by the lowest. The performed experiments showed that 'Ambrozja 'cultivar is the most suitable one for cultivation in containers.

Key words: *dill, cultivars, light, development*

INTRODUCTION

Dill (*Anethum graveolens* L.) is an annual and sometimes biennial herb of the *Apiaceae* family, native to South-West Asia or South-East Europe. It has been cultivated since ancient times [1] as a vegetable, aromatic, carminative and antispasmodic [13] as well as an inhibitor of sprouting in stored potatoes [14]. Dill is one of the most popular seasonings both in our country and in the world. Fresh herb is very instable and after harvesting unsuitable for storage. Therefore, the sale of dill as well as other seasonings in containers is gaining a popularity. One of the significant factors limiting the growth of dill plants is shortage of light. Insufficient light intensity can cause exuberant growth of plants which are also poorly leaved and dyed. Excessive density of seasoning plants grown in containers hinders light access to lower plant parts and causes them to overgrow [2]. The main parameters in the cultivation of seasoning plants in containers include the height and plants area. These parameters are decisive for the termination of cultivation and the suitability of plants for sale. The objective of this study was to compare eight cultivars of garden dill with aim to determine their usefulness for cultivation in containers in different lighting conditions.

MATERIAL AND METHODS

Experiments were carried out in the experimental station "Marcelin" of the Poznań University of Life Sciences in 2006. The following eight cultivars of dill were compared in the described experiment: 'Amat', 'Ambrozja', 'Herkules', 'Krezus', 'Kronos', 'Lukullus', 'Skaner' and 'Szmaragd'. Seeds were obtained directly from growers or from seed companies. Plants were grown in growth chambers. A two-factor experiment was performed in eight repetitions, where one pot was treated as a one repetition. The investigations were conducted in two series. The first factor comprised eight cultivars of dill mentioned above, the second – photosynthetic photon flux density (PPFD): 100 and 75 $\mu mol \cdot m^{-2} \cdot s^{-1}$. The day length amounted 16 hours. Artificial light was provided using fluorescent lamps 36W/84 (Philips). The temperature in growth chambers was 25°C during the day and 20°C at night. The experimental plants were grown in pots of 280-cm^3 volume, filled peat substrate for vegetable transplanting production. The number of plants grown in pots was identical and amounted to 50. The plants were measured every 7 days during four weeks, for the first time 7 days after emergence. In every pot, 10 plants were measured. The harvesting involved hand cutting of plants close to the surface of the substrate. After the harvest, the volume of the fresh matter of plants from the pot and the yield of dry matter with the application of drier-balance WPS 210S were determined. In addition, measurements of plant heights, hypocotyls length and the area of entire plants were measured. A scanner and Skwer program were used to calculate the surface of experimental plants.

The significance of the impact of light and cultivars on the height, yields and area of dill plants was determined with the use of F test. Differences between means were estimated with the assistance of the Newman-Keuls test at the level of significance of $\alpha=0.05$. In order to determine correlations between the applied experimental factors and fresh and dry matter of yields of the experimental plants, the correlation coefficient was calculated and regression analysis was performed. All statistical analyses were carried out employing the Stat program.

The index of the relative growth rate (RGR) was calculated using the following formula:

$$\text{RGR} = \frac{dW}{W \cdot td}$$

where: W – mass of fresh plant material at the moment of harvesting (g^{-1}),
dW – fresh mass increment (g),
dt – time of cultivation (day).

The leaf area index (LAI) refers to the size of the leaf surface related to the land area taken up by all plants. It was calculated on the basis of the following formula:

LAI =A/P

where: A – plant assimilation area (dm^2), P – soil surface (pots, dm^{-2}).

RESULTS AND DISCUSSION

In all examined dill cultivars, the first week of vegetation was characterized by the strongest height increment which was associated with the development and elongation of the hypocotyl. In consecutive weeks of vegetation, height increment was smaller and was connected, primarily, with the formation of leaf blades. Heins et al. [7] maintain that following smaller quantities of light reaching the plants, they tend to overgrow and are characterized by elongated hypocotyl and leaf stalks. However, in the described investigations, the author failed to observe significant differences in the hypocotyl length depending on PPFD, both in the first as well as during the successive weeks of cultivation (tab. 1). However, there was a significant difference in the length of hypocotyl in relation to the examined cultivars. The hypocotyl was found the shortest in the case of 'Skaner' cultivar, while 'Ambrozja' and 'Krezus' cultivars were characterized by the longest hypocotyls. This, however, was associated with the growth dynamics of individual cultivars. 'Ambrozja', 'Herkules' and 'Kronos' cultivars were characterized by the highest proportion of the hypocotyl in the height of plants during the first week of cultivation (fig. 1). After 4 weeks of cultivation, the greatest heights were recorded in plants of 'Ambrozja' cultivar, while the smallest – in the case of 'Skaner' plants. From the outset, 'Ambrozja' and 'Krezus' cultivars were characterized by the strongest growth dynamics, in contrast to Skaner cultivar which exhibited the poorest growth dynamics (fig. 2). In their studies, Kawecka and Dyduch [8] reported the greatest plant heights in 'Szmaragd' and 'Fantazos' cultivars. PPFD was fund to have a significant impact on plant height during the first two weeks of cultivation. Significantly heigher plants were obtained in cultivations at 100 $\mu mol \cdot m^{-2} \cdot s^{-1}$ in comparison with plants cultivated at 75 $\mu mol \cdot m^{-2} \cdot s^{-1}$ (unpublished data). During the consecutive two weeks of cultivation, differing lighting conditions did not exert a significant influence on the height of plants of the examined cultivars. This could have been associated with plant adaptation to a given level of light and small differences in the amount of light reaching plants. Frąszczak et al. [4] reported higher dill plants during the entire period of vegetation at smaller diurnal light quantities. This, however, was caused by the excessive plant growth resulting from light shortage.

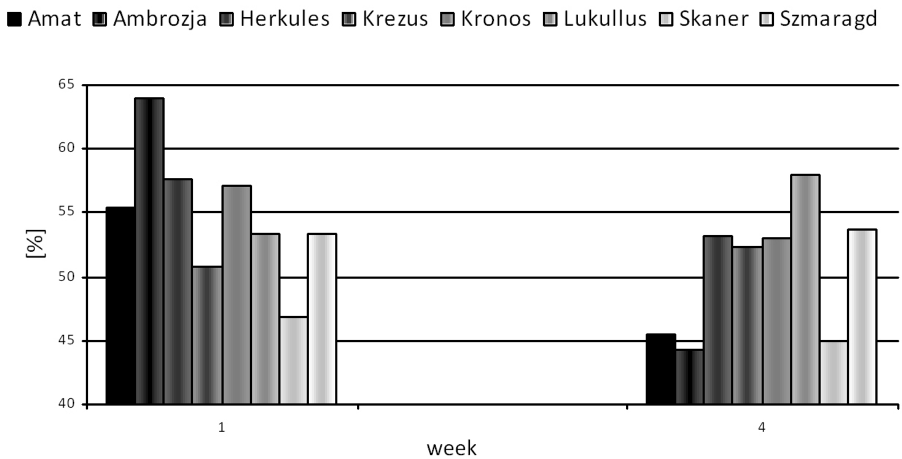

Figure 1. Percentage share of hypocotyl in the heights of plants

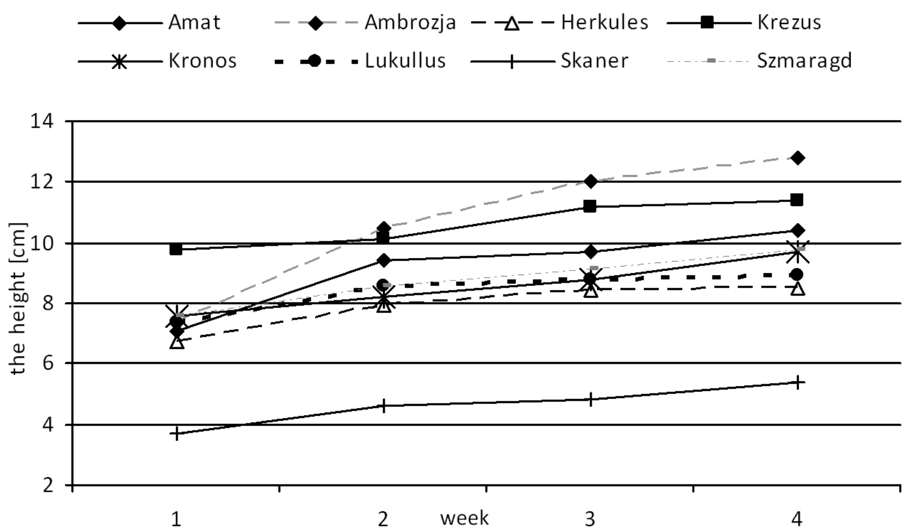

Figure 2. The height rate of dill cultivars in the vegetation period

Monteith [11] was the first who demonstrate that biomass production in the case of cultivations obtaining appropriate quantities of water and fertilization depends linearly on quantities of the absorbed light. In the described investigations, higher plant biomass only during the first week of vegetation was obtained in the case of plants cultivated at 100 μmol·m^{-2}·s^{-1} in comparison with those cultivated at 75 μmol·m^{-2}·s^{-1} (tab. 1). During the remaining weeks, the amount of light did not exert a significant impact on the fresh mass of foliage. Hälvä [6] reported increased fresh biomass of dill together with the increase of light quantity. The highest fresh biomass was obtained for 'Ambrozja' cultivar. This was the only cultivar whose yields depended significantly on PPFD, throughout the vegetation period, plants cultivated at 100 μmol·m^{-2}·s^{-1} were characterized by higher biomass yields (unpublished data). 'Ambrozja' cultivar was also reported by Dyduch and Kawecka [3] as well as Kawecka and Dyduch [9] to yield the highest biomass from among all examined cultivars. During the first week, plants were found to have a significantly greater area when cultivated at 100 μmol·m^{-2}·s^{-1} in comparison with plants cultivated at 75 μmol·m^{-2}·s^{-1} (tab. 1). The greatest leaf area at the highest amount of light in sage species was also reported by Li et al. [10]. After four weeks of cultivation in pots, 'Ambrozja' cultivar was characterized by the greatest plant area, while 'Lukullus', 'Skaner' and 'Szmaragd' cultivars having the smallest areas.

Table 1.

The influence of PPFD and dill cultivars on some morphological characteristic in individual vegetation weeks

factor	PPFD (μmol·m^{-2}·s^{-1})		cultivars							
	75	100	Amat	Ambrozja	Herkules	Krezus	Kronos	Lukullus	Skaner	Szmaragd
						hypocotyl length [cm]				
1st week	4.0 a	3.8 a	3.9 b	4.7 a	3.8 b	4.9 a	4.5 a	3.9 b	1.8 c	4.0 b
2nd week	4.2 a	4.0 a	4.0 d	5.1 a	4.0 d	5.0 ab	4.6 bc	4.1 d	2.0 e	4.4 cd
3rd week	4.4 a	4.3 a	4.4 b	5.2 a	4.4 b	5.3 a	4.8 ab	4.4 b	2.3 c	4.5 b
harvest	4.7 a	4.9 a	4.7 cd	5.6 ab	4.5 d	5.9 a	5.1 bc	5.1 bc	2.4 e	5.1 bc
						fresh mass [g]				
1st week	0.81 b	0.95 a	1.07 b	1.29 a	0.71c	0.85 c	0.75 c	0.84 c	0.54 d	1.02 b
2nd week	1.17 a	1.24 a	1.28 b	2.40 a	0.99 ab	1.25 b	0.90 ab	0.96 ab	0.71 c	1.15b
3rd week	1.59 a	1.85 a	1.81 b	4.51 a	1.33 bcd	1.61 bc	1.12 cd	1.38 bc	0.78 d	1.25 bcd
harvest	2.43 a	2.37 a	3.02 b	5.65 a	1.64 c	3.04 b	1.72 c	1.60 c	0.85 c	1.68 c
						area plants [dm^2·pot^{-1}]				
1st week	0.53 b	0.65 a	0.67 b	0.68 b	0.50 d	0.74 a	0.61 c	0.54 d	0.37 e	0.62 c
2nd week	0.84 a	0.82 a	0.95 b	0.91 b	0.79 c	1.10 a	0.67 d	0.68 d	0.59 d	1.00 ab
3rd week	1.15 a	1.22 a	1.12 c	2.08 a	1.08 c	1.54 b	1.08 c	0.78 d	0.74 d	1.08 c
harvest	1.49 a	1.43 a	1.69 b	2.65 a	1.25 cd	1.70 b	1.47 bc	0.92 e	0.94 e	1.06 de

* Values followed by the same letters for individual dates and factors do not differ significantly at α=0.05.

Relative growth rate (RGR) is a useful indicator of the extent to which a species is using its photosynthates for growth [5].'Ambrozja' cultivar was characterized by the highest fresh matter increment (fig. 3). It is evident that the highest biomass increment took place during the first and third weeks of cultivation (except 'Ambrozja' and 'Lukullus' cultivars) and the curve is of sinusoidal nature. Relative growth intensity is the greatest at the beginning and exhibits a decreasing trend in the course of ontogenesis. On the other hand, in the majority of cultivars, the highest LAI increment occurred in the fourth week of cultivation (fig. 4). Pietkiewicz [12] reported that the LAI value underwent changes during the vegetation period; it increased initially and decreased with the passage of time. Due to a short period of vegetation, no decrease in the LAI value was observed in the described experiments. It is worth emphasizing that, in comparison with the remaining cultivars, 'Ambrozja' was characterized by a considerably higher value of this coefficient.

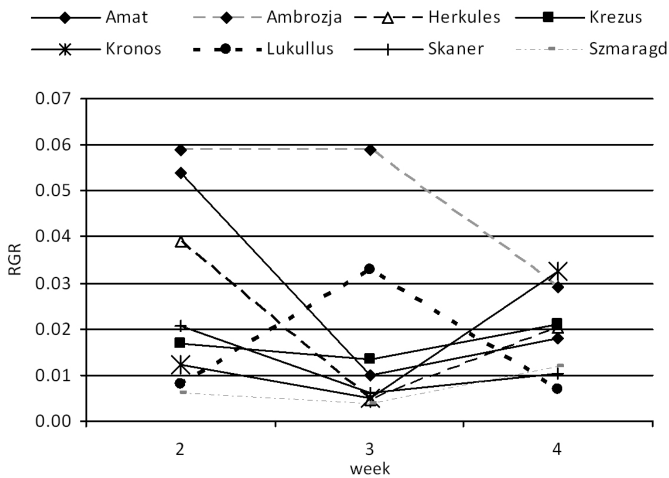

Figure 3. Relative growth rate the individual dill cultivars in the vegetation period

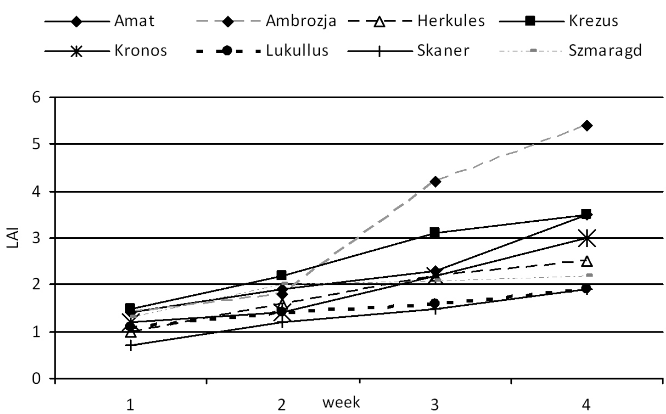

Figure 4. Leaf area index the individual dill cultivars in the vegetation period

CONCLUSIONS

1. Only in the first week of cultivation, higher plants and greater biomass were obtained in the cultivation at 100 μmol·m^{-2}·s^{-1} in comparison with plants growing at 75 μmol·m^{-2}·s^{-1}.
2. After four weeks of growth, no differences in the parametric assessment of plants growing at 100 μmol·m^{-2}·s^{-1} and at 75 μmol·m^{-2}·s^{-1} were observed.
3. 'Ambrozja' cultivar was characterized by the highest growth dynamics and value of LAI index, while Skaner by the lowest.
4. The performed experiments showed that 'Ambrozja' cultivar is the most suitable one for cultivation in containers.

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PORÓWNANIE OŚMIU ODMIAN KOPRU OGRODOWEGO UPRAWIANEGO W POJEMNIKACH W RÓŻNYCH WARUNKACH ŚWIETLNYCH

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S t r e s z c z e n i e

Doświadczenie zostało przeprowadzone w Stacji Doświadczalnej „Marcelin" Uniwersytetu Przyrodniczego w Poznaniu w 2006 roku. Celem pracy było porównanie ośmiu odmian kopru ogrodowego w celu określenia ich przydatności do uprawy w pojemnikach w zróżnicowanych warunkach świetlnych (PPFD -100 i 75 μmol·m^{-2}·s^{-1}). Porównywano następujące odmiany: 'Amat', 'Ambrozja', 'Herkules', 'Krezus', 'Kronos', 'Lukullus', 'Skaner' i 'Szmaragd'. W pierwszym tygodniu uprawy wyższe rośliny i większą masę ziela uzyskano w uprawie przy 100 μmol·m^{-2}·s^{-1}w porównaniu z 75 μmol·m^{-2}·s^{-1}. Po czterech tygodniach uprawy nie było różnic w ocenie parametrycznej roślin uprawianych przy 100 i 75 μmol·m^{-2}·s^{-1}. Największą dynamiką wzrostu oraz największą wartością współczynnika LAI charakteryzowała się odmiana 'Ambrozja', najmniejszą odmiana 'Skaner'. W wyniku przeprowadzonych badań stwierdzono, że do uprawy w pojemnikach pośród badanych odmian najlepiej nadaje się odmiana 'Ambrozja'.

Słowa kluczowe: *koper, odmiana, światło, rozwój*