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EFFECT OF LIGHT CONDITIONS ON YIELD AND QUALITY OF GARDEN ROCKET (*ERUCA SATIVA* LAM.) AND GARDEN CHERVIL (*ANTHRISCUS CEREFOLIUM* L. HOFFM.)

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ABSTRACT. The purpose of this research was to compare yield and quality of the two herbs: garden rocket and garden chervil grown in natural and artificial light. The highest yield of the herb of garden rocket was obtained in both years, when it was cultivated in the greenhouse conditions. The lowest levels of vitamin C in the herbs were found to be when they were grown in conditions of artificial light: at 12-hour day length.

Key words: *Eruca sativa* Lam., *Anthriscus cerefolium* L. Hoffm., artificial light, radiation

Introduction

In recent years, a growing interest in off-season spice plants has been observed. The assortment of these plants offered to Polish customers has increased dramatically and they are available as fresh plants throughout the whole year. Reduced light availability in winter may result in the lengthening of the period of plants growth and may also lead to reductions in their nutritive value in comparison with the plants grown in summer (**Li** et **al.** 1996, **Hornok** 1980). The objective of this research was to compare herbage yield and qualities of the two species of spice plants grown in the conditions of sunlight and artificial light.

Experiments were carried out for two species of spice plants: garden rocket (*Eruca sativa* Lam.) and garden chervil (*Anthriscus cerefolium* L. Hoffm.). Garden rocket is known to contain large quantities of vitamin C, minerals and organic acids, while from its small, smooth, brown seeds oil rich in erucic acid is pressed (**Boxer** 1996). Garden rocket grows best at moderate temperatures, has high water requirements, can grow in full sunlight or in places which are partly shaded. Excessive temperatures and shortage of water lead to early flowering of plants and bittering of leaves (**Clevely** and **Richmond** 1995).

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The herbage of garden chervil contains 0.03% volatile oil of delicate, anise aroma (**Tyszyńska-Kownacka** 1986). This herb grows best at moderate temperatures in shaded places. In response to excessive temperatures and radiation, it reacts with stunted growth, anthocyan discoloration or whitening of leaves and it switches much faster into its generative phase (**Clevely** and **Richmond** 1995).

Materials and methods

Investigations were carried out in the years 1998-1999. Experimental plants were grown in a greenhouse from 16.07 to 19.08 in 1998 and from 14.07 to 11.08 in 1999. Cultivation in growing chambers was conducted from 07.01 to 27.02 and from 05.03 to 11.04 in 1998. Artificial light was provided using fluorescent lamps 36W/840 of Philips Company designed to supply light for plants in vegetation chambers. Plants were growing at the dose of light of 55 $\mu mol \cdot m^{-2} \cdot s^{-1}$ and at daylight length of 12 and 16 hours. The temperature in chambers was maintained at 25°C during the day and 20°C at night, while air humidity was kept at the level of 50-60%. Climatic conditions in the greenhouse are shown in Figures 1 and 2. The average 24-hour temperature in 1998 was 16.2°C, whereas in 1999 – 23.5°C. Daylight doses were as follows: 18.1 $MJ \cdot m^{-1} \cdot day^{-1}$ in 1998 and 20.6 $MJ \cdot m^{-1} day^{-1}$ in 1999.

The experimental plants were grown in pots of 220 cm^3 volume. The substrate was prepared with the use of deacidified highmoor peat (70%) mixed with loamy soil (30%). Ferticare fertiliser composed of N:P:K (12:9:7) was added to the substrate in the amount of 1 g fertiliser per 1 cm^3 soil. The plants were not fertilised again during vegetation. The substrate reaction was established at pH 6.8. The experiment was performed in eight repetitions where each single pot was treated as one repetition. The pots were

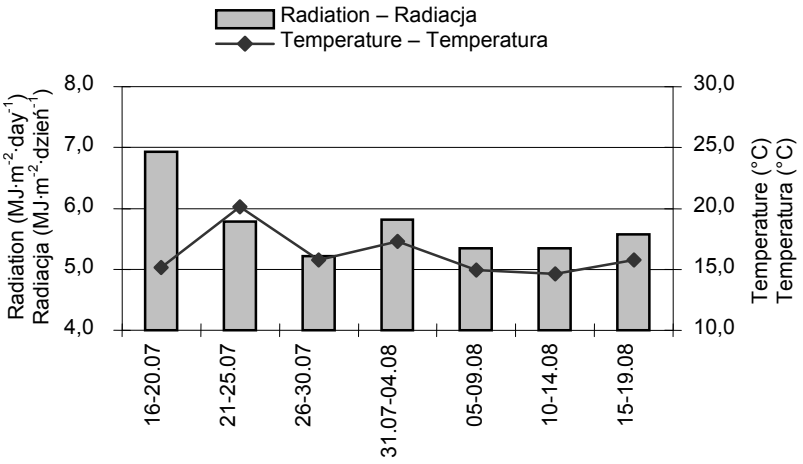


Fig. 1. Mean air temperature and radiation during the experiment in the greenhouse in 1998

Ryc. 1. Średnia temperatura powietrza i radiacja w okresie trwania doświadczenia w szklarni w 1998 roku

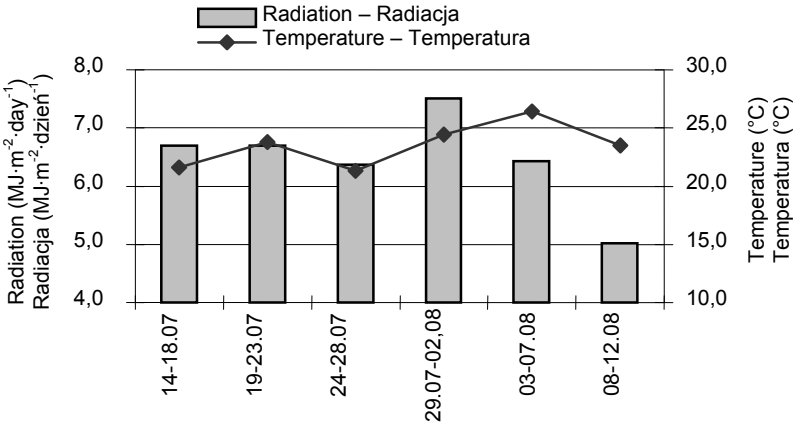


Fig. 2. Mean air temperature and radiation during the experiment in the greenhouse in 1999
Ryc. 2. Średnia temperatura powietrza i radiacja w okresie trwania doświadczenia w szklarni w 1999 roku

placed on suction mats, which were supplied with water automatically. The number of seeds sown into pots was identical for individual species and amounted to 40 seeds in the case of garden rocket and 50 seeds for chervil. Throughout the vegetation period, the height of plants was measured every 7 days, from emergence to harvest. Both species were harvested once, when the plants reached the height of about 10 cm and then their fresh herbage yield was determined. In herbage there were determined the following parameters: dry matter, nitrates and vitamin C. Vitamin C has been estimated by the Tilmans' method. Nitrate contents were determined with the potentiometer's method by the Orion apparatus. The obtained results were subjected to statistical analysis applying ANOVA and the Duncan test for the level of significance $\alpha = 0.05$.

Results and discussion

In the case of garden rocket, the highest yield was recorded in both years in the treatment where plants grew in natural light (Table 1). These results are confirmed by the results obtained by **Putievsky** (1983) who recorded the highest yields of sweet basil and oregano at the longest, 16-hour daylight. In 1998, in greenhouse cultivation, garden chervil gave the highest yield. Greenhouse yields in 1999 were lower because of excessive temperatures and radiation. This appears to prove the assumption that the influence of light may vary for each species and its impact can be modified by other factors which have complex effect and interact with one another (**Rumińska** et **al.** 1990). The lowest yields of both garden rocket and chervil herbage were obtained in the conditions of artificial light. **Ikeda** et **al.** (1988) also reported that, in their investigations on lettuce, they recorded the lowest yields from cultivation, which received the smallest quantities of light.

Table 1

Plant height, herbage yield and content of dry matter in herbage at harvest time
Wysokość roślin, plon ziela oraz zawartość suchej masy w zielu w czasie zbioru

Plant species Gatunek	Vegetation chambers Kamery wegetacyjne	Vegetation chambers Kamery wegetacyjne	Greenhouse – Szklarnia	
	12-hour lighting 12-godz. oświetlenie	16-hour lighting 16-godz. oświetlenie	1998	1999
Height of plants (cm) – Wysokość roślin (cm)				
Rocket – Rokietta	8.3 c*	9.8 b	10.6 a	9.8 b
Chervil – Trybula	10.5 ab	11.2 a	10.6 ab	9.6 b
Herbage yield (g) – Plon ziela (g)				
Rocket – Rokietta	6.7 b	6.5 b	21.8 a	21.2 a
Chervil – Trybula	6.2 b	5.2 b	11.2 a	6.0 b
Dry matter content (%) – Zawartość suchej masy (%)				
Rocket – Rokietta	8.1	11.0	16.1	11.6
Chervil – Trybula	10.9	10.1	16.1	11.4

*Values followed by the same letters in individual lines do not differ significantly at $\alpha = 0.05$.
*Wartości oznaczone tymi samymi literami w pojedynczych liniach nie różnią się istotnie przy $\alpha = 0{,}05$.

The length of the vegetation period for both species was the shortest (29 days) in 1999 when they were growing in the greenhouse and the longest (48 days) – at 12-hour lighting period (Table 2). In the initial stages of vegetation, plants grown in vegetation chambers were characterized by faster growth, however, later on, the growth rate in vegetation chambers and in the greenhouse were almost the same (Fig. 3 and 4). Nevertheless, it should be observed here that the plants in vegetation chambers were characterized by rank growth. The ratio of height to weight for both species grown in the conditions of artificial light was considerably higher than in the case of plants cultivated in the greenhouse with the exception of chervil grown in the greenhouse in 1999. This is confirmed by the results of **Li** et **al.** (1996) who obtained the highest sage plants in the worst lighting conditions. Also **Putievsky** (1983), when growing basil obtained the highest plants at 10-hour daylight in comparison with 16-hour daylight.

The content of vitamin C (Fig. 5 and 6) and dry matter (Table 2) in the case of the two species were the highest in the greenhouse; those of vitamin C in 1999, while of dry matter in 1998. Also **Franke** (1978) reported the highest content of vitamin C at high light intensity and length of day. The highest nitrate accumulation in leaves of garden rocket was observed in the conditions of 12-hour daylight and artificial lighting (Fig. 5). **Michalik** (1986, 1996) obtained similar results in investigations of lettuce. The highest nitrate accumulation occurred at small light intensity and short daytime. In 1999 garden chervil was characterized by the highest concentration of nitrates in conditions of greenhouse cultivation following delayed growth as a result of high temperature (Fig. 6).

Table 2

Date of emergence and duration of the vegetation period of rocket and chervil in relation to cultivation conditions
Termin wschodów i długość okresu wegetacji rokietty siewnej i trybuli ogrodowej w zależności od warunków uprawy

Plant species Gatunek	Vegetation chambers Kamery wegetacyjne	Vegetation chambers Kamery wegetacyjne	Greenhouse – Szklarnia	
	12-hour lighting 12-godz. oświetlenie	16-hour lighting 16-godz. oświetlenie	1998	1999
Date of emergence (days from sowing) Termin wschodów (w dniach od wysiewu)				
Rocket – Rokietta	2	3	4	5
Chervil – Trybula	5	7	11	9
Duration of the vegetation period (days) Długość okresu wegetacji (dni)				
Rocket – Rokietta Chervil – Trybula	48	38	35	29

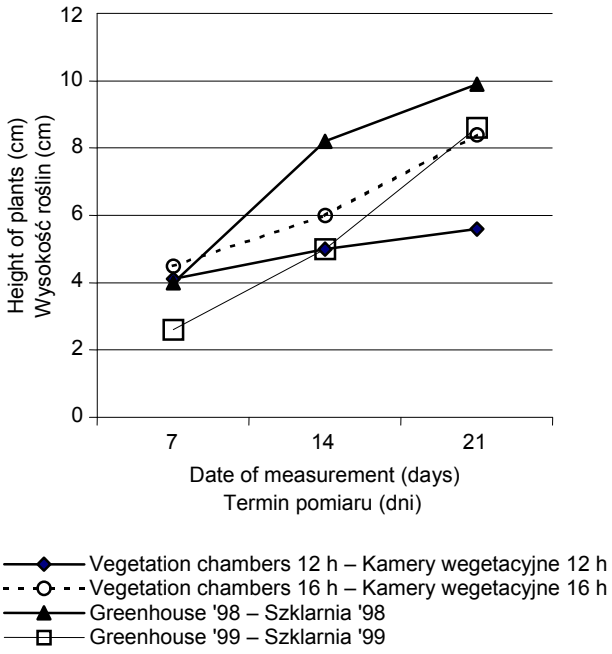


Fig. 3. Growth rate of garden rocket
Ryc. 3. Dynamika wzrostu rokietty siewnej

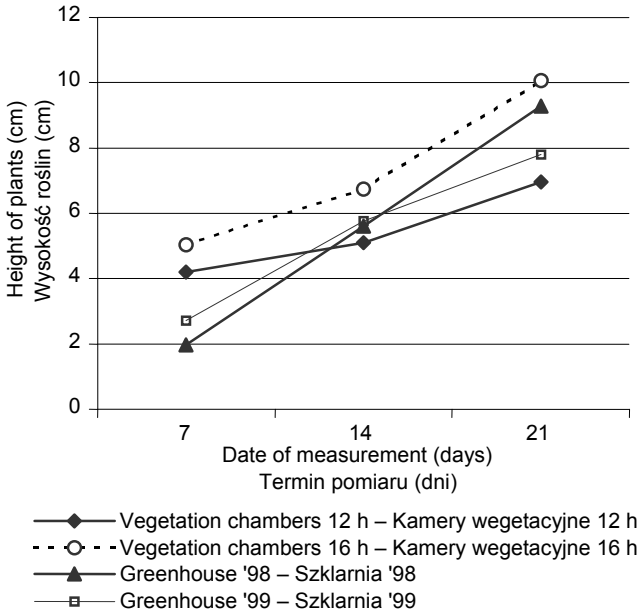
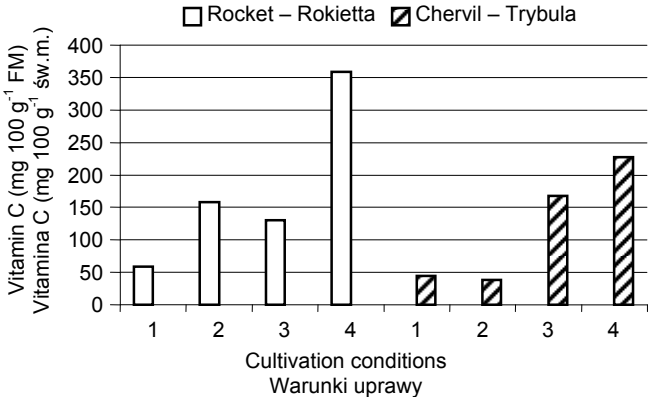
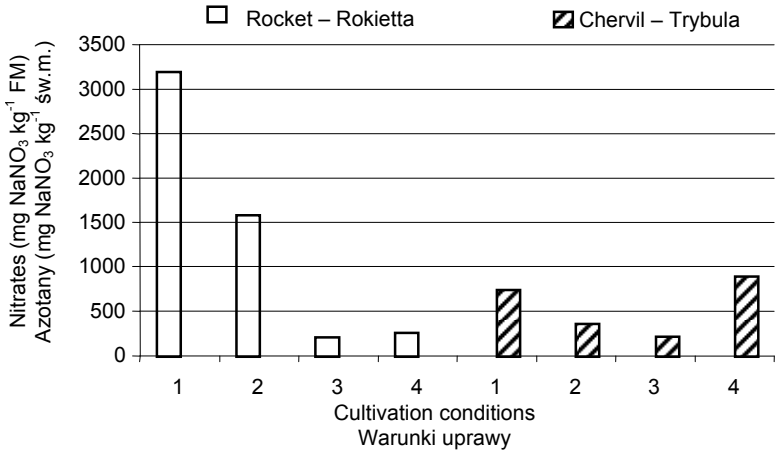


Fig. 4. Growth rate of garden chervil
Ryc. 4. Dynamika wzrostu trybuli ogrodowej



1. Vegetation chambers 12 h – Kamery wegetacyjne 12 h
2. Vegetation chambers 16 h – Kamery wegetacyjne 16 h
3. Greenhouse '98 – Szklarnia '98
4. Greenhouse '99 – Szklarnia '99

Fig. 5. Vitamin C content in herbage of garden rocket and garden chervil
Ryc. 5. Zawartość witaminy C w zielu rokiety siewnej i trybuli ogrodowej



1. Vegetation chambers 12 h – Kamery wegetacyjne 12 h
2. Vegetation chambers 16 h – Kamery wegetacyjne 16 h
3. Greenhouse '98 – Szklarnia '98
4. Greenhouse '99 – Szklarnia '99

Fig. 6. Nitrates content in herbage of garden rocket and garden chervil
Ryc. 6. Zawartość azotanów w zielu rokietty siewnej i trybuli ogrodowej

Conclusions

1. When cultivated at the most favourable light conditions (summer of 1998 and 1999) and optimum of the remaining cultivation factors, garden rocket gave the highest yield and was characterized by the highest content of vitamin C.

2. Garden chervil was characterized by lower yields both at deficiency and excess of radiation.

3. The yield of the obtained herbage harvested with artificial light did not vary significantly for 12- and 16-hour daylight.

4. Worse light conditions resulted in the increased accumulation of nitrates in herbage and prolongation of the vegetation period.

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WPŁYW WARUNKÓW ŚWIETLNYCH NA PLON I JAKOŚĆ ZIELA ROKIETTY SIEWNEJ (*ERUCA SATIVA* LAM.) I TRYBULI OGRODOWEJ (*ANTHRISCUS CEREFOLIUM* L. HOFFM.)

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

Celem pracy było porównanie wielkości i jakości plonu ziela rokietty siewnej i trybuli ogrodowej, uprawianych w warunkach światła naturalnego i sztucznego. Rośliny uprawiano latem 1998 i 1999 roku w szklarni oraz w komorach wegetacyjnych, przy dawce światła 55 $\mu mol \cdot m^{-2} \cdot s^{-1}$ i długości dnia wynoszącej 12 i 16 godzin.

W obydwu latach największy plon ziela rokietty uzyskano w uprawie w warunkach szklarniowych, natomiast największy plon trybuli uzyskano w uprawie szklarniowej w 1998 roku. Ziele rokietty i trybuli charakteryzowało się największą zawartością witaminy C w uprawie szklarniowej w 1999 roku (rokietta 359 mg 100 g^{-1} św.m., trybula 227 mg 100 g^{-1} św.m.), a trybuli także w 1998 roku. Najmniej witaminy C w zielu stwierdzono w uprawie w warunkach światła sztucznego – dla rokietty przy 12-godzinnym oświetleniu (59 mg 100 g^{-1} św.m.), a dla trybuli przy oświetleniu 16-godzinnym (38,7 mg 100 g^{-1} św.m.). Ziele rokietty uprawianej w warunkach światła sztucznego odznaczało się również znacznie większą zawartością azotanów niż roślin uprawianych w szklarni. Dużą zawartością azotanów charakteryzowało się ziele trybuli uprawianej w warunkach 12-godzinnego dnia oraz w szklarni w 1999 roku ze względu na niekorzystny wpływ zbyt dużej ilości światła i wysokiej temperatury na wzrost roślin.