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EFFECT OF THE CONTROLLED FERTILIZATION ON THE MINERAL COMPONENTS OF CHOSEN VARIETIES OF ONION (*Allium cepa* L.) PART I. MACROELEMENTS

WPŁYW KONTROLOWANEGO NAWOŻENIA NA ZAWARTOŚĆ SKŁADNIKÓW POKARMOWYCH W WYBRANYCH ODMIANACH CEBULI (*Allium cepa* L.) CZ. I. MAKROSKŁADNIKI

Abstract: The main aims of conducted studies was the estimation of the controlled fertilization effect in case of 21 chosen cultivars of onion (*Allium cepa* L.) and the bulb storage in controlled conditions on their nutritive value based on the macroelement content: nitrogen, phosphorus, potassium, calcium, magnesium and sulphur. During the total period of vegetative experiments, controlled fertilization was applied based on cyclic soil analyses recommended in the Integrated Production of Vegetables. A significant effect was found to be exerted by the cultivars on the content of dry matter and macroelements in the onion bulbs. At the same time, no significant effect was found to be exerted by the storage on the content of dry matter as well as on potassium and calcium content in the onions. On the other hand, the storage significantly decreased content of nitrogen, phosphorus and sulphur with a simultaneous increase of magnesium content. Because of a high content in the onion dry matter of (average in d.m.) phosphorus (0.43 % P), calcium (1.97 % Ca) and magnesium (0.26 % Mg), onion is a valuable source of these elements in the human diet. The controlled fertilization based on regular chemical soil analyses is useful to obtain good quality crops in horticulture production.

Keywords: onion, controlled fertilization, macroelements, cultivar-induced differentiation, storage, nutritive value

Because of dietetic reasons, fresh vegetables should be frequently applied in human diets. The low content of dry matter causes that usually vegetables are characterized by a low caloric value. However, they are a very rich source of biologically active compounds. Vegetables are the basic sources of vitamins: C, A, B_1, B_2, B_6 and of such compounds as terpenoids, flavonoids, tannins and quinones [1]. Thanks to a high content of cellulose, they exert a favorable effect on the digestive duct facilitating food

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digestion [2]. Furthermore, vegetables are a valuable source of macro- and micro-elements. Among factors modifying the nutritive value of vegetables, one can mention, among others, the method of their cultivation [3], the applied fertilizers, both the mineral and the organic ones [4–7], the cultivar and the applied substrate [8, 9].

One of the most frequently consumed vegetables in Poland is onion which occupies in the consumption structure the 5th place (11 %), following immediately after tomatoes (17 %), cabbage (14 %), cucumbers (14 %) and carrot (13 %) [10]. On the seed-market, there are dozens of onion cultivars. Therefore, the essential question is the number of the nutritive components contained in the bulbs of the particular onion cultivars.

The main aims of conducted studies was the estimation of the controlled fertilization effect in case of 21 chosen cultivars of onion (*Allium cepa* L.) and the storage of onions in controlled conditions on their nutritive value based on the macroelement content: nitrogen, phosphorus, potassium, calcium, magnesium and sulphur on their macro-element, which extends both our knowledge in the field of human nutrition and in the field of onion cultivation.

Material and methods

The studies was carried out in 2008–2009 years in a private horticultural farm growing a collection of 83 onion cultivars, while the laboratory studies were carried out in the Department of Horticultural Plant Nutrition in the University of Life Sciences in Poznan. Twenty-one onion cultivars (*Allium cepa* L.) included: 'Bennito' (Seminis), 'Mission', 'Napoleon', 'Stamford' (Syngenta), 'Eureka', 'Wolska' (Vilmorin), 'Slawa Ozarowa', 'Sochaczewska', 'Wiktoria Skierniewic' (PNOS Ozarow Mazowiecki), 'Kutnowska' (PlantiCo Zielonki), 'Cymes', 'Topolska' (Polan), 'Grabowska' (Doruchowski, Zuranski), 'Lawica', 'Wojka', 'Wola' (Spojnia Nochowo), 'Marbella', 'Sherpa' (Frimeko), 'Tandem' (MoravoSeed), 'Aurora', 'Consuelo' (ISI Sementi).

Seed sowing was carried out in the period from the 15th to the 20th of April. During the whole period of studies, controlled fertilization was applied based on cyclical soil analyses carried out three times in the period of vegetation: before seed sowing, in the middle of the vegetation season and in the moment of onion leaves breaking down (end of vegetation). The soil before seeds sowing characterized following of average chemical composition [mg · dm^{-3}]: N-NH_4 12.0, N-NO_3 0.0, P-PO_4 49.0, K 75.1, Ca 720.0, Mg 44.1, S-SO_4 0.1, Cl 13.0, Fe 30.6, Mn 4.1, Zn 5.0, Cu 0.1, pH 7.80, EC 0.20 mS · cm^{-1}. The content of nutritive components was maintained based on the cyclic chemical soil analyses on the standard level [mg · dm^{-3}]: N 90.0, P 70.0, K 225.0, Mg 90.0, Fe 50.0, Mn 15.0, Zn 25.0, Cu 5.0, pH in H_2O 6.0–6.5, EC < 0.6 mS · cm^{-1} [11–13 modified]. It was used fertilizers in following doses (per ha): 180 kg of nitrate ammonium (34 % N), 300 kg of double phosphate (40 % P_2O_5), 200 kg of potassium sulphure (50 % K_2O), 150 kg of magnesium sulphure (16 % MgO), 30 kg manganese sulphure (32.3 % Mn), 30 kg zinc sulphure (22 % Zn), 40 kg copper sulphure (25.6 % Cu), 2 kg of borax (11.3 % B).

Experiment was established in a belt-and-row design. On one field patch, 5 rows were localized, where seeds were sown by a single-seed drill Monosem (seed density

was 100 seeds · m^2). Experimental plot for the given cultivar was represented by a field patch of 1.35 × 100 m divided into two blocks. All agrotechnical treatments were carried out according to the actual recommendations for onion cultivation. Yielding and plant health were optimal throughout the whole period of studies.

Soil samples were taken for analyses using Egner's sampling stick; 18–20 individual samples from the arable layer (0–20 cm) were mixed and the mixture constituted a representative mixed sample (0.4–0.5 dm^3). For chemical analyses, 20 cm^3 of soil in the state of actual moisture were taken using the Drews' instrument which permits to obtain the same sample density as it is in the given field patch [11]. The volumetric sample was transferred to a glass bulb and then, in order to extract macroelements and chlorides, active carbon and 200 cm^3 of extraction solution (acetic acid – 0.03 M CH_3COOH) were added in 1:10 proportion of soil to extraction solution. The suspension was shaken for 30 minutes in rotational agitator, and then, it was filtered. In order to determine microelements, a successive soil sample was taken, it was flooded with Lindsay's solution containing in 10 dm^3: 50 g of EDTA (ethylenediamine-tetraacetic acid), 90 cm^3 of 25 % NH_4OH solution, 40 g of citric acid, 20 g of $Ca(CH_3COO)_2 \cdot 2H_2O$ [11, 14] and then, the same procedure was carried out as in case of the extraction with acetic acid. Determination of components was performed using the following methods: nitrate nitrogen, ammonia nitrogen – by microdistillation method (according to Bremner in Starck's modification), phosphorus – colorimetrically using the phosphovanadomolybdic complex, potassium and calcium – by flame photometry, chlorides – nephelometrically with $AgNO_3$, sulphate sulphur ($S\text{-}SO_4$) –nephelometrically with $BaCl_2$, magnesium, iron, manganese, zinc and copper – by atomic absorption spectrometry (AAS) on Carl Zeiss Jena AAS apparatus. Furthermore, the following determinations were made: salinity (in EC units) – conductometrically at soil : water proportion = 1 : 2 (v/v).

After the termination of vegetation, representative mixed samples of plant material were taken (consisting of 18–20 healthy onions typical of the given cultivar), without any symptoms of mechanical damages or diseases. The collected plant material was divided into 2 parts. One half of the bulbs were peeled, sliced, dried at 45–50 ^oC and homogenized. The other half of the collected plant material was transferred for a period of 60 days to a refrigerator, where the temperature was maintained at 6 ^oC and 50 % of air humidity. After 60 days, the material was prepared according to the procedure – mentioned earlier and homogenized.

In order to determine the general forms of nitrogen, phosphorus, potassium, calcium and magnesium, the homogenized plant material was mineralized in concentrated sulphuric acid and sulphur was mineralized in a mixture of nitric(V) and chloric(VII) acids (3:1 v/v) [14]. After mineralization of plant material, the following determinations were made: total nitrogen – by distillation method acc. to Kjeldahl in Parnas-Wagner apparatus, phosphorus –colorimetrically with ammonium molybdate (acc. to Schillak), potassium, calcium and magnesium – by AAS method (on Carl Zeiss Jena AAS-3 apparatus), sulphur – nephelometrically with $BaCl_2$.

Analysis of variance was carried out and the effects of cultivars and of the storage method exerted on the content of macroelements in the onion bulbs were studied.

Coefficients of variance (CV) of nutritive components content were determined both before and after the storage of onion bulbs. Statistical analyses were carried out with the use of the Duncan's Test at the significance level of $\alpha = 0.05$.

Results and discussion

Effect of the cultivar on the contents of dry matter and macroelements

In our studies, a significant influence was found to be exerted by the cultivar on the content of dry matter in onion bulbs (Table 1).

Table 1

Effect of cultivar and of the storage on the content of dry matter [%], nitrogen [% N in d.m.], phosphorus [% P in d.m.] and on the coefficient of variation

Variety (A)	[% of dry matter]			N			P		
	T1(B)	T2(B)	Mean	T1(B)	T2(B)	Mean	T1(B)	T2(B)	Mean
'Aurora'	8.10	8.00	8.05	2.08	1.58	1.83	0.40	0.35	0.38
'Bennito'	9.20	8.83	9.02	2.59	2.19	2.39	0.80	0.45	0.63
'Consuelo'	8.40	7.10	7.75	1.71	1.73	1.72	0.40	0.35	0.38
'Cymes'	12.13	11.40	11.77	2.62	1.84	2.23	0.64	0.33	0.49
'Eureka'	10.87	10.20	10.54	2.58	2.45	2.52	0.47	0.34	0.41
'Grabowska'	8.73	8.66	8.70	2.30	2.73	2.52	0.39	0.40	0.40
'Kutnowska'	12.40	12.06	12.23	1.91	1.74	1.83	0.41	0.33	0.37
'Lawica'	11.56	10.00	10.78	2.20	2.03	2.12	0.40	0.39	0.40
'Marbella'	10.10	9.50	9.80	2.46	1.80	2.13	0.45	0.46	0.46
'Mission'	10.70	9.30	10.00	2.63	2.55	2.59	0.50	0.38	0.44
'Napoleon'	9.37	9.10	9.24	2.26	2.64	2.45	0.40	0.36	0.38
'Sherpa'	10.50	10.40	10.45	2.45	2.18	2.32	0.43	0.40	0.42
'Slawa Ozarowa'	9.80	9.50	9.65	2.23	2.18	2.21	0.35	0.37	0.36
'Sochaczewska'	11.83	11.80	11.82	2.23	2.50	2.37	0.43	0.36	0.40
'Stamford'	10.40	10.20	10.30	2.63	2.25	2.44	0.63	0.40	0.52
'Tandem'	9.50	8.80	9.15	1.78	1.88	1.83	0.38	0.35	0.37
'Topolska'	13.00	12.00	12.50	2.28	2.50	2.39	0.40	0.35	0.38
'Wiktoria Skierniewicka'	9.36	9.20	9.28	2.20	1.83	2.02	0.93	0.39	0.66
'Wojka'	11.00	10.70	10.85	2.46	2.19	2.33	0.42	0.37	0.40
'Wola'	10.60	9.20	9.90	2.20	2.06	2.13	0.47	0.38	0.43
'Wolska'	11.73	11.60	11.67	2.00	2.40	2.20	0.35	0.36	0.36
Mean	10.44	9.88	10.16	2.28	2.15	2.22	0.48	0.37	0.43
CV [%]	12.60	13.30	13.10	11.70	15.10	13.60	31.20	12.60	28.60
LSD for A	0.52			0.12			0.10		
LSD for B	n.s.			0.11			0.05		
LSD for A×B	0.70			0.13			0.07		

T1 – directly after harvest; T2 – after 60 days of storage; n.s. – no significant.

A higher dry matter content in the particular cultivars, usually predisposes them to a longer storage, while a smaller dry matter content qualifies them rather for fresh consumption. The smallest dry matter content included cultivars: 'Consuelo' (7.75 %) and 'Aurora' (8.05 %), while the highest dry matter content was shown by 'Kutnowska' (12.23 %) and 'Topolska' (12.50 %) (Table 1). The mean coefficient of variation (CV) for dry matter content (from the studied cultivars) was comparatively low (CV 13.1 %).

Similarly as in case of dry matter, also a significant variation was found in the contents of macroelements (nitrogen, phosphorus, potassium, calcium, magnesium and sulphur) in the onion bulbs. The determined nitrogen values ranged from 1.72 % N ('Consuelo') to 2.59 % N d.m. ('Mission') (Table 1). The determined low nitrogen coefficient of variation indicates that the content of this component (N) shows a comparatively small mean value (CV 13.6 %). Cultivars with the smallest content of phosphorus included: 'Slawa Ozarowa' (0.36 % P), 'Tandem' and 'Kutnowska' (each contained 0.37 % P). Significantly the highest content of P characterized the cultivar 'Wiktoria Skierniewicka' (0.66 % P). Calculated mean coefficient of variation for phosphorus was comparatively high (CV 28.6 %) which indicates high differences between the cultivars. The determined values of potassium ranged from 1.62 % K (in case of 'Wola' cultivar) to 2.55 % K ('Bennito' cultivar) (Table 2).

Table 2

Effect of cultivar and of the storage on the content of potassium [% K in d.m.] and calcium [% Ca in d.m.] and on the coefficient of variation

Variety (A)	K			Ca		
	T1(B)	T2(B)	Mean	T1(B)	T2(B)	Mean
'Aurora'	1.95	2.00	1.95	2.00	1.95	2.00
'Bennito'	2.55	2.22	2.55	2.22	2.55	2.22
'Consuelo'	2.13	2.12	2.13	2.12	2.13	2.12
'Cymes'	1.84	2.12	1.84	2.12	1.84	2.12
'Eureka'	2.13	1.84	2.13	1.84	2.13	1.84
'Grabowska'	1.75	2.05	1.75	2.05	1.75	2.05
'Kutnowska'	1.80	1.76	1.80	1.76	1.80	1.76
'Lawica'	1.71	2.06	1.71	2.06	1.71	2.06
'Marbella'	2.24	2.03	2.24	2.03	2.24	2.03
'Mission'	1.96	1.88	1.96	1.88	1.96	1.88
'Napoleon'	2.23	2.08	2.23	2.08	2.23	2.08
'Sherpa'	1.95	2.12	1.95	2.12	1.95	2.12
'Slawa Ozarowa'	2.10	2.04	2.10	2.04	2.10	2.04
'Sochaczewska'	1.93	2.25	1.93	2.25	1.93	2.25
'Stamford'	2.16	1.79	2.16	1.79	2.16	1.79
'Tandem'	1.63	1.63	1.63	1.63	1.63	1.63
'Topolska'	1.74	2.02	1.74	2.02	1.74	2.02
'Wiktoria Skierniewicka'	1.93	1.98	1.93	1.98	1.93	1.98
'Wojka'	1.82	2.14	1.82	2.14	1.82	2.14

Table 2 contd.

Variety (A)	K			Ca		
	T1(B)	T2(B)	Mean	T1(B)	T2(B)	Mean
'Wola'	1.62	1.88	1.62	1.88	1.62	1.88
'Wolska'	1.88	1.90	1.88	1.90	1.88	1.90
Mean	1.95	2.00	1.97	2.00	1.95	1.97
CV [%]	12.10	8.60	10.50	31.00	31.50	31.40
LSD for A		0.11			0.02	
LSD for B		n.s.			n.s.	
LSD for A×B		0.17			0.03	

Descriptions as in Table 1.

Potassium coefficient of variation was comparatively low and showed 10.5 %. In case of calcium, its content was significantly the lowest (1.63 % Ca) in 'Tandem' cultivar, while the highest value was shown in 'Sochaczewska' cultivar (2.25 % Ca) (Table 2). The determined coefficient of variation for calcium was high amounting to 31.4 %. Similarly as in case of calcium, the cultivar with the lowest content of magnesium was 'Tandem' (0.19 % Mg) (Table 3).

Table 3

Effect of cultivar and of storage on the content of magnesium [% Mg in d.m.] and sulphur [% S in d.m.] and on the coefficient of variation

Variety (A)	Mg			S		
	T1(B)	T2(B)	Mean	T1(B)	T2(B)	Mean
'Aurora'	0.19	0.31	0.25	0.37	0.41	0.39
'Bennito'	0.26	0.22	0.24	0.45	0.53	0.49
'Consuelo'	0.21	0.39	0.30	0.38	0.43	0.41
'Cymes'	0.20	0.41	0.31	0.52	0.40	0.46
'Eureka'	0.25	0.41	0.33	0.95	0.43	0.69
'Grabowska'	0.23	0.30	0.27	0.75	1.12	0.93
'Kutnowska'	0.21	0.32	0.27	0.62	0.43	0.53
'Lawica'	0.20	0.24	0.22	0.83	1.01	0.92
'Marbella'	0.25	0.25	0.25	0.85	0.40	0.62
'Mission'	0.23	0.27	0.25	0.64	0.40	0.52
'Napoleon'	0.23	0.25	0.24	0.85	0.40	0.63
'Sherpa'	0.26	0.28	0.27	0.59	0.45	0.52
'Slawa Ozarowa'	0.22	0.26	0.24	0.48	0.42	0.45
'Sochaczewska'	0.22	0.31	0.27	0.81	0.44	0.63
'Stamford'	0.26	0.25	0.25	0.69	0.42	0.56
'Tandem'	0.16	0.21	0.19	0.45	0.43	0.44
'Topolska'	0.20	0.35	0.28	0.69	0.55	0.62
'Wiktoria Skierniewicka'	0.22	0.22	0.22	1.00	0.48	0.74

Table 3 contd.

Variety (A)	Mg			S		
	T1(B)	T2(B)	Mean	T1(B)	T2(B)	Mean
'Wojka'	0.22	0.25	0.24	0.74	0.88	0.81
'Wola'	0.20	0.36	0.28	0.49	0.75	0.62
'Wolska'	0.21	0.28	0.25	0.51	0.42	0.46
Mean	0.22	0.29	0.26	0.65	0.53	0.59
CV [%]	13.80	21.20	23.70	28.80	40.30	35.40
LSD for A		0.07			0.12	
LSD for B		0.03			0.07	
LSD for A×B		0.03			0.11	

Descriptions as in Table 1.

The highest content of Mg was shown by 'Eureka' cultivar (0.33 % Mg). In reference to magnesium, the cultivars were characterized by a high variability (CV 23.7 %). A significant differentiation was found between the cultivars in the content of sulphur. The least content of sulphur was shown by 'Aurora' and 'Consuelo' (0.39 and 0.41 % S, respectively), while the highest S content was shown by 'Lawica' and 'Grabowska' cultivars (0.92 and 0.93 % S, respectively). Sulphur showed the highest variation among the studied nutritive components (CV 35.4 %).

Effect of onion storage on the content of dry matter and macroelements

No significant influence of onion storage in controlled conditions (temperature 6 ^{o}C, air humidity 50 %) was found to be exerted on their content of dry matter or on their content of potassium and calcium. The determined coefficients of variation (CV) for the contents of dry matter, both before and after storage, were similar (12.6 and 13.3 %, respectively). Together with the storage time, the content of nitrogen decreased significantly (from 2.28 to 2.15 % N d.m.), but the nitrogen content variation increased (from 11.7 to 15.1 %). Also the phosphorus content significantly decreased from 0.48 to 0.37 % P d.m. with a simultaneous decrease of the coefficient of variation from 31.2 to 12.6 %. Similarly as in case of nitrogen and phosphorus, also the sulphur content decreased (from 0.65 % to 0.53 % S). In turn, there was a significant increase of the mean content of magnesium (from 0.22 to 0.29 % Mg d.m.).

Nutritive value of onion in comparison with other vegetable species

Results of chemical analyses of onion in reference to the content of macroelements were compared with earlier studies referring to this species [3] and with other vegetable species: common white cabbage (leaves) [4], eggplant (fruits) [15], sweet pepper (fruits) [6], spinach (leaves) [5], tomato (fruits) [8] and potatoes (bulbs) [7]. Onion as species (the average from the studied cultivars) is characterized by a content of dry matter similar to the majority of the studied vegetables (Table 4). Distinctly a smaller dry

matter content was shown only by tomato fruits (6.52–6.94 % d.m.). Regarding nitrogen content, spinach contained distinctly less dry matter (0.65–0.77 % N), while potato contained the highest N content (15.4–17.3 % N d.m.). Among the comparable vegetable species, immediately after potato, onion contained the greatest amount of phosphorus (0.37–0.48 % P d.m.). In reference to potassium, onion was the last one among all studied vegetable species. Onion is a rich source of calcium (1.95–2.00 % Ca d.m.), although earlier studies showed distinctly lesser amounts of this element [3]. Magnesium content determined in the present studies (0.22–0.29 % Mg d.m.) was distinctly higher than that in the mentioned earlier studies [3]. Higher contents of magnesium were shown by spinach (1.02–1.10 % Mg d.m.) and potato (0.5–0.9 % Mg d.m.). There were no data referring to sulphur content in the comparable vegetable species.

Table 4

Contents of dry matter [% of d.m.] and macroelements [% in d.m.] in the edible part of selected vegetable species (according to different authors)

Species	Nutrient [% in d.m.]						
	Dry matter [%]	N	P	K	Ca	Mg	S
Onion – own studies	9.88–10.44	2.15–2.28	0.37–0.48	1.95–2.00	1.95–2.00	0.22–0.29	0.53–0.65
Onion	9.95–11.19	1.91–2.57	0.32–0.33	1.33–1.72	0.08–0.18	0.04–0.06	—
White cabbage	8.96–9.14	2.67–2.87	0.25–0.29	2.22–2.31	0.64–0.72	0.14–0.15	—
Eggplant	—	1.99–2.10	0.26–0.28	2.41–3.15	0.13–0.16	0.10–0.13	—
Sweet pepper	10.15–11.59	2.44–2.86	0.19–0.22	2.60–2.95	—	0.06–0.13	—
Tomato	6.52–6.94	1.91–2.66	—	3.49–4.12	0.12–0.16	0.13–0.16	—
Potato	—	15.4–17.3	2.5–3.1	14.1–16.2	0.7–1.2	0.5–0.9	—

Generally, human body demand for mineral elements is differentiated depending on age, body weight, physiological status (pregnancy, breast feeding) and sex (among others for magnesium, iron, zinc and selenium). Calcium and phosphorus are usually analysed together because the correct mineralization of human bones depends on the contents and proportions of these elements in the diet, as well as on the content of vitamin D. On the other hand, magnesium is mainly necessary for the regular functioning of the nervous and muscular systems [16]. Taking into consideration the nutritive value determined on the basis of nutritive components content in dry matter, one can conclude that onion is a valuable source of phosphorus, calcium and magnesium in the human diet. The controlled fertilization based on regular chemical soil analyses is useful to obtain good quality onion bulbs in horticulture production.

Conclusions

1. The factor which significantly modifies the content of dry matter and of macroelements in case of onion is the cultivar.

2. No differentiating effect was found to be exerted by the storage on the content of dry matter, as well as on the potassium and calcium contents in onion bulbs. However, storage significantly decreased the contents of nitrogen, phosphorus and sulphur – with a simultaneous increase of magnesium content.

3. Comparing the nutritive value of onion defined on the basis of the nutritive components contents with other vegetable species, one can conclude that onion – next to its specific taste values – is a valuable source of phosphorus, calcium and magnesium in the human diets.

4. The controlled fertilization based on regular chemical soil analyses is useful to obtain good quality crops in horticulture production. The consideration of chemical soil analyses in the fertilization programs may reduction and protection soil against possible contamination with excessive mineral fertilizers.

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WPŁYW KONTROLOWANEGO NAWOŻENIA NA ZAWARTOŚĆ SKŁADNIKÓW POKARMOWYCH W WYBRANYCH ODMIANACH CEBULI (*Allium cepa* L.) CZ. I. MAKROSKŁADNIKI

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Abstrakt: Głównymi celami przeprowadzonych badań była ocena wpływu kontrolowanego nawożenia w przypadku 21 wybranych odmiany cebuli (*Allium cepa* L.) oraz przechowywania cebuli w kontrolowanych warunkach na ich wartość odżywczą określoną na podstawie zawartości makroskładników: azotu, fosforu, potasu, wapnia, magnezu i siarki. Przez cały okres doświadczeń wegetacyjnych stosowano, polecane w Integrowanej Produkcji Warzyw, kontrolowane nawożenie poprzez cykliczne analizy gleby. Wykazano wyraźny wpływ odmiany na zawartość suchej masy i wspomnianych makroelementów w główkach cebuli. Równocześnie nie stwierdzono różnicującego wpływu przechowywania na zawartość suchej masy, a także potasu i wapnia w cebulach. Przechowywanie natomiast znacznie zmniejszało zawartość azotu, fosforu i siarki – przy równoczesnym znacznym wzroście zawartości magnezu. Ponadto cebula jest cennym źródłem zawartości (średnio w s.m.) fosforu (średnio 0,43 % P), wapnia (1,97 % Ca) oraz magnezu (0,26 % Mg) w diecie człowieka. Kontrolowane nawożenie korzystające z cyklicznych analiz chemicznych gleby jest użyteczne, by otrzymać dobrej jakości plony w produkcji ogrodniczej.

Słowa kluczowe: cebula, kontrolowane nawożenie, makroelementy, zróżnicowanie odmianowe, przechowywanie, wartość odżywcza