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USEFULNESS OF JAPANESE BUNCHING ONION (*ALLIUM FISTULOSUM* L.) FOR FORCING IN GREENHOUSE

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Summary

The purpose of this work was the evaluation of yielding and the content of some chemical ingredients of Japanese bun ching onion yield obtained from forcing in greenhouse condi tions. Plants used for forcing were from field cultivation and had the pseudostem trimmed in the autumn of each year (2002, 2003 and 2004) at the height of 2 4 and 8 10 cm. In the spring of the following year (2003, 2004 and 2005) from the middle of March, the plants were forced in a heated greenhouse (temperature 16 20°C) and an unheated one (temperature 6 12 °C). The whole yield was evaluated when the plants reached the market size for bunching. The weight and height were determined in the plants, as well as the number of laterals and leaves in clusters. In green shoots and the pseudostem, the content of dry weight, total and reducing sugars, L ascorbic acid, flavonoids and phenolic acids were determined. Very high yield of plants useful for bunching was obtained (average 13.7 kg·m ^{2} of area). The plants with a lon ger pseudostem before forcing yielded better. The conditions of forcing did not have a significant influence on the size of the ob tained yield, but the content of L ascorbic acid and flavonoids was much higher (especially in green shoots) in the plants from forcing in the unheated greenhouse. Lower temperature at the time of forcing was favorable to higher reducing sugar content, especially in the pseudostem. Japanese bunching onion turned out to be useful for forcing for harvest in bunching form.

Key words: Japanese bunching onion, forcing, yield for bun ching, content of sugars, flavonoids, phenolic acids, L ascorbic acid

INTRODUCTION

Japanese bunching onion is a widely known perennial plant in cultivation and usage in Europe, and especially in the Far East countries – Japan, Korea, and China (Grevsen, 1989; Yamasaki and Miura, 1995). In Poland it does not have a great significance, because the dominating species is the common onion, which is grown not only for the bulb, but also for its green leaves.

An advantage of the Japanese bunching onion is its rapid growth, creating a large bunch of leaves of delicate consistency, which contain a great amount of vitamin C, flavonoids and other ingredients important for health (Lazić et al. 2002; Štajner et al. 2006). A great characteristic of this plant is its resistance to low temperature and low soil requirements (Kotlińska and Kjima, 2000; Yamasaki et al. 2003).

The characteristics of Japanese bunching onion, as a plant with rapid growth and a great dietetic value, lead the authors to conducting studies with the purpose of evaluation of yielding and the content of important dietetic values in plants of bunching onion from forcing in greenhouse conditions.

MATERIAL AND METHODS

The plants used for forcing were Japanese bunching onion plants obtained from sowing of seeds directly onto the field in the third decade of April in the years 2002, 2003, and 2004. The area of cultivation of these plants in the field was 200 m^2. The plants grew in spacing of 20 x 40 cm (12 plants per 1 m^2 of the field area).

In the autumn of every year in the third decade of October, whole plants with roots were dug out from the ground, and the pseudostem of the plants was cut in half at the height of 2-4 cm and in the second half at the height of 8-10 cm. The plants were placed in boxes made of plastic material (dimensions 600 x 400 x 131 mm) filled with compost soil. One box accomodated 35 plants and this was one replication in the conducted experiment. The plants, now ready for forcing, were stored in the unheated greenhouse until March of the following year (2003, 2004 and 2005).

Forcing of Jananese bunching onion began in the second decade of March. The studied factors included the following: the conditions of forcing – heated greenhouse (average 24-hour period at air temperature of

16-20°C) and unheated greenhouse (average 24-hour period at air temperature of 6-12°C); the method of preparation of plants for forcing – trimming at the height of 2-4 cm and 8-10 cm.

The experiment was established in four replications. In the heated greenhouse, eight boxes were placed (4 with plants with the pseudostem trimmed at the height of 2-4 cm and 4 with plants with the pseudostem trimmed at the height of 8-10 cm). The same number of boxes was placed for forcing in the unheated greenhouse. Forcing lasted until the end of April.

The harvest of bunching onion was conducted successively as the plants reached the market size. Whole plants, with the height of approximately 40 cm and weight approximately 80 g, were harvested. At the time of harvest, the average number of laterals in one plant was 13.8. After the harvest, the marketable yield was determined for the plants useful for bunching and chemical analyses were conducted on green shoots and the pseudostem. The dry weight was determined (oven-dry method), total and reducing sugars (Luff Schörl method), flavonoids, recalculated to quercetin (Christ-Muller's method), phenolic acids recalculated to coffee acid (Arnov's method) and L-ascorbic acid (Roe's method, modified by Ewelin).

RESULTS AND DISCUSSION

Forcing of Japanese bunching onion lasted on average 40 days in the heated greenhouse and 47 days in the unheated one. The temperature at the time of forcing did not have a significant influence on the weight of plants and the yield obtained (Table 1 and 2). Only significantly more leaves in cluster were formed from forcing in the heated greenhouse (average 38.3) in comparison with the conditions in the unheated greenhouse (average 33.8).

The obtained marketable yield of bunching onion plants, on average 13.72 kg·m^{-2} of the surface area, can be considered very high. According to the opinion of many authors (Grevsen 1989; Armstrong and Ford - Lloyd 1993; Leong 2001; Lazić et al. 2002), this plant is characterized by a very rapid growth and it does not require very good conditions for its vegetation.

The height of trimming of the pseudostem in the plants before forcing did not have a significant effect on the size of marketable yield. Only the plants in which the pseudostem was left higher before forcing were significantly higher and with higher weight (Table 1).

The height or the yield of bunching onion in a great degree is decided by the number of created laterals. In the first year of cultivation on the field, a single plant of bunching onion can create around 14-15 laterals, and in the second year even 18-19 (Tendaj and Mysiak, 2007). The conditions of forcing of Japanese bunching onion did not have a significant influence on the number of created laterals, which was on average 13.8. The formation of a large number of laterals is a very positive characteristic of this onion, because the bunch can form easily and in this form it can be assigned for trade. A similar relation was indicated with shallot (Tendaj and Mysiak 2004).

Based on the analysis of the content of some of the chemical ingredients, it was shown that Japanese bunching onion is a very rich plant in terms of its dietetic value. Even the earlier studies indicate its value as an important source of flavonoids, phenolic acids, and vitamin C (Horbowicz and Kotlińska, 1998; Štajner et al. 2006).

Table 1.

Influence of conditions of forcing and trimming of pseudostem at various heights before forcing on weight, height, number of laterals, and number of leaves of single plant of Japanese bunching onion in the marketable yield (average from years 2003 2005).

Place of forcing	Height of trimming of pseudostem (cm)	Weight of single plant (g)	Height of plant (cm)	Number of laterals per plant	Number of leaves per plant
Heated greenhouse	2 4	72.0	38.4	13.9	37.3
	8 10	80.6	40.3	14.8	39.3
	mean	76.3	39.3	14.3	38.3
Unheated greenhouse	2 4	76.5	37.9	13.7	35.3
	8 10	84.3	42.6	12.9	32.3
	mean	80.4	40.2	13.2	33.8
Mean	2 4	74.3	38.1	13.8	36.3
	8 10	82.5	41.4	13.8	35.8
	mean	78.4	39.7	13.8	36.0
LSD α 0,05					
Place of forcing (A)		n.s.	n.s.	n.s.	2.911
Height of trimming of pseudostem (B)		8.023	2.123	n.s.	n.s.
Interaction (AB)		n.s.	n.s.	n.s.	n.s.

However, the content of the analyzed chemical ingredients in the plants of Japanese bunching onion varied significantly depending on the conditions of forcing and the edible part of the plant (Table 3).

Plants from forcing in the non-heated greenhouse, that is at a lower temperature of 6-12°C, in comparison with the plants from forcing in the heated greenhouse (temperature 16-20°C) contained significantly more dry matter, reducing sugars, flavonoids, and L-ascorbic acid, whereas those from the heated greenhouse contained significantly more phenolic acids. In agreement with the opinion of other researchers who study the reaction of plants to environmental factors, the lower temperature favors accumulation of reducing sugars and phenol compound (Lachman et al. 1999). The greater content of L-ascorbic acid in bunching onion plants from forcing (at a lower temperature, on average 63.45 mg·100 g^{-1} f.w.) resulted probably from a slower growth of plants. As given by Lee and Kader (2000), the content of vitamin C in vegetables and fruits depends, among other things, on the intensity of growth. A faster growth is not favorable to higher content of this vitamin.

Regardless of the conditions of forcing, the content of analyzed chemical ingredients varied significantly depending on the edible part of the plant. Green shoots contained significantly more flavonoids, phenolic

Table 2.
Influence of conditions of forcing and trimming of pseudostem at various heights before forcing on marketable yield of Japanese bunching onion (kg·m ^{2})

Place of forcing	Height of trimming of pseudostem (cm)	Years			Mean for 2003 2005
		2003	2004	2005	
Heated greenhouse	2 4	12.65	16.06	9.10	12.60
	8 10	13.77	18.53	9.89	14.06
Unheated greenhouse	mean	13.21	17.30	9.49	13.33
	2 4	13.53	17.43	9.53	13.50
	8 10	15.31	18.02	10.92	14.75
Mean	mean	14.42	17.72	10.22	14.12
	2 4	13.09	16.75	9.31	13.05
	8 10	14.54	18.27	10.41	14.41
mean		13.81	17.51	9.86	13.72
LSD α 0,05					
Place of forcing (A)		n.s.	n.s.	n.s.	n.s.
Height of trimming of pseudostem (B)		n.s.	n.s.	n.s.	n.s.
Interaction (AB)		n.s.	n.s.	n.s.	n.s.
Years (C)					2.072

Table 3.
Content of selected chemical components in edible parts of Japanese bunching onion depending on the conditions of forcing (average from years 2003 2005)

Place of forcing	Part of plant	Dry matter (%)	Total sugars (% f.w.)	Reducing sugars (% f.w.)	Flavonoids per quercitine (mg·kg ^{1} f.w.)	L ascorbic acid (mg·100g ^{1} f.w.)	Phenolic acids per coffee acid (mg·100g ^{1} f.w.)
Heated greenhouse	green shoots	6.81	1.45	0.90	1420.57	60.81	0.14
	pseudostem	5.79	1.63	1.16	52.86	59.12	0.04
	mean	6.30	1.54	1.03	736.72	59.96	0.09
Unheated greenhouse	green shoots	7.44	1.40	1.01	1643.67	65.08	0.08
	pseudostem	6.36	1.57	1.26	52.04	61.82	0.02
	mean	6.90	1.48	1.14	847.85	63.45	0.05
Mean	green shoots	7.12	1.42	0.96	1532.12	62.94	0.11
	pseudostem	6.08	1.60	1.21	52.45	60.47	0.03
	mean	6.60	1.51	1.08	792.29	61.71	0.07
LSD α 0,05							
Place of forcing (A)		0.194	n.s.	0.053	9.033	1.784	0.011
Part of plant (B)		0.194	0.116	0.053	9.033	1.784	0.011

acids and L-ascorbic acid. The pseudostem contained more total and reducing sugars.

CONCLUSIONS

1. Japanese bunching onion turned out to be a useful plant for forcing in greenhouse conditions for yield for bunching. Regardless of conditions of forcing (heated and non-heated greenhouse), the obtained yield of whole plants per m^2 was very high (average 13.7 $kg \cdot m^{-2}$).

2. The usefulness of Japanese bunching onion for forcing for bunching yield results from its rapid growth and the formation of numerous laterals with plentiful leaves.

3. Plants with a longer pseudostem reached a greater weight because they formed longer shoots.

4. Plants of Japanese bunching onion from forcing in the conditions of heated and unheated greenhouse were especially rich in L-ascorbic acid and flavonoids. Green shoots contained significantly more of those ingredients and phenolic acids in comparison with the pseudostem. However, in the pseudostem there were more total and reducing sugars.

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Przydatność cebuli siedmiolatki do pędzenia w warunkach szklarniowych

Streszczenie

Celem pracy była ocena plonowania i zawartości niektórych składników chemicznych w plonie cebuli siedmiolatki uzyskanym z pędzenia w warunkach szklarniowych. Pędzeniu poddano roczne rośliny z uprawy polowej, u których jesienią każdego roku (2002 - 2004) przycięto łodygę rzekomą na wysokość 2-4 i 8-10 cm. Wiosną następnego roku (2003 - 2005) od połowy marca rośliny poddawano pędzeniu w szklarni ogrzewanej (temperatura 16-20°C) i nieogrzewanej (temperatura 6-12°C). Ocenie poddano plon całych roślin, gdy osiągały wielkość handlową do pęczkowania. Określono masę i wysokość roślin, liczbę odrostów i liści. W szczypiorze i łodydze rzekomej oznaczono zawartość suchej masy, cukrów ogółem i redukujących, kwasu L-askorbinowego, flawonoidów i fenolokwasów. Uzyskano bardzo wysoki plon roślin przydatnych do pęczkowania (średnio 13,7 $kg \cdot m^{-2}$ powierzchni). Lepiej plonowały rośliny z wyżej przyciętą łodygą rzekomą przed pędzeniem. Warunki pędzenia nie miały istotnego wpływu na wielkości uzyskanego plonu, lecz zawartość kwasu L-askorbinowego i flawonoidów była istotnie większa (zwłaszcza w szczypiorze) u roślin z pędzenia w szklarni nieogrzewanej. Niższa temperatura podczas pędzenia sprzyjała gromadzeniu większej ilości cukrów redukujących, zwłaszcza w łodydze rzekomej siedmiolatki. Roślina ta okazała się w pełni przydatna do pędzenia na zbiór w postaci pęczkowanej.