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THE SULFUR CONTENT IN SOIL AFTER APPLICATION OF COMPOSTED MATERIALS CONTAINING FOILS

ZAWARTOŚĆ SIARKI W GLEBACH PO APLIKACJI PRZEKOMPOSTOWANYCH MATERIAŁÓW Z DODATKIEM FOLII

Abstract: The aim of the research was to assess the content of total and assimilable forms of sulphur in soil after application of composted materials with the addition of polyethylene and corn starch foils. The experimental design consisted of 7 treatments carried out in 3 replications on two soils: 0 – non-fertilized soil, NPK – soil fertilized with mineral fertilizers, K1 – soil fertilized with composted material without the addition of foil, K2 – soil fertilized with composted material with the addition of foil A (which included 47.5% polyethylene C + 45% corn starch + 7.5% compatibilizer), K3 – soil fertilized with composted material with the addition of foil B (which included 65% polyethylene C + 30% corn starch + 5% compatibilizer), K4 – soil fertilized with composted material with the addition of foil C (which included 65% polyethylene C + 30% corn starch + 5% compatibilizer and copolymer), and K5 – soil fertilized with composted material with the addition of foil C and microbiological inoculum. The experiments were conducted in soils with the granulometric composition of light loam and medium loam. Cock's-foot was the test plant. The mean yield of *Dactylis glomerata* L., collected from the treatments located in soil with the granulometric composition of light loam, was between 1.4 and 2.4 Mg d.m. $\cdot$ ha^{-1} and between 1.8 and 3.6 Mg d.m. $\cdot$ ha^{-1} for treatments conducted in soil with the granulometric composition of medium loam. Total S content was determined after sample mineralization in a chamber furnace at 450^{o}C for 8 h, after prior binding of sulphur sulfate $Mg(NO_3)_2$. Assimilable forms of S were extracted with solution of 0.03 mol $\cdot$ dm^{-3} CH_3COOH. The S content in the obtained solutions and extracts was determined using the ICP-OES method. The highest content of total forms of sulphur was determined in soil with the granulometric composition of medium loam, to which composted materials K3 and K4 (220 mgS $\cdot$ kg^{-1} d.m. of soil) were introduced. The content of assimilable forms of sulphur ranged from 8.3 to 12.9 mgS $\cdot$ kg^{-1} d.m. of soil in the case of treatments located in soil with the granulometric composition of light loam, and from 13.1 to 17.4 mgS $\cdot$ kg^{-1} d.m. of soil for medium loam treatments.

Keywords: soil, compost, sulphur, polyethylene, corn starch, *Dactylis glomerata* L.

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Introduction

As a result of pro-environmental actions (aiming at restricting the emission of sulphur compounds to the atmosphere by industry), limiting the use of natural and organic fertilizers, and increasing the acreage of plants with high demands for sulphur, an increasing sulphur deficiency in soil has been observed in many countries (including Poland) [1–3]. Forecasts made the Sulphur Institute indicate that the global deficit of this element in 2015 will amount to 12.5 mln Mg [4]. Taking into account the problem of sulphur deficiency in soils, the need for fertilization with this element is becoming more and more important [5]. It is necessary to take innovative and effective actions to improve the balance of this element in Polish soils. There is also a real need to provide plants with adequate amounts of sulphur (through fertilization).

A way to improve the nutrient balance in soil, including sulphur, may be to apply composts (among other things), and using biodegradable waste for composting may solve many problems connected with waste management [6]. Mineralization and humification of organic matter, which take place during biological processing of biomass, lead to significant changes in physical, chemical, and biological properties of the composted biomass [7]. An addition of structure-forming materials (*eg* post-use polymeric materials) may have a positive effect on the rate and direction of the process. Plastics waste constitutes a serious problem (both ecological and economic) many EU Member States have been wrestling with for many years [8], and composting of this waste may find wide application in decomposition of such materials [9].

Composting of polymeric materials is an alternative solution which will undoubtedly contribute to reducing the stream of waste getting into landfills [10]. However, the rate of degradation of such materials is influenced by a lot of factors, such as their chemical structure, molecular weight, supermolecular structure, physical properties, and the degree of size reduction [11]. In recent years there have been many studies on developing polymeric materials that would undergo biodegradation in the natural environment. One way is to diversify their chemical composition by addition of a biocomponent which can significantly diversify properties of polymers and in consequence decide on their susceptibility to disintegration and biodegradation [12].

Taking into account the possibility of natural use of products (obtained in the composting process) with the addition of polyethylene and corn starch foils, in terms of improving the balance of nutrients (including sulphur) in soil, studies have been conducted aiming at evaluating the content of selected sulphur forms in soil.

Material and methods

The assessment of the effect of application of composted plant materials with the addition of polyethylene and corn starch foils to soil on the content of total and assimilable forms of sulphur in the soil was conducted in field experiment conditions. The experiments were located at the Experimental Station of the Faculty of Agriculture and Economics in Krakow in Mydlniki. The research was conducted in 2013 in soil with the granulometric composition of light loam (hereinafter referred to as light soil) and of medium loam (hereinafter referred to as medium soil). Selected properties of the soil material prior to the commencement of the research are presented in Table 1.

Table 1

Some chemical properties of soils material before establishment of experiments (0–20 cm)

Determination	Unit	Light loam	Medium loam
pH in H_2O	—	7.03 ± 0.02*	6.84 ± 0.02
pH in KCl	—	5.60 ± 0.51	5.95 ± 0.40
Electrolytic conductivity	[mS · cm^{-1}]	0.05 ± 0.01	0.02 ± 0.01
Organic C		9.23 ± 0.01	9.24 ± 0.02
Total N	[g · kg^{-1} d.m.]	0.84 ± 0.03	1.02 ± 0.01
Total S		0.10 ± 0.02	0.15 ± 0.07

* ± standard deviation, n = 3.

The micro-plot experiments were set up with the randomized blocks method. The area of a plot was 1 m^2 (which was dictated by a reduced amount of produced materials). Doses of the composted materials were calculated based on nitrogen content in them (Table 4). Phosphorus and potassium were topped up to the highest amounts amended with composted material. These two elements were applied in the form of enriched triple superphosphate and potassium salt. Mineral components in the treatment marked as NPK were used in equivalent doses to those in treatments where composted materials were used but in the form of mineral fertilizers (N – ammonium nitrate, P – enriched triple superphosphate, and K – potassium salt). In all the treatments (except the control treatment), total NPK doses introduced before sowing (with composted materials and with mineral fertilizers) and for top dressing after harvest of the first and second cuts (mineral fertilization) were: 170 kgN · ha^{-1}, 40 kgP · ha^{-1}, and 120 kgK · ha^{-1}. After application of composted materials and mineral fertilizers, followed by mixing them with soil, *Dactylis glomerata* L. seeds were sown, and then rolling was conducted.

The experimental design consisted of 7 treatments carried out in three replications:
– 0 – soil without fertilization,
– NPK – soil fertilized with mineral fertilizers (NPK),
– K1 – soil fertilized with composted material I without the addition of foil,
– K2 – soil fertilized with composted material II with the addition of foil A,
– K3 – soil fertilized with composted material III with the addition of foil B,
– K4 – soil fertilized with composted material IV with the addition of foil C,
– K5 – soil fertilized with composted material V with the addition of foil C and microbiological inoculum.

The biomass for composting was prepared from rape straw, wheat straw, freshly chipped corn, and from waste generated during cleaning of pea seeds. The mixture of the crushed and moistened components was prepared assuming a value of the C:N ratio ~ 30:1 as optimal for the conditions of the composting process. The assumed C:N value was obtained at the following proportion of biomass components: corn chips – 13.1 kg d.m., rape straw – 4.3 kg d.m., wheat straw – 8.3 kg d.m., and waste from cleaning of pea seeds – 2.8 kg d.m. After mixing, the materials were moistened to approximately 45%. Selected properties of the components used for biomass preparation are presented in Table 2.

Table 2

Some chemical properties of raw materials used to prepare a mixture of composts

Material	Dry matter	Organic matter	Total N	Total S
	$[g \cdot kg^{-1}]$	$[g \cdot kg^{-1}$ d.m.]		
Wheat straw	*941.5 ± 1.3*	996.7 ± 4.3	5.2 ± 0.8	0.26 ± 0.01
Rape straw	945.0 ± 2.0	990.0 ± 2.0	9.2 ± 0.3	0.28 ± 0.00
Waste from the cleaning of pea seeds	905.2 ± 1.9	944.3 ± 20.0	35.6 ± 0.8	0.90 ± 0.01
Corn chips	932.2 ± 0.6	960.1 ± 0.5	7.0 ± 0.3	0.89 ± 0.07

* ± standard deviation, n = 3.

8 per cent (in relation to dry matter of the mixture) of crushed polymeric materials (foils) which had been produced at the Central Mining Institute in Katowice was added to such prepared biomass. The foils used in the research differed in density, share of polyethylene and of corn starch (Table 3). The percentage of polymeric materials introduced to the composted biomass was limited not only due to physical parameters of the used foils, but also due to technological restrictions. Foils F(B) and F(C) had the highest (65%) content of polyethylene C. The foils which were subjected to composting contained 30% corn starch and 5% compatibilizer. On the other hand, foil F(A) contained 45% corn starch and 7.5% compatibilizer.

Table 3

Selected compositions of polymeric films used for composting

Foil	Polyethylene C	Corn starch	Compatibilizer
	[% d.m.]		
F(A)	47.5	45.0	7.5
F(B)	65.0	30.0	5.0
F(C)	65.0	30.0	5.0 + copolymer

The following were determined in the materials used for the research, in the soil material before commencement of the field experiments, and in the soil material collected after harvest of the second cut: total nitrogen content by Kjeldahl method after prior $N\text{-}NO_3$ reduction with Devarda's alloy and mineralization of the material sample in concentrated sulphuric acid in an open system; organic carbon content by oxidation-titration method; and total sulphur content was determined after sample mineralization in a chamber furnace at 450°C for 12 hours, after prior binding of sulphate sulphur with $Mg(NO_3)_2$ solution. Assimilable forms of sulphur were determined after extraction with CH_3COOH with the concentration of 0.03 mol · dm^3. Sulphur content in the solutions and extracts was determined using the ICP-OES method on a Perkin Elmer Optima 7300 DV instrument (Table 4). The presented results of the analyses are an arithmetic mean from 3 replications. Standard deviations (SD) were computed for the arithmetic mean values presented in the tables. The significance of differences between arithmetic means was verified on the basis of homogenous groups determined by Tukey's test at the significance level $\alpha \le 0.05$. All statistical computations were conducted using Statistica PL package (version 12.5).

Table 4

The nitrogen and sulfur content in the composted materials used in the experiment

Determination	Composted material				
	I	II	III	IV	V
	[g · kg^{-1} d.m.]				
Total N	28.5 ± 0.1*	27.7 ± 0.1	23.3 ± 0.3	23.0 ± 0.2	27.1 ± 0.7
Total S	3.4 ± 0.2	2.8 ± 0.5	2.9 ± 0.1	3.8 ± 0.2	3.5 ± 0.2

* ± standard deviation, n = 3.

The course of weather conditions during the experiment varied especially between individual months. The greatest amount of precipitation (total from April to September) was recorded in June, and the smallest in April. The highest mean annual air temperature was recorded in July. Meteorological conditions (precipitation, temperature) during the experiment are shown in Fig. 1.

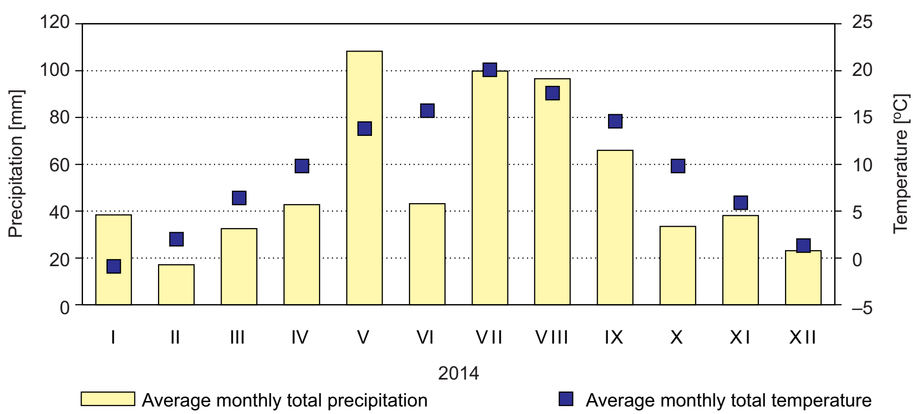

Fig. 1. Monthly and periodic total precipitation and mean daily air temperature in study year

Results and discussion

The ability to use the yield-forming role of sulphur remains an important part of agricultural science. Undoubtedly one of the actions whose purpose is to improve the balance of sulphur in soil is to add this element to multi-component mineral fertilizers (which in recent years have become more and more popular among farmers) [13–14]. Organic materials generated from waste substances might be another alternative source of this element. Reuse of waste organic matter for plant and soil fertilization now appears to be one of the most rational ways of its management.

The amount and rate of uptake of sulphate anions depend on many factors, the most important of which are: soil reaction, atmospheric conditions, content of organic matter, and type of flora. Based on the authors' own research it was established that soil fertilization with composted materials with the addition of foil did not have a significant effect on the change in soil reaction (Table 5). Treatments K2 and K5, conducted in light soil, were an exception – a significant increase (by 0.8 unit) in pH value took place there. The pH values of the treatments conducted on medium soil, with respect to the control treatment, increased by 0.2 to 0.4 unit depending on the applied fertilization. Similarly to the case of light soil, the highest pH value was found in the soil to which composted material with the addition of foil C and microbiological inoculum (K5) was added.

Table 5

pH, nitrogen and organic carbon content in soil (0–10 cm)

Object	Light loam			Medium loam		
	pH KCl [-]	Total N	Organic C	pH KCl [-]	Organic C	Total N
		$[g \cdot kg^{-1}$ d.m.]			$[g \cdot kg^{-1}$ d.m.]	
0	$5.5^{a} \pm 0.2$*	$0.80^{a} \pm 0.09$	$8.5^{a} \pm 1.2$	$5.5^{a} \pm 0.3$	$10.7^{ab} \pm 0.3$	$1.06^{abcd} \pm 0.03$
NPK	$5.9^{abc} \pm 0.5$	$0.82^{a} \pm 0.08$	$8.4^{a} \pm 0.7$	$5.7^{abc} \pm 0.4$	$11.6^{ab} \pm 1.2$	$1.05^{abcd} \pm 0.03$
K1	$5.4^{a} \pm 0.3$	$1.01^{abcd} \pm 0.16$	$11.6^{ab} \pm 2.0$	$5.5^{a} \pm 0.2$	$12.9^{ab} \pm 0.9$	$1.20^{cd} \pm 0.06$
K2	$6.3^{bc} \pm 0.2$	$0.93^{abc} \pm 0.14$	$10.9^{ab} \pm 1.4$	$5.8^{abc} \pm 0.1$	$12.6^{ab} \pm 1.2$	$1.16^{bcd} \pm 0.07$
K3	$5.5^{a} \pm 0.4$	$1.05^{abcd} \pm 0.14$	$10.9^{ab} \pm 1.1$	$5.7^{abc} \pm 0.2$	$14.3^{b} \pm 0.6$	$1.28^{d} \pm 0.09$
K4	$5.5^{a} \pm 0.2$	$0.97^{abc} \pm 0.13$	$10.8^{ab} \pm 1.8$	$5.7^{abc} \pm 0.1$	$13.2^{ab} \pm 1.3$	$1.21^{cd} \pm 0.10$
K5	$6.3^{bc} \pm 0.3$	$0.87^{ab} \pm 0.11$	$10.2^{ab} \pm 2.0$	$5.9^{abc} \pm 0.1$	$12.4^{ab} \pm 1.9$	$1.14^{bcd} \pm 0.13$

* ± standard deviation, n = 3; Means followed by the same letters in columns did not differ significantly at $\alpha \leq 0.05$ according to the t-Tukey test.

The organic carbon content in the soil material ranged from 8.42 to 10.9 $g \cdot kg^{-1}$ d.m. for the treatments conducted on light soil, and from 10.7 to 14.3 $g \cdot kg^{-1}$ d.m. for treatments conducted on medium soil (Table 5). A beneficial effect of application of composted materials on the increase in organic carbon content in both soils was recorded. Compared to the organic carbon content in the soil material taken from the control treatments (0), application of composted materials with the addition of foil marked F(B) had a significant and beneficial effect on the content of this element, regardless of soil type. Soil fertilization with composted materials with the addition of foil F(C) and microbiological inoculum (K5), regardless of soil type, caused a reduction of organic C content in comparison with the soil to which composted material with the addition of the same foil F(C) but without microbiological inoculum was introduced (K4).

When analyzing total nitrogen content in the soils fertilized with composted materials with the addition of foil it was found that the content of this element was varied, depending on applied fertilization and soil granulometric composition. Total nitrogen content in light soil, regardless of treatment, ranged from 0.80 to 1.05 gN · kg^{-1} d.m. (Table 5). Total nitrogen contents in medium soil were higher and ranged from 1.05 to 1.28 gN · kg^{-1} d.m. Regardless of soil granulometric composition, the highest nitrogen content was determined in the treatment into which composted material with the addition of foil F(B) was applied (K3).

Motowicka-Terelak and Terelak [15] and Kabata-Pendias et al [16] state that total sulphur content in Polish soils is varied and depends on organic matter content, soil granulometric composition, and on the level of industrial emissions. Based on the authors' own research it was found that the content of total forms of sulphur was between 150 and 180 mgS · kg^{-1} d.m. in the treatments located on light soil, and between 190 and 220 gS · kg^{-1} d.m. in the treatments located on medium soil (Table 6). Kulczycki and Spiak [17] also state that agriculturally used soils of south-western Poland contain between 72 and 490 gS · kg^{-1} d.m. The contents of total sulphur determined in the soil material coming from the field experiments are within the range given by the quoted authors and do not indicate contamination with this element. Assessment of the content of total sulphur in the examined soil material, taking into account the agronomic category of the soil and conducted according to the elaboration by Kabata-Pendias et al [16], showed that the content of total forms of this element determined in all the treatments fertilized with composted materials with the addition of foil (introduced on light and medium soil) corresponded with mean content. Low total sulphur content was found in both soils in the treatment without fertilization (0) and in the treatment fertilized with mineral fertilizers (NPK).

Table 6

Total and assimilable forms of sulphur content in soil

Object	Light loam		Medium loam	
	Total S	Assimilable S	Total S	Assimilable S
	[mg · kg^{-1} d.m.]		[mg · kg^{-1} d.m.]	
0	$148.04^{ab} \pm 0.02$	$9.22^{abc} \pm 0.76$	$195.80^{b} \pm 0.01$	$13.1^{abcd} \pm 1.8$
NPK	$153.18^{ab} \pm 0.02$	$12.9^{abcd} \pm 2.9$	$192.20^{b} \pm 0.01$	$13.1^{abcd} \pm 1.1$
K1	$183.86^{b} \pm 0.03$	$12.7^{abcd} \pm 4.7$	$211.49^{b} \pm 0.01$	$16.6^{cd} \pm 2.7$
K2	$182.51^{b} \pm 0.03$	$10.2^{abcd} \pm 2.0$	$208.19^{b} \pm 0.03$	$16.6^{cd} \pm 3.0$
K3	$182.47^{b} \pm 0.02$	$8.97^{ab} \pm 0.39$	$219.73^{b} \pm 0.02$	$12.5^{abcd} \pm 1.0$
K4	$181.21^{b} \pm 0.03$	$12.0^{abcd} \pm 4.3$	$216.57^{b} \pm 0.02$	$17.4^{d} \pm 3.7$
K5	$158.40^{ab} \pm 0.03$	$8.3^{ab} \pm 1.1$	$203.51^{b} \pm 0.02$	$16.2^{bcd} \pm 1.4$

In the experiment located on light soil, application of composted organic materials with the addition of foil caused a 20% increase in total S content in comparison to the control treatment (without fertilization) and the treatment where fertilization with mineral fertilizers was applied (Table 6). In the case of the treatments located on medium soil, the most beneficial effect was recorded after application of composted materials with the addition of foil F(B) and F(C) in treatments K3 and K4. It was also found that soil fertilization with composted plant materials with the addition of foil and microbiological inoculum (K5) contributed to the decrease in the content of total forms of sulphur, as compared with the treatment in which the same composted material, but without the addition microbiological inoculum, was applied (K5). A similar dependence was observed in the case of analogical treatments located on light soil. However, a statistical analysis of the obtained results did not confirm the significant differences.

In the majority of agriculturally used soils in Poland the content of assimilable forms of sulphur does not exceed 25 mg $\cdot$ kg^{-1} soil, and in approximately 70% of the area of agricultural lands this content is within a range from 5 to 20 mg $\cdot$ kg^{-1} soil [18]. Based on the authors' own research it was found that the content of assimilable forms of sulphur was much more diversified than in the case of total forms and was between 8.28 and 12.89 mgS $\cdot$ kg^{-1} d.m. for the treatments located on light soil, and between 12.5 and 17.4 mgS $\cdot$ kg^{-1} d.m. for the treatments on medium soil (Table 6). According to the limit values proposed by Lipinski et al [18], the analyzed light soil was classified into soils of average content of this element (10.1–15.0 mgS $\cdot$ kg^{-1} d.m.), whereas the medium soil had a high content of assimilable forms of sulphur (15.1–20 mgS $\cdot$ kg^{-1} d.m.). According to Terelak et al [19], the mean sulphate content in sandy soils amounts to 15 mg $\cdot$ kg^{-1} d.m., whereas in heavy loam soils it is 20 mg $\cdot$ kg^{-1} d.m. In the authors' own research the content of assimilable forms of sulphur was determined in medium soil in treatment K4, in which fertilization with composted material with the addition of foil F(C) (17.4 mgS $\cdot$ kg^{-1} d.m.) was applied. This may have been directly influenced by the content of this element amended with the composted material IV (Table 4). Attention should also be drawn to the fact that both light and medium soil (to which the same composted material but with the addition of microbiological inoculum was added) had a lower content of assimilable forms of sulphur.

The average percentage of assimilable forms of sulphur in the total content of this element for the treatments located on light soil was 6.3%, whereas for the treatments on medium soil it was 7.3%. A similar percentage of sulphate sulphur in the total content of this element was shown in the research by Kulczycki and Spiak [17]. According to Kalembasa and Godlewska [20], the content of assimilable forms of sulphur is directly associated with the content of total forms of this element in soil, and soil fertilization with composts does not cause larger changes in the content of assimilable forms of S in soil. Szulc et al [1] highlight that changes in the content of sulphates in soil are conditioned mainly by transformations of organic matter.

Despite little diversification in the content of individual forms of sulphur in soil depending on applied fertilization, the carbon to sulphur ratio indicates an advantage of mineralization processes of sulphur-containing organic compounds in all the analyzed treatments. As numerous studies show, at C:S ratio < 200 mineralization is predominant, and immobilization of sulphur compounds is predominant only at C:S ratio >

400 [21, 22]. Rejman-Czarnecka [23] states that at C:S ratio below 50 relative sulphur deficiency in soil takes place, which may result in reduction of plant yield and deterioration of yield quality. Relatively low values of the C:S ratio (light soil: between 57 and 64; medium soil: between 56 and 65) were found in this research. Similar values of the C:S ratio (between 53 and 58) were found in the research of Kulczycki and Spiak [17].

Conclusions

1. In comparison to the soils fertilized with mineral fertilizers, the most beneficial effect on the increase in content of total forms of sulphur was found after application of composted plant materials with the addition of foils (F(B) and F(C)) with 30% corn starch, regardless of soil.

2. The average percentage of assimilable forms of sulphur in the total content of this element for the treatments located on light and medium soil did not exceed 10%.

3. The content of assimilable forms of sulphur in the soil with the granulometric composition of medium loam, after fertilization with composted materials with the addition of foil, increased by, on average, 21% compared with the soil fertilized only with mineral fertilizers. A reverse dependence was found in the case of light soil, where a decrease in content of assimilable forms of sulphur by, on average, 19% took place.

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ZAWARTOŚĆ SIARKI W GLEBACH PO APLIKACJI PRZEKOMPOSTOWANYCH MATERIAŁÓW Z DODATKIEM FOLII

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Abstrakt: Celem badań była ocena zawartości form ogólnych oraz przyswajalnych siarki w glebie po aplikacji materiałów przekompostowanych z dodatkiem folii otrzymanych z polietylenu i skrobi kukurydzianej. Schemat doświadczenia obejmował 7 obiektów prowadzonych w 3 powtórzeniach na dwóch glebach: 0 – gleba nienawożona, NPK – gleba nawożona nawozami mineralnymi, K1 – gleba nawożona materiałem przekompostowanym bez dodatku folii, K2 – gleba nawożona materiałem przekompostowanym z dodatkiem folii A zawierającej 47,5% PE C + 45% skrobi kukurydzianej + 7,5% kompatybilizatora, K3 – gleba nawożona materiałem przekompostowanym z dodatkiem folii B zawierającej 65% PE C + 30% skrobi kukurydzianej + 5% kompatybilizatora, K4 – gleba nawożona materiałem przekompostowanym z dodatkiem folii C zawierającej 65% PE C + 30% skrobi kukurydzianej + 5% kompatybilizatora i kopolimer oraz K5 – gleba nawożona materiałem przekompostowanym z dodatkiem folii C i szczepionki mikrobiologicznej. Eksperymenty przeprowadzono na glebach o składzie granulometrycznym gliny lekkiej oraz gliny średniej. Rośliną testową była kupkówka pospolita. Średni plon biomasy kupkówki pospolitej zebrany z obiektów zlokalizowanych na glebie o składzie granulometrycznym gliny lekkiej wynosił od 1,4 do 2,4 Mg s.m. $\cdot$ ha^{-1} oraz od 1,8 do 3,6 Mg s.m. $\cdot$ ha^{-1} dla obiektów prowadzonych na glebie o składzie granulometrycznym gliny średniej. Zawartość S ogólnej oznaczono po mineralizacji próbki w piecu komorowym w temperaturze 450^{o}C przez 8 godzin, po uprzednim związaniu siarki siarczanowej $Mg(NO_3)_2$. Przyswajalne formy S wyekstrahowano roztworem 0,03 mol$\cdot$dm^3 CH_3COOH. W uzyskanych roztworach i ekstraktach zawartość S oznaczono metodą ICP-OES. Największa zawartość form ogólnych siarki oznaczono w glebie o składzie granulometrycznym gliny średniej, do której wprowadzono przekompostowany materiał K3 i K4 (220 mgS · kg^{-1} s.m. gleby). Zawartość przyswajalnych form siarki mieściła się w przedziale od 8,3 do 12,9 mgS · kg^{-1} s.m. gleby w przypadku obiektów zlokalizowanych na glebie o składzie granulometrycznym gliny lekkiej oraz od 13,1 do 17,4 mgS · kg^{-1} s.m. gleby dla obiektów na glinie średniej.

Słowa kluczowe: gleba, kompost, siarka, polietylen, skrobia kukurydziana, kupkówka pospolita