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THE INFLUENCE OF CONSERVATION TILLAGE ON THE MINERAL ELEMENTS CONTENT IN SOIL AND CHEMICAL COMPOSITION OF ONION

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Abstract. In a field experiment with conservation tillage of Wolska variety of onion the influence of cover plants such as spring rye (*Secale cereale*) and common vetch (*Vicia sativa*) as well as varied pre-sowing cultivation measures: no-tillage, disc harrowing during the spring, disc harrowing before the winter in comparison with conventional cultivation, on the content of mineral elements in soil and onion were studied. The content of mineral elements in soil and in onion was modified in greater degree by the changes in weather than by the agro-technical factors. No significant influence of conservation tillage on the content of mineral components in soil or in the onion was found. Soil covered with plant mulch contained slightly more potassium and magnesium in the arable layer in comparison with bare soil. The onion cultivated by using cover plants accumulated slightly more dry mass, N-total and potassium.

Key words: onion, conservation tillage, cover plants, rye, vetch, mulch

INTRODUCTION

Onion is one of the main vegetables cultivated in Poland. Its high nutritious aspects and taste values, in particular its health qualities are the reason of high consumption of onion, not only by itself, but also as an addition to many dishes. Onion is also an important export product. It is the first among all exported Polish vegetables [Mały rocznik statystyczny 2005, Strojewska 2006, Kaniszewski 2006, Wilson and Demmig-Adams 2007].

In developed countries, the quality and biological value of food is increasingly more important. The increase in the share of fruit and vegetables in consumption and the growing significance of pro-health ingredients in diet result in the consumers' searching for produce cultivated ecologically [Rembiałtowska 2003, Łuczka-Bakuła 2005].

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The conservation tillage of plants has a pro-ecological character. It combines the simplified field cultivation with usage of cover plants and it enriches the soil with organic matter.

Covering of soil surface with organic matter in the form of mulch prevents water- and wind-erosion, it positively affects the soil structure, it decreases its sealing and it prevents crusting, it also improves the infiltration and water retention, limits the evaporation of water from soil, decreases losses of nitrogen during the winter season, reduces weeds, and positively affects biological activity in the soil [Höppner et al. 1995, Kuś 1995, Nyakatawa et al. 2001, Parker et al. 2002].

The aim of this study, constituting a fragment of broader research, was to evaluate chemical composition of onion and the content of basic nutritive elements in soil in the conditions of conservation tillage that is under the influence of mulch cover plants and varied pre-winter and spring pre-sowing cultivation.

MATERIAL AND METHODS

The field experiment was conducted during years 2004–2006 in the Experimental Station Felin, on soil lessive, derived from medium silty loam. The experimental plant was onion (*Allium cepa* var. *cepa* Helm.) of the Wolska variety.

In the experimental scheme, founded using the random sub-block method in 4 replications, cover mulching plants were included: spring rye (*Secale cereale*) and common vetch (*Vicia sativa*) as well as varied cultivation: A) without the pre-sowing cultivation, that is the group of pre-sowing measures, sowing of mulching plants, in the spring direct sowing the onion in the mulch of spring rye and vetch, into the non-tilled field, B) group of pre-sowing measures, sowing of mulching plants, in the spring disc harrowing (mixing of plant mulch with soil) and measures leading to sowing of onion, C) group of pre-sowing measures, sowing of mulching plants, in the autumn disc harrowing (mixing of green mass of cover plants with soil), in the spring additional measures. The control (K) was the traditional tillage accompanied with pre-winter measures and spring pre-sowing without mulching plants. The cover plants were sown at the end of July in the year preceding the onion cultivation.

The onion seeds were sown in the 3rd decade of April in rows, every 35 cm. The mineral fertilizing: phosphorus in the amount of 66 kg P·ha^{-1} (in the form of triple super-phosphate) as well as potassium – 166 kg K·ha^{-1} (in the form of KCl) used before sowing; nitrogen (in the form of ammonium nitrate) – 75 kg N before sowing and 75 kg N·ha^{-1}as top dressing. The onion harvest was conducted at the beginning of September.

Every year, in the initial period of onion growth, during full vegetation and during harvesting, soil samples were taken for the chemical analyses from the tilled layer of soil (0-20 cm). The phosphorus and potassium content was determined using the Egner-Riehm method (P – collorimetrically, K – AAS method), magnesium (in 0,025N calcium chloride) using the AAS method, and the soil reaction – pH in KCl. In the commercial yield of onion the content in dry mass was determined: N-total – using Kjeldahl method, and after dry combustion: P – collorimetrically with ammonium vanade-molybdate, K, Ca, Mg – using the AAS method.

Table 1. Mean monthly air temperatures and amount of precipitation in ES Felin in the years 2004–2006

Tabela 1. Średnie miesięczne temperatury i sumy opadów w GD Felin w latach 2004–2006

	Year – Rok	Month – Miesiąc					
		IV	V	VI	VII	VIII	IX
Temperature Temperatura °C	2004	7.9	11.9	15.8	18.1	18.3	12.8
	2005	9.1	13.2	16.0	19.8	16.9	14.9
	2006	8.7	13.6	16.9	21.9	17.4	15.7
	mean– średnio 1951–2000	7.5	13.0	16.5	17.9	17.3	12.9
Amount of precipitation Suma opadów mm	2004	38.1	38.0	49.9	90.5	48.5	14.2
	2005	18.6	98.0	55.9	109.8	108.7	18.0
	2006	30.3	59.5	37.9	6.8	132.6	11.0
	mean– średnio 1951–2000	40.6	58.3	65.8	78.0	69.7	52.1

The results were statistically evaluated using the analysis of variance. The significance was determined using Tukey's test with $p = 0.05$.

RESULTS AND DISCUSSION

The soil reaction (pH) in the onion cultivation during the years 2004–2006 was from acidic to slightly acidic and it ranged from pH 4.87 to 6.09 (tab. 2). In the control plot, cultivated traditionally, the soil had a slightly higher pH than after conservation tillage, but in 2006 in the plots where the cover plant was rye pH of soil was somewhat higher. However, in all the cultivation treatments, were the cover plant was vetch the soil acidity was higher than in control soil in all years.

The weather during the study years had a considerable influence on the content of nutrients in soil under the cultivation of onion (tab. 3). In 2006 there was a substantially greater content of phosphorus (15.29 mg P·100 g^{-1}) and potassium (23.89 mg K) in soil comparing with the earlier years of studies. In 2005 the soil contained the fewest of the nutrients analysed. In that year, the lowest was also the content of magnesium in soil. Such a low content of potassium and magnesium in 2005 can be explained by the abundant precipitation. In total, during the vegetation period the rainfall in that year was 409 mm, while in 2004 and 2006 it was 279.2 and 278.1 mm, respectively. This caused the leaching of potassium and magnesium deeper into the soil profile.

The conservation tillage system used did not significantly influence the content of P, K and Mg in soil, although certain tendencies were observed. Irrespective of the year of research, the soil tilled traditionally contained slightly more phosphorus (14.03 mg P·100 g^{-1}) and less potassium (15.02 mg K·100 g^{-1}) than in conservation tillage plot (on average 12.12 mg P·100 g^{-1} and 17.63 mg K·100 g^{-1}). The increase of P and K content after mixing of the biomass of white mustard, vetch and phacelia with the soil, in comparison with traditional tillage without cover plants was also observed in other studies [Konopiński et al. 2003].

In our experiment, from among the variants of conservation tillage, the most P, K, and Mg in the tilled layer contained the non-tilled soil covered with plant mulch

(12.43 mg P, 18.57 mg K and 9.08 mg Mg·100 g^{-1}). The mixing of cover plants biomass with soil by pre-winter or spring harrowing caused slight decrease of K and Mg values in the tilled layer comparing with the treatment where the mulch covered the surface of the non-tilled soil. Covering of soil with plant mulch protected K and Mg from washing out into the deeper soil layers. The protective effect of plant covers on the nutrient contents in soil has been confirmed by other authors [Sanford 1982, Duer 1996, Willumsen and Thorup-Kristensen 2001].

Table. 2. Soil reaction (pH in KCl) in arable layer (0–20 cm) under onion cultivation in years 2004–2006

Tabela 2. Odczyn gleby (pH w KCl) w warstwie ornej (0–20 cm) w uprawie cebuli w latach 2004–2006

Treatment – Kombinacja		Soil reaction – Odczyn gleby		
Plant cover	soil tillage	pH in KCl		
Roślina okrywowa	uprawa roli	2004	2005	2006
Control –ontrola	K	6.09	5.61	5.10
Secale cereale	A	5.60	5.10	5.30
	B	5.01	5.47	5.50
	C	5.01	5.28	5.30
Vicia sativa	A	5.44	4.87	5.00
	B	5.32	5.17	4.90
	C	5.04	5.08	4.90

K – control: pre-winter ploughing + spring pre-sowing measures; A – direct sowing in non-tilled soil; B – spring disc harrowing + spring pre-sowing measures; C – pre-winter disc harrowing + spring pre-sowing measures

K - kontrola: orka przedzimowa + wiosenne uprawki przedsiewne; A - siew bezpośredni w rolę nieuprawnioną; B – talerzowanie wiosną + wiosenne uprawki przedsiewne; C - talerzowanie przed zimą + wiosenne uprawki przedsiewne

Vetch mulch increased potassium content in the soil (on average 18.61 mg K·100 g^{-1}) as compared to rye mulch (16.64 mg K) and control (15.02 mg K). The content of magnesium was lower in soil with vetch mulch (7.96 mg Mg·100 g^{-1}). The non-tilled soil covered with rye mulch contained the most magnesium (10.43 mg Mg·100 g^{-1}).

Based on the statistical analysis of the obtained data, we did not observe significant influence of cover plants used or the varied methods of cultivation on the dry mass content in the onion bulbs, as well as on the amounts of N-total, phosphorus, potassium, calcium, and magnesium. Certain regularities, however, were observed and they are described below (tab. 4, 5).

Dry mass. The content of dry mass in onion ranged from 9.61 to 11.86% (tab. 4). A tendency to increase the dry mass content in onion under influence of conservation tillage was observed. Higher content of dry mass in onion cultivated ecologically noted also Hallman and Rembiałtowska [2006]. This was also confirmed by the results of the studies with ploughing of the biomass of after-crop plants in the cultivation of white cabbage and red beet [Jabłońska-Ceglarek and Franczuk 2002, Jabłońska-Ceglarek and Rosa 2003]. However, in other studies Jabłońska et al. [2006] noted a decrease of dry

Table. 3. Content of nutrient elements in mg ·100 g-1 in arable layer (0–20cm) under onion cultivation in 2004–2006
Tabela 3. Zawartość składników pokarmowych w mg ·100 g-1 w ornej warstwie gleby (0–20cm) w uprawie cebuli w latach 2004–2006

Treatment – Kombinacja		Nutrient in mg 100 g^{-1} Składnik w mg 100 g^{-1}											
Cover plant Roślina okrywowa	soil tillage uprawa roli*	P				K				Mg			
		2004	2005	2006	Mean	2004	2005	2006	Mean	2004	2005	2006	Mean
Control – Kontrola	K	17.25	11.00	13.83	14.03	15.19	12.08	17.79	15.02	8.78	7.88	10.48	9.04
Secale cereale	A	12.03	10.18	16.17	12.79	16.01	9.65	23.66	16.44	13.00	7.78	10.50	10.43
	B	9.48	9.58	15.71	11.59	13.98	6.53	25.83	15.45	10.16	7.10	10.93	9.40
	C	9.25	11.20	16.30	12.25	14.88	13.73	25.52	18.04	8.84	7.68	9.63	8.71
	mean	10.25	10.32	16.06	12.21	14.96	9.97	25.00	16.64	10.67	7.52	10.35	9.51
Vicia sativa	A	12.38	8.75	15.09	12.07	24.58	11.85	25.65	20.69	7.59	6.70	8.89	7.73
	B	11.45	9.60	14.70	11.92	18.77	13.23	24.76	18.92	8.51	6.45	7.43	7.46
	C	11.48	9.55	15.21	12.08	12.81	11.83	24.03	16.22	10.75	7.13	8.16	8.68
	mean	11.77	9.30	15.00	12.02	18.72	12.30	24.81	18.61	8.95	6.76	8.16	7.96
Średnia – Mean	A	12.20	9.46	15.63	12.43	20.30	10.75	24.65	18.57	10.30	7.24	9.69	9.08
	B	10.46	9.59	15.20	11.75	16.37	9.88	25.30	17.18	9.33	6.78	9.18	8.43
	C	10.36	10.38	15.76	12.17	13.85	12.78	24.77	17.13	9.79	7.40	8.90	8.70
	mean	11.01	9.81	15.53	12.12	16.84	11.13	24.91	17.63	9.81	7.14	9.26	8.73
Mean – Średnia		11.90	9.98	15.29	12.39	16.60	11.27	23.89	17.25	9.66	7.24	9.43	8.78
$LSD_{0.05}$ for:	treatment – kombinacji		n.s.				n.s.				n.s.		
$NIR_{0.05}$ dla:	year – lat		2.50				4.17				1.53		

*Denotations as in table 2 – Oznaczenia jak w tabeli 2;
n.s. – not significant – różnice nieistotne

Table. 4. Contents of dry mass, nitrogen, and potassium in onion in years 2004–2006
Tabela 4. Zawartość suchej masy, azotu i fosforu w cebuli w latach 2004–2006

Treatment – Kombinacja		Dry mass – Sucha masa %				Nutrient in % d.m. – Składnik w % s.m.							
						N-total N-ogółem				P			
Cover plant Roślina okrywowa	soil tillage uprawa roli*	2004	2005	2006	Mean	2004	2005	2006	Mean	2004	2005	2006	Mean
Control Kontrola	K	9.99	10.86	9.85	10.23	2.10	2.27	2.57	2.32	0.41	0.31	0.32	0.34
Secale cereale	A	9.71	10.61	10.01	10.11	1.76	2.93	2.27	2.32	0.37	0.37	0.33	0.36
	B	10.89	11.23	10.15	10.76	1.76	2.76	2.31	2.28	0.35	0.38	0.33	0.35
	C	10.13	11.41	9.95	10.50	1.98	2.59	2.60	2.39	0.32	0.31	0.35	0.33
	mean	10.24	11.08	10.03	10.45	1.83	2.76	2.39	2.33	0.35	0.35	0.34	0.35
Vicia sativa	A	11.11	11.32	10.04	10.82	1.76	2.66	2.62	2.35	0.31	0.33	0.28	0.30
	B	11.67	11.04	10.03	10.92	1.84	2.36	2.72	2.31	0.26	0.28	0.33	0.29
	C	11.50	11.86	9.61	10.99	2.15	2.40	2.79	2.45	0.26	0.31	0.36	0.31
	mean	11.43	11.41	9.89	10.91	1.92	2.48	2.71	2.37	0.28	0.30	0.32	0.30
Średnia Mean	A	10.41	10.97	10.02	10.47	1.76	2.80	2.45	2.33	0.34	0.35	0.31	0.33
	B	11.28	11.14	10.09	10.84	1.80	2.56	2.52	2.29	0.31	0.33	0.33	0.32
	C	10.82	11.63	9.78	10.74	2.06	2.50	2.70	2.42	0.29	0.31	0.36	0.32
	mean	10.84	11.24	9.96	10.68	1.88	2.62	2.55	2.35	0.31	0.33	0.33	0.32
Średnia – Mean		10.72	11.19	9.95	10.62	1.91	2.57	2.55	2.34	0.33	0.32	0.33	0.33
$LSD_{0.05}$ for:	treatment – kombinacji		n.s.				n.s.				n.s.		
$NIR_{0.05}$ dla:	year – lat		0.66				0.33				n.s.		

*Denotations as in table 2, Oznaczenia jak w tabeli 2;
n.s. – not significant – różnice nieistotne

Table. 5. Contents of potassium, calcium, and magnesium in onions in years 2004–2006
Tabela 5. Zawartość potasu, wapnia i magnezu w cebuli w latach 2004–2006

Treatment – Kombinacja		Nutrient in % d.m. – Składnik w % s.m.											
Cover plant Roślina okrywowa	soil tillage uprawa roli*	K				Ca				Mg			
		2004	2005	2006	Mean	2004	2005	2006	Mean	2004	2005	2006	Mean
Control Kontrola	K	1.24	1.31	1.74	1.43	0.20	0.15	0.14	0.16	0.06	0.06	0.04	0.05
Secale cereale	A	1.50	1.43	1.67	1.53	0.17	0.12	0.08	0.12	0.08	0.06	0.04	0.06
	B	1.30	1.51	1.62	1.48	0.17	0.13	0.07	0.12	0.07	0.07	0.04	0.06
	C	1.30	1.04	1.78	1.37	0.19	0.15	0.09	0.14	0.06	0.06	0.04	0.06
	mean	1.37	1.33	1.69	1.35	0.18	0.13	0.08	0.13	0.07	0.06	0.04	0.06
Vicia sativa	A	1.55	1.40	1.74	1.56	0.17	0.10	0.11	0.13	0.06	0.06	0.04	0.05
	B	1.30	1.31	1.81	1.47	0.19	0.14	0.07	0.13	0.06	0.05	0.04	0.05
	C	1.14	1.32	1.69	1.38	0.18	0.12	0.05	0.12	0.06	0.06	0.04	0.05
	mean	1.33	1.34	1.75	1.47	0.18	0.12	0.08	0.13	0.06	0.06	0.04	0.05
Mean Średnia	A	1.52	1.42	1.70	1.55	0.17	0.11	0.10	0.13	0.07	0.06	0.04	0.06
	B	1.30	1.41	1.71	1.47	0.18	0.13	0.07	0.13	0.06	0.06	0.04	0.05
	C	1.22	1.18	1.73	1.38	0.19	0.14	0.07	0.13	0.06	0.06	0.04	0.05
	mean	1.35	1.33	1.72	1.47	0.18	0.13	0.08	0.13	0.06	0.06	0.04	0.05
Mean – Średnia		1.33	1.33	1.72	1.46	0.18	0.13	0.08	0.13	0.06	0.06	0.04	0.05
$LSD_{0.05}$ for: $NIR_{0.05}$ dla:	treatment – kombinacji	n.s.				n.s.				n.s.			
	year – lat	0.27				0.24				0.007			

*Denotations as in table 2 – Oznaczenia jak w tabeli 2;
n.s. – not significant – różnice nieistotne

mass content in cabbage cultivated after tilling of mulch consisted of vetch and phacelia. Whereas in the roots of parsley, the highest content of dry mass was observed when the mulch from vetch and phacelia were mixed with soil [Błażewicz-Woźniak and Mitura 2004]. In the roots of carrots the tilling of mulch from white clover caused a decrease of dry mass content in comparison with mineral fertilization and no fertilization [Adamczewska-Sowińska 2004]. Increase of dry mass content in the fruit of cucumber, tomato, and paprika in the ecological cultivation, in comparison with conventional methods was noted by Szafirowska and Babik [2005] and Hallmann et al. [2005].

Nitrogen. Content of total nitrogen (N-total) in the onion of the Wolska variety, regardless of the studied factors of the experiment was on average 2.34% d.m. (tab. 4). The onion harvested from the plots with vetch mulch contained slightly more nitrogen (2.37% d.m.) then onion from the soil with rye mulch (2.33% d.m.) and from the traditionally cultivated fields (2.32% d.m.). A positive influence of the biomass of vetch and other types from the family *Fabaceae* on the accumulation of nitrogen in vegetables is confirmed in other studies [Weerden et al. 2000, Willumsen and Thorup-Kristensen 2001, Konopiński 2003, Błażewicz-Woźniak and Mitura 2004]. In the analyzed experiment, the varied pre-sowing cultivation had slightly higher influence on nitrogen content than the usage of plant mulch. Most nitrogen (2.42% d.m.) was found in onion from the plots where the mulching plants were mixed with soil by pre-winter disc harrowing. The biomass of the cover plants introduced into the soil before the winter underwent mineralization and became a source of nitrogen for the onion plants [Cline and Silvernail 2001]. In the research of Adamczewska-Sowińska [2004], the biomass of white clover supplied more nitrogen than ryegrass, while ryegrass accumulated in its biomass more K, P, Mg and Ca. The content of $N\text{-}NO_3$ in the roots of celery cultivated after tilling in these mulches was proportional to the amount of biomass introduced in soil. In soils cultivated ecologically a distinct increase of biological activity is observed, which can explain the higher content of some mineral elements in ecological raw materials [Worthington 2001]. In the analyzed experiment, the disc harrowing of a soil covered with mulch in the spring limited most the supply of nitrogen for plants of onion (2.29% d.m.). The microbiological studies of soil from this variant of cultivation proved more bacteria and fungi [Pięta and Kęsik 2007], which could cause the immobilization of nitrogen during the decomposition of the plant parts and reduced the uptake of nitrogen by onion [Masiunas et al. 1996, Bottenberg et al. 1997]. Significant influence on nitrogen content in general in the onion had the weather in particular years of cultivation. The highest nitrogen content was observed in onion in 2006 (2.55% d.m.), and the lowest in 2004 (1.91% d.m.). Year 2006 was characterized by high temperatures and drought in June and July that is in the full vegetation period of onion (tab. 1). In August, when the onion should have been finishing its vegetation, heavy rainfall occurred and caused another vegetation of plants, which was shown by the low dry mass content in onion harvested in that year and the significant differences in nutrients' content (N-total, K, Ca and Mg).

Phosphorus. Regardless of the plant mulches used and the varied pre-sowing cultivation, the content of phosphorus in onion was 0.33% d.m. on average (tab. 4). Comparable methods of plant mulch usage and direct sowing did not have significant influence on phosphorus content in plants. Onion grown in rye mulch accumulated slightly more

phosphorus (0.35% d.m.) than in vetch mulch (0.30% d.m.). This can be explained with the acidic (ranging from pH 4.87 to 5.44) reaction of soil in the plots under vetch mulch, which caused substantial lowering of the phosphorus availability. The weather in particular years did not have an influence on the accumulation of phosphorus in onion. This element was stable and its content in plant, regardless of the effects of varied factors, remained at a constant level.

Potassium. Content of potassium in onion was 1.46% d.m. on average (tab. 5). The use of mulches increased slightly the uptake of this element by the onion plants. The influence of the pre-sowing cultivation measures on potassium content was observed. The maximum simplification of cultivation and direct sowing into mulched soil had a positive effect on the availability and supply of plants in potassium. In this treatment the onion was characterized by higher potassium content, on average 1.55% d.m. Lower content of this element (1.47% d.m.) showed the plants collected from plots on which the mulch was mixed with soil as a result of disc harrowing of soil in the spring, and the lowest, when this procedure was done before the winter (1.38% d.m.). This can be related to better moisture conditions under the mulch, which increased the availability of potassium for plants [Kęsik et al. 2007] as well as with the protective effects of mulch from washing out of potassium deeper into the soil, which is indicated by the highest content of potassium in soil in this cultivation treatment (tab. 2). The evaluation of the potassium content in onion in particular years of cultivation indicated significant influence of weather conditions on the uptake of this element. The most potassium in the dry mass was noted in onions picked in 2006 (1.72%). The highest phosphorus content and the lowest potassium content in the roots of scorzonera Konopiński [2003] noted after using white mustard mulch. The most potassium was accumulated in the roots of scorzonera after using the mulch of vetch.

Calcium. Calcium content in onion was on average 0.13% d.m. (tab. 5). Neither varied cultivation of plants, nor the way of pre-sowing cultivation, including the direct sowing, significantly affected the content of calcium. With various ways of using the plant mulches the calcium content in plants did not change and in all cases it was on average 0.13% d.m. The higher influence on the supply of plants in this element had the weather conditions in particular years of cultivation. The availability of calcium for the onion plants was the highest in 2004, in which its content in onion was the highest (0.18% d.m.), while the lowest content of calcium had the onions harvested in 2006 (0.08% d.m.).

Magnesium. Content of magnesium in onion was on average 0.05% d.m. and it ranged from 0.04 to 0.08% d.m. The compared ways of cultivation (the traditional and conservation tilling of soil) did not have any influence on the content of this element in plants. Similarly, we did not observe influence of varied pre-sowing cultivation or the mulches from rye and vetch on the intake of calcium. The lack of significant influence of the ploughed biomass with white clover and ryegrass and the content of N-total, P, K, Ca and Mg in the roots of carrot and celery was noted by Adamczewska-Sowińska [2004], while in the studies of Gundersen et al. [2000] the ecological cultivation influenced significantly the content of Mg and Ca in onion in comparison with the conventional method.

CONCLUSIONS

1. Content of the mineral elements in soil and in onion was modified in greater degree by the weather than the agro-technical factors.

2. No significant influence of conservation tillage on the mineral element content in neither soil nor the onion was observed.

3. Soil covered with plant mulch contained slightly more potassium and magnesium in the tilled layer of soil in comparison with the uncovered soil.

4. Onion cultivated with using of cover plants accumulated slightly more dry mass, N-total and potassium.

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WPŁYW UPRAWY KONSERWUJĄCEJ NA ZAWARTOŚĆ SKŁADNIKÓW MINERALNYCH W GLEBIE I SKŁAD CHEMICZNY CEBULI

Streszczenie. W doświadczeniu polowym z uprawą konserwującą cebuli odm. Wolska badano wpływ zastosowania roślin okrywowych: żyta jarego (*Secale cereale*) i wyki siewnej (*Vicia sativa)* oraz zróżnicowanych sposobów uprawy przedsiewnej: uprawa zerowa, talerzowanie wiosną, talerzowanie przed zimą w porównaniu z uprawą konwencjonalną, na zawartość składników mineralnych w glebie i w cebuli. Zawartość składników mineralnych w glebie i w cebuli była modyfikowana w większym stopniu przebiegiem pogody niż czynnikami agrotechnicznymi. Nie stwierdzono istotnego wpływu uprawy konserwującej na zawartość składników mineralnych w glebie i w cebuli. Gleba okryta mulczem roślinnym zawierała nieco więcej potasu i magnezu w warstwie ornej w porównaniu z glebą nieosłoniętą. Cebula uprawiana z użyciem roślin okrywowych gromadziła nieznacznie więcej suchej masy, N-ogółem i potasu.

Słowa kluczowe: cebula, uprawa konserwująca, rośliny okrywowe, żyto, wyka, mulcz

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