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Yielding and nutritional value of Japanese bunching onion in relation to the date of planting and type of flat cover

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ABSTRACT

During a three-year field experiment, the possibilities of cultivating the 'Performer' cultivar of Japanese bunching onion for early harvest bunching were assessed through the use of autumn and spring planting terms. The seedlings, produced in multi-pots, were planted in the open field on 8-10 September, 9-10 October and 6-12 April, and covered with a perforated foil and agrotextile in mid-November or directly following the spring planting. The covers were removed at the end of April, and the harvest of Japanese bunching onion was conducted at the end of May. The percentage of plants that survived the winter, how many produced flowering stems and the height of the total and marketable yield of plants with a pseudostem diameter >10 mm were determined. We evaluated the content of selected components with a nutritional value in samples of edible plant parts.

The results of the study showed that it is possible to obtain a high yield of plants harvested for bunches following an early spring term seedling planting. The majority of plants planted in the autumn froze during the winter, while those that were overwintered produced flower stems, especially if planted in September. The application of flat covers increased the percentage of plants that survived the winter, though in spite of this fact, the obtained marketable yield of Japanese bunching onion planted in the autumn was very low. Plants from the spring planting were characterised by a lower content of dry matter, chlorophyll a+b and volatile oils, while their content of K, Ca and Mg showed enhanced levels. Covering plants with a perforated foil positively influenced the content of total sugars and volatile oils, while negatively influencing the amounts of vitamin C, potassium and calcium as compared to those cultivated without covers.

Key words: agrotextile, bolting, perforated foil, plant composition, plant overwintering

INTRODUCTION

Japanese bunching onion (*Allium fistulosum* L.), also called Welsh onion or Japanese leek, is a highly popular vegetable in Asian countries, mainly in China where it has been cultivated for more than 2,000 years (Wang et al. 2005) and now provides for about 10% of the total vegetable crop production in this country (Liu et al. 2009). This vegetable also has a considerable economic value in Japan, Korea and Indonesia, where edible parts include the cut green foliage or the entire plants with a blanched, leek-like, pseudostem (Grubben 1994, Rubatzky and Yamaguchi 1997, Warade and Shinde 1998). Japanese bunching onion was likely introduced in Europe in the Middle Ages, when it was given the

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name Welsh onion, which in German meant a plant of foreign origin (Helm 1956).

The economic importance of this vegetable species in Europe is still negligible and its cultivation is generally limited to home gardens. The advantageous features of Japanese bunching onion include moderate thermal and soil requirements as well as a high nutritive value. Most data from the literature indicate this vegetable as a rich source of vitamin C, carotenoids, vitamins from the B group, potassium, calcium and also phenolic compounds like quercetin and kaempferol (Horbowicz and Kotlińska 1998; 2000, Kotlińska and Kojima 2000, Kotlińska et al. 2005, Mysiak and Tendaj 2006; 2008, Aoyama and Yamamoto 2007).

Japanese bunching onion, a plant resistant to low temperatures, can be cultivated and used in a number of ways. The kind of cultivation most often introduced in Poland involves the establishment of a several-year plantation from seeds sown directly into the field, from seedlings or from vegetative cultivation propagated by the use of tillers (Dobromilska and Rekowska 2000). The harvest of green leaves, starting from the second year of cultivation, takes place in the spring when they reach the height of 20-30 cm. The most advantageous for that purpose are cultivars with a strong tendency for producing tillers, such as 'Siedmiolatka Czerwona' (Tendaj and Mysiak 2010), as well as other cultivars present in the Polish Register List such as 'Kroll', 'Wita' and 'Flamenco', which produce a short pseudostem with rich foliage and many tillers.

New cultivars that have been introduced to cultivation in the last few years, like 'Performer' and 'Parade', feature poor production of tillers, a long pseudostem (Tendaj and Mysiak 2010, 2011), and a high rate of growth, and are therefore suitable for harvesting for bunches. In cultivation they can become an alternative for the widely used common onion for this purpose, especially taking into account their higher resistance to pests and diseases (Martinez et al. 2005), as well as longer storage life after harvesting (Ibaraki et al. 1999).

The previous study reported research data pointing to the possible cultivation of the 'Performer' cultivar of Japanese bunching onion harvested for bunches from June to mid-October in different stages of plant development, within a period of 60-150 days after seedling planting (Kołota et al. 2012). The results presented in this study, which are supplementary to the earlier ones, are the basis for the determination of the possibility of Japanese bunching onion cultivation for early harvest from the autumn and spring terms of seedling planting and using flat covers in the form of a perforated foil or agrotextiles.

MATERIAL AND METHODS

Field experiments were conducted in 2009-2012 in the Horticultural Research Station located in Piastow near Wroclaw (southwest Poland) on a clay-sandy soil with a pH of 7.1 and organic matter content amounting to 1.8%. The content of available forms of phosphorus was equal to 55-64 mg dm^{-3}, 50-68 mg dm^{-3} of potassium and 20-31 mg dm^{-3} of mineral nitrogen (NO_3+NH_4–N) in the soil, depending on the year of the study. The two-factorial experiment was established according to the split-plot method in four replications. The first factor included three terms of seedling planting: 8-10 September (I), 9-10 October (II) and 6-12 April (III), (depending on the weather conditions in the spring of particular years). Factor II included covers in the form of a perforated foil, with 100 holes per 1 m^2 and agrotextile weighing 17g m^{-2}, which were compared to the control without covers. The size of one plot was 6 m^2 (1.5 × 4 m).

The required doses of phosphorus and potassium were established on the basis of an annual chemical analysis of soil samples in order to obtain a level of 80 mg of available form of P and 200 mg K per 1 dm^3 of the soil. Triple superphosphate and potassium chloride, applied 3-4 days before seedling planting, were used as the sources of these nutrients. Nitrogen fertilisation was applied in the dose of 150 kg N ha^{-1}, in the form of ammonium nitrate. At autumn planting of the seedlings with 1/3 of the N dose was used as the pre-plant fertilisation, while the remaining part was introduced once, as a top dressing, after removing the covers in the spring. Japanese bunching onion planted in the spring was fertilised with all of the nitrogen in a single pre-plant dose.

The seedlings of the 'Performer' cultivar Japanese bunching onion were produced in high plastic tunnels and in a greenhouse in multi-pots filled with peat substrate for the spring planting term, where pot volume ranged to 54 cm^3. Three to four seeds were sown into each pot and at the stage of the first true leaves, the number of seedlings was reduced to two. Seedlings at the stage of 2-3 fully developed leaves were planted into plots of 0.30 × 0.15 m spacing, which, at two plants per pot, ensured 44 plants per 1 m^2.

Flat covers were applied in mid-November to Japanese bunching onion planted in the autumn,

Table 1. Meteorological data during the growing seasons of Japanese bunching onion in 2009-2012

Months	Mean monthly air temperature (°C)			Minimum temperature (°C)			Monthly sums of precipitation (mm)		
	2009/2010	2010/2011	2011/2012	2009/2010	2010/2011	2011/2012	2009/2010	2010/2011	2011/2012
September	16.9	12.5	15.9	3.9	4.3	2.5	7.0	88.8	21.8
October	8.3	7.5	9.7	-0.9	-3.7	-1.8	59.0	-	29.0
November	7.3	6.5	4.8	-1.8	-10.0	-5.0	25.4	58.6	-
December	-0.2	-5.1	4.3	-16.7	-20.1	-6.0	34.5	36.4	32.5
January	-5.7	0.7	1.2	-21.2	-10.6	-13.2	14.4	31.6	67.8
February	-0.4	-1.1	-4.2	-16.8	-16.0	-20.3	-	10.6	36.6
March	4.7	5.6	7.4	-13.0	-7.0	-7.0	17.3	24.0	6.9
April	10.8	13.2	10.7	-0.4	-0.9	-1.0	26.4	24.0	15.6
May	13.3	14.9	15.9	6.1	0.0	0.8	134.5	41.4	20.5

when the mean daily temperature decreased below 5°C, while in the spring this occurred directly after planting the seedlings. The covers were removed from the plots at the same term – on 28-30 April. Standard plant management was applied during cultivation, limited to soil loosening and systematic weeding of the plots. The weather conditions in subsequent years of Japanese bunching onion cultivation are shown in Table 1.

A single plant harvest took place on 25-30 May, when the majority of plants had a pseudostem diameter greater than 10 mm. The marketable yield consisted of entire plants with a stem diameter >10 mm, after removing roots and yellowing leaves. The plants that did not reach such a diameter were included in the total yield. When harvesting, samples of 15 plants from three replications of each treatment were collected for phytometric measurements (mean plant weight, plant length, diameter of pseudostem, number of leaves) as well as for chemical analyses. The subject of the assessment was the content of dry matter (dried at 105°C to constant weight), vitamin C (using the Tillman method), carotenoids (colorimetric method), total sugars (Looff-Schoorl method) chlorophyll a+b (spectrometric method), sums of volatile oils (distillation method PN – ISO 6571), nitrates (ion-selective method), P and Mg (colorimetric method) and Ca and K (photometric method).

The obtained results were subjected to statistical evaluation on the basis of the analysis of variance for a two factorial design, and the least significant differences were calculated using the Tukey test, at a significance level of p = 0.05.

RESULTS AND DISCUSSION

In spite of lower than average monthly air temperatures in the 2009/2010 growing period, the percentage of plants surviving the winter was the highest (56.1%), which can be explained by the occurrence of thicker and longer-lasting snow cover compared to the remaining research years. This proved that older plants from the first term of planting appeared to be more frost–resistant and survived in higher numbers than the ones planted in October (Tab. 2). It is also worth stressing that a disadvantageous phenomenon that accompanied earlier planted seedlings was a stronger tendency for bolting, the percentage of which for the three year period amounted to 23.0% in the first term and 3.4% in the second term (Tab. 3).

Table 2. Percentage of overwintered plants depending on the term of planting and type of flat cover in 2010-2012

Kind of flat cover	2010			2011			2012		
	term of planting			term of planting			term of planting		
	I*	II	mean	I	II	mean	I	II	mean
Perforated foil	75.9	36.7	56.3	52.0	31.6	41.8	36.5	8.4	22.4
Agrotextile	70.2	56.4	63.3	50.0	39.7	44.8	15.2	14.9	15.0
Control – without cover	54.4	43.2	48.8	25.5	18.9	22.2	12.6	6.5	9.5
Mean	66.8	45.4	56.1	42.5	30.1	36.3	21.4	9.9	15.6

*I – 8-10 September, II – 9-10 October

Table 3. Percentage of bolting plants depending on the term of planting and type of flat cover in 2010-2012

Kind of flat cover	2010			2011			2012			Mean for 2010-2012		
	term of planting			term of planting			term of planting			term of planting		
	I*	II	mean	I	II	mean	I	II	mean	I	II	mean
Perforated foil	26.8	7.7	17.2	38.4	0.8	19.6	25.9	2.8	14.3	30.4	3.8	17.1
Agrotextile	24.8	7.9	16.3	34.5	1.8	18.1	9.4	4.0	6.7	19.6	4.6	12.1
Control – without cover	35.6	3.7	19.6	15.9	0.3	8.1	5.7	1.8	3.7	19.1	1.9	10.5
Mean	29.0	6.4	17.7	29.6	0.9	15.2	13.7	2.9	8.2	23.0	3.4	13.2

*I – 8-10 September, II – 9-10 October

Table 4. Marketable and total yield of Japanese bunching onion depending on the term of planting and type of flat cover (t ha^{-1}) in 2010-2012

Kind of flat cover		Marketable yield				Total yield			
		term of planting				term of planting			
		I*	II	III	mean	I	II	III	mean
2010									
Perforated foil		5.63	4.59	16.44	5.55	9.84	5.80	16.44	7.36
Agrotextile		5.72	6.27	15.29	5.76	6.68	7.71	15.29	6.56
Control – without cover		2.79	5.84	18.10	5.58	7.85	6.49	18.10	7.48
Mean		4.71	5.57	16.61	5.63	8.12	6.67	16.61	7.13
LSD p = 0.05 for:	term of planting				1.41				1.49
	kind of flat cover				n.s.				n.s.
	interaction				3.21				3.92
2011									
Perforated foil		0.59	2.54	13.42	5.52	8.21	4.18	13.75	8.71
Agrotextile		0.56	3.92	13.02	5.83	6.02	5.60	13.82	8.48
Control – without cover		0.32	1.73	13.98	5.34	2.82	2.17	14.33	6.44
Mean		0.49	2.73	13.48	5.56	5.68	3.98	13.97	7.88
LSD p = 0.05 for:	term of planting				1.52				1.51
	kind of flat cover				n.s.				0.92
	interaction				1.73				1.98
2012									
Perforated foil		0.22	0.33	17.81	9.45	4.99	0.60	18.45	11.35
Agrotextile		0.20	0.45	19.01	9.88	1.80	1.05	19.34	10.73
Control – without cover		0.45	0.39	15.97	8.94	1.73	0.56	16.64	9.64
Mean		0.29	0.39	17.60	9.43	2.84	0.74	18.15	10.58
LSD p = 0.05 for:	term of planting				1.34				1.67
	kind of flat cover				n.s.				n.s.
	interaction				n.s.				n.s.
Mean 2010-2012									
Perforated foil		2.15	2.49	15.89	6.84	7.68	3.53	16.21	9.14
Agrotextile		2.16	3.54	15.77	7.16	4.83	4.78	16.15	8.59
Control – without cover		1.19	2.66	16.02	6.62	4.13	3.07	16.36	7.85
Mean		1.83	2.90	15.89	6.87	5.55	3.79	16.24	8.53
LSD p = 0.05 for:	term of planting				0.97				1.12
	kind of flat cover				n.i.				0.62
	interaction				n.i.				1.42

*I – 8-10 September, II – 9-10 October, III – 6-12 April

Covering plants with a perforated or agrotextile foil contributed to a significant improvement in the survival of Japanese bunching onion in winter conditions, which is evidenced by a higher percentage of plants not destroyed by winter frosts than in the control. As far as the percentages of surviving plants covered by perforated or agrotextile foil are concerned, their numbers were similar, while a higher percentage of bolting was recorded for plants covered with perforated film. This effect was especially evident for plants originating from the earlier, September term of seedling planting. According to Su et al. (2007), Japanese bunching onion is a plant prone to bolting, and the mentioned phenomenon has a tendency to increase when the temperature falls below 13°C, the day is short or when a plant reaches the minimum size inducing the stage of flowering (Rubatzky and Yamaguchi 1997). Brewster (2008) also underlines that the flowering of this species is induced by exposure to cool temperatures when the plants are larger than a certain critical size. For example, the 'Kaga' cultivar must have initiated 11 or 12 leaves corresponding to a pseudostem diameter of 5-7 mm before it can respond to flower inducing conditions. The latter of the mentioned factors seems to determine why a higher percentage of plants from the September planting term produced flower stalks. Results obtained by Yamasaki and Tanaka (2005), as well as by Shiraiva et al. (2005), proved that reduced nitrogen fertilisation can also be the cause of higher numbers of early flowering plants.

The considerable percentage of frozen plants and those bolting in the spring resulted in a very low total and marketable yield obtained from the plots sowed with seedlings in September and in October (Tab. 4). The marketable yield of Japanese bunching onion from those terms of planting provided for only 11.2% and 18.3%, respectively, of the yield size obtained from the spring planting, and the applied covers did not significantly influence its increase. The marketable yield of plants from both covered and uncovered plots planted in the spring ranged throughout the entire period of research from 15.77 to 16.02 t ha^{-1}. Taking into account the results obtained by Tendaj and Mysiak (2007), as well as the data of our own research involving Japanese bunching onion cultivated for bunch harvest in different seasons of the year (Kołota et al. 2012), a marketable yield of that size should be regarded as satisfactory. Contrary to our expectations and to the literature data (Tendaj and Mysiak 2007), the covers applied in the study did not bring about a significant increase in the yield size of Japanese bunching onion harvested for bunches. The evaluation of such yield quality features as mean weight and height of plant, pseudostem diameter and number of leaves per plant did not show any clear dependence on the date of planting and the type of plant cover, and for this reason these data are not included in the paper.

The results of the chemical analysis of the samples collected at the time of harvest proved that plants wintering in the field were characterised by a higher content of dry matter, chlorophyll a+b, as well as volatile oils in relation to those planted in the spring (Tabs 5 and 6). The application of flat covers in the form of a perforated foil and agrotextiles also had a significant effect on the chemical composition of this vegetable. The covers, particularly the perforated foil, had an advantageous influence on the content of dry matter, total sugars and volatile oils. The level of vitamin C was the highest in plants cultivated in the control without covers, which can be explained by the lower air temperature in that treatment. This hypothesis is confirmed by the results

Table 5. Dry matter, total sugar and vitamin C contents in Japanese bunching onion depending on the term of planting and type of flat cover (mean for 2010-2012)

Kind of flat cover	Dry matter (%)				Total sugar (% f.w.)				Vitamin C (mg 100 g^{-1} f.w.)			
	term of planting				term of planting				term of planting			
	I*	II	III	mean	I	II	III	mean	I	II	III	mean
Perforated foil	11.36	12.44	10.39	11.40	4.49	4.36	4.61	4.49	30.99	35.31	34.28	33.53
Agrotextile	12.05	11.67	10.09	11.27	4.33	3.92	4.12	4.12	34.76	39.06	35.56	36.46
Control – without cover	10.89	11.14	9.98	10.67	4.25	3.91	4.16	4.11	40.06	37.45	35.73	37.75
Mean	11.43	11.75	10.15	11.11	4.36	4.06	4.30	4.24	35.27	37.28	35.19	35.91
LSD p = 0.05 for: term of planting				0.41				n.s.				n.s.
kind of flat cover				0.26				0.20				2.20
interaction				0.80				n.s.				n.s.

*I – 8-10 September, II – 9-10 October, III – 6-12 April

Table 6. Carotenoids, chlorophyll a+b and volatile oil contents in Japanese bunching onion depending on the term of planting and type of flat cover (mean for 2010-2012)

Kind of flat cover	Carotenoids (mg 100 g^{-1} f.w.)				Chlorophyll a+b (mg 100 g^{-1} f.w.)				Volatile oils (mg 100 g^{-1} f.w.)			
	term of planting				term of planting				term of planting			
	I*	II	III	mean	I	II	III	mean	I	II	III	mean
Perforated foil	1.73	1.96	1.73	1.81	54.78	55.18	52.23	54.06	1.78	1.08	0.96	1.27
Agrotextile	1.64	1.87	1.79	1.77	52.66	52.82	47.48	50.99	1.25	0.90	0.92	1.02
Control – without cover	2.04	1.94	1.77	1.92	57.52	56.13	47.35	54.33	1.16	0.89	0.88	0.98
Mean	1.80	1.92	1.76	1.83	54.99	54.71	49.69	53.13	1.40	0.96	0.92	1.09
LSD p = 0.05 for: term of planting				n.s.				3.87				0.08
kind of flat cover				n.s.				n.s.				0.11
interaction				n.s.				n.s.				n.s.

*I – 8-10 September, II – 9-10 October, III – 6-12 April

of other researchers, which indicates that a lower temperature during the growing period favours the accumulation of both vitamin C and carotenoids in plants representing moderate thermal requirements (Mozafar 1994, Lester 2006), such as, amongst others, Japanese bunching onion. Considering carotenoids, such a relation was evident, but not statistically confirmed, only in plants from the first autumn term of planting.

The effect of the examined factors on changes in the mineral composition of Japanese bunching onion harvested for bunches was, in most cases, insignificant and without a clear tendency (Tabs 7 and 8). The level of nitrates was relatively high,

Table 7. Nitrates, phosphorus and potassium contents in Japanese bunching onion depending on the term of planting and type of flat cover (mean for 2010-012)

Kind of flat cover	Nitrates (mg NO_3-N kg^{-1} f.w.)				Phosphorus (% d.m.)				Potassium (% d.m.)			
	term of planting				term of planting				term of planting			
	I*	II	III	mean	I	II	III	mean	I	II	III	mean
Perforated foil	1980	2196	2134	2103	0.17	0.19	0.22	0.19	2.33	2.73	2.89	2.65
Agrotextile	1878	2124	2051	2018	0.18	0.19	0.20	0.19	2.20	2.74	3.23	2.72
Control – without cover	2135	2490	1809	2145	0.21	0.20	0.19	0.20	2.89	3.11	2.97	2.99
Mean	1998	2270	1998	2089	0.19	0.19	0.20	0.19	2.47	2.86	3.03	2.79
LSD p = 0.05 for: term of planting				n.s.				n.s.				0.22
kind of flat cover				n.s.				n.s.				0.26
interaction				n.s.				n.s.				n.s.

*I – 8-10 September, II – 9-10 October, III – 6-12 April

Table 8. Calcium and magnesium contents in Japanese bunching onion depending on the term of planting and type of flat cover (mean for 2010-2012)

Kind of flat cover	Calcium (% d.m.)				Magnesium (% d.m.)			
	term of planting				term of planting			
	I*	II	III	mean	I	II	III	mean
Perforated foil	1.04	1.27	1.43	1.25	0.12	0.19	0.20	0.17
Agrotextile	1.17	1.37	1.59	1.38	0.14	0.17	0.18	0.16
Control - without cover	1.25	1.31	1.46	1.34	0.16	0.15	0.18	0.16
Mean	1.15	1.32	1.49	1.32	0.14	0.15	0.19	0.16
LSD p = 0.05 for: term of planting				0.03				0.02
kind of flat cover				0.07				n.s.
interaction				0.12				n.s.

*I – 8-10 September, II – 9-10 October, III – 6-12 April

similarly to other species of vegetables with a short growing period. In most treatments it exceeded 2,000 mg kg^{-1} f.w., but, as in the case of phosphorus, it was not dependent on the term of seedling planting nor the type of cover applied. Therefore, the opinion of Zhu et al. (1998), regarding rather the low tendency of this vegetable to accumulate nitrates, could not be confirmed.

The potassium, calcium and magnesium content in younger plants obtained from seedling planting in the second term in autumn and from the spring planting was higher than in plants planted in the first term, in spite of a similar stage of development of the harvested plants. The results refer to the dependence between the age of the harvested plants and the content of magnesium and potassium in leeks, and in kohlrabi in the case of calcium and potassium (Biesiada et al. 2007). The effect of covers used in the experiment was limited only to lower potassium content, while it also referred to calcium in plants at harvest in the case of perforated foil.

CONCLUSIONS

1. The spring term of seedling planting at the beginning of April made it possible to obtain a satisfactory, marketable yield of Japanese bunching onion harvested for bunches at the end of May. The application of flat covers in the form of a perforated or agrotextile foil did not influence the yield size of this vegetable crop.
2. Seedlings planted in September were characterised by higher resistance to frost, but at the same time, they featured a higher tendency for bolting in the spring as compared to those planted at the beginning of October. In spite of the fact that the application of flat covers provided better wintering of plants, the marketable yield obtained from both autumn terms of planting was very low in all years of the study.
3. Plants obtained from the seedlings planted in the spring generally featured lower contents of dry matter, chlorophyll a+b, volatile oils and, at the same time, higher amounts of potassium, calcium and magnesium in comparison to those wintering in the field.
4. Covering plants with a perforated foil had a positive effect on the content of total sugars and volatile oils, yet the content of vitamin C, potassium and calcium in plants was decreased in relation to the uncovered control. The effect of covering plants with an agrotextile foil was mostly insignificant for changes in the plants' chemical composition.

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PLONOWANIE I WARTOŚĆ ODŻYWCZA CEBULI SIEDMIOLATKI W ZALEŻNOŚCI OD TERMINU SADZENIA I RODZAJU PŁASKIEJ OSŁONY

Streszczenie: W 3-letnim doświadczeniu polowym oceniono możliwości uprawy cebuli siedmiolatki odmiany 'Performer' na wczesny zbiór pęczkowy przy zastosowaniu jesiennego oraz wiosennego terminu sadzenia roślin. Rozsada produkowana w wielodoniczkach sadzona była na miejsce stałe w terminie 8-10 września, 9-10 października oraz 6-12 kwietnia. Rośliny sadzone jesienią okrywano folią perforowaną i włókniną w połowie listopada, zaś wiosną bezpośrednio po sadzeniu rozsady. Zdjęcie osłon znad roślin przeprowadzano w końcu kwietnia. Jednorazowy zbiór cebuli siedmiolatki wykonywano w końcu maja, określając odsetek roślin, które przezimowały oraz wytworzyły pędy kwiatostanowe, plon ogólny i handlowy o średnicy łodygi rzekomej >10 mm, a w próbkach części jadalnych oznaczono zawartość wybranych składników wartości odżywczej. Uzyskane wyniki badań dowiodły, że wysoki plon roślin na pęczki można uzyskać przy wczesno-wiosennym terminie sadzenia rozsady. Rośliny sadzone jesienią w znacznej części przemarzały w ciągu zimy, a na wiosnę wybijały w pędy kwiatostanowe, zwłaszcza przy sadzeniu we wrześniu. Zastosowanie płaskich osłon zwiększyło odsetek roślin zimujących, lecz mimo to uzyskany plon handlowy cebuli siedmiolatki sadzonej jesienią był bardzo niski. Rośliny sadzone na wiosnę posiadały mniejszą zawartość suchej masy, chlorofilu i olejków lotnych, więcej zaś K, Ca i Mg. Okrycie folią perforowana wpłynęło dodatnio na zawartość cukrów ogółem i olejków lotnych, ujemnie natomiast na nagromadzenie witaminy C, potasu i wapnia w roślinach przy zbiorze, w stosunku do uprawianych bez okrycia.

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