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# EFFECT OF BOTTOM SEDIMENT SUPPLEMENT TO SOIL ON YIELD AND CHEMICAL COMPOSITION OF MAIZE

## WPŁYW DODATKU OSADU DENNEGO DO GLEBY NA PLON I SKŁAD CHEMICZNY KUKURYDZY

**Abstract:** A two-year pot experiment was conducted to assess the effect of bottom sediment, used as a supplement to the light soil, on the yield and contents of macroelements in maize. The bottom sediment was added to light soil in the proportion of 5 and 10 %. The material was classified to a group of ordinary silt deposit. Moreover, the analyzed sediment revealed alkaline reaction, organic matter content of 25.8 g · kg$^{-1}$, low content of bioavailable phosphorus and potassium and natural content of heavy metals. After the experiment completion the amount of maize dry matter yield was assessed. The contents of minerals in the plant mass was determined after dry mineralization and the ash dissolving in $HNO_3$ (1:3), K, Mg, Ca, and Na were determined using AAS and P with ICP-AES technique. Nitrogen content was determined by means of Kjeldahl distillation method.

The experiment demonstrated a positive effect of bottom sediment supplement to light soil on the amount of produced maize biomass. The greatest maize biomass was obtained on the treatment with a 5 % admixture of bottom sediment. However, the plant shoot biomass did not meet the criteria for good quality fodder because of too low contents of most macroelements. It was found that the analyzed bottom sediment may be used as an admixture to light and acid soils to improve their productivity, owing to a considerable share of silt and clay fractions in its composition, neutral reaction and low content of heavy metals. However, each agricultural application of bottom sediment requires a supplementary mineral fertilization because of low contents of fertilizer elements in the sediment and in the obtained maize biomass.

**Keywords:** bottom sediment, light soil, yield, macroelements

Chemical composition and properties of bottom deposits are shaped in result of physical, chemical and biological processes occurring in a water reservoir and within its catchment, and usually are important indicators of anthropopressure [1]. Therefore,

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identification of bottom sediment chemical composition is important not only for an assessment of water reservoir degradation but also for determining potential applications of extracted deposit [2]. Bottom sediments are drawn in some countries (Germany, Holland, Belgium, United Kingdom and USA) from bottoms of rivers, retention reservoirs, channels, ports and ponds in order to maintain their navigability, increase their retention capacity and to improve their recreational and aesthetic values [3–7]. Because the phenomenon of silting and shallowing of water reservoirs is inevitable, it seems reasonable to manage the portions of sediments which do not contain harmful amounts of heavy metals or macroelements contents but may affect the quality of crops cultivated in the soil with their supplement. An important aspect of bottom sediment removal is reducing the unfavourable effect of impurities accumulated in them on the quality of water ecosystem [2]. Methods and techniques of bottom sediment removal from water reservoirs, as well as their in-situ and ex-situ remediation were the subject of numerous papers [2, 3, 8, 9]. If the material extracted from the bottom of silted water reservoir does not pose a hazard for the environment, the environmentally justified method of the sediments management is their use as structure and soil forming material on soilless grounds and wastelands [3, 10]. Bottom sediments, particularly these revealing neutral or alkaline reaction and high contents of silt and clay fractions, may be used for improving physicochemical properties of light and acid soils to improve their productivity [11, 12]. Investigations on their environmental potential, including agricultural applications were conducted among others by Niedzwiecki and Van Chinh [6, 13, 14], Fonseca et al [4, 5, 15], Rahman et al [16], Pleczar et al [17].

Presented experiment was conducted to assess the effect of bottom deposit supplement to light soil on yielding and selected parameters of maize chemical composition, as well as to identify potential use of the produced biomass for forage.

## Material and methods

The two-year pot experiment (2006–2007) was conducted on light soil with granulometric composition of weakly loamy sand, neutral pH and organic matter content of 16.0 g · kg$^{-1}$ (Table 1 and 2). The applied bottom sediment originated from small retention reservoir localized in Zeslawice village on the Dlubnia river (Malopolska province). The reservoir was constructed in 1966 in order to intake water for the metallurgical plant in Nowa Huta. The river catchment has a loess substratum, little resistant to erosion, therefore an intensive silting of the reservoir was observed. Detailed

Table 1

Selected properties of soil and bottom sediment

| Component | Share of ∅ [mm] fraction | | | $pH_{KCl}$ | Total N | Bioavailable forms | | |
|---|---|---|---|---|---|---|---|---|
| | 1–0.1 | 0.1–0.02 | < 0.02 | | | $P_2O_5$ | $K_2O$ | Mg |
| | [%] | | | | [g · kg$^{-1}$ d.m.] | [mg · kg$^{-1}$ d.m.] | | |
| Soil | 78 | 13 | 9 | 6.21 | 0.3 | 78.7 | 165.9 | — |
| Bottom sediment | 8 | 66 | 26 | 7.35 | 1.0 | 44.6 | 69.7 | 117.4 |

Table 2

Heavy metal content in soil and bottom sediment

| Component | Cr | Zn | Pb | Cu | Cd | Ni | Fe | Mn |
|---|---|---|---|---|---|---|---|---|
| | [mg · kg$^{-1}$ d.m.] | | | | | | [g · kg$^{-1}$ d.m.] | |
| Soil | 5.93 | 62.00 | 29.75 | 4.00 | 0.68 | 4.15 | 3.01 | 0.15 |
| Bottom sediment | 15.0 | 76.31 | 12.85 | 12.23 | 0.35 | 11.0 | 7.55 | 0.14 |
| Norm[a] | < 200 | < 1000 | < 200 | < 150 | < 7.5 | < 75 | — | — |
| Norm (grounds B)[b] | 150 | 300 | 100 | 150 | 4 | 100 | — | — |
| IUNG | — | < 100 | < 70 | < 40 | < 1 | < 50 | — | — |

[a] Journal of Laws of 2002, No. 55, item 498, [b] Journal of Laws of 2002, No. 165, Item 1359.

characteristics of the reservoir and methods of bottom sediment collecting were presented by Tarnawski [18]. The sediment was classified to a group of ordinary silt deposits with alkaline pH. The material was characterized by low concentrations of bioavailable phosphorus and potassium, high content of magnesium and contained 25.8 g · kg$^{-1}$of organic matter (Table 1). Bottom sediment was added to the soil in the first year of the research. The experimental design comprised 3 treatments: soil without the sediment admixture (control), soil + 5 % sediment supplement and soil + 10 % sediment admixture to the soil. Equal NPK fertilization with a dose of respectively: 1.8 g N; 1.1 g P and 2.2 g K per pot (8 kg d.m. of soil) was applied on all treatments. Mineral salts: $NH_4NO_3$; $KH_2PO_4$ and KCl were added once before the test plant sowing. The quality of bottom sediment was assessed on the basis of the Decree of the Minister of the Natural Environment of 15 April 2002 on the kind and concentrations of substances which cause that the spoil is polluted [19], and the way of its management was determined according to IUNG criterion [20] and the Decree of the Minister of the Natural Environment of 9 September 2002 on the soil and ground quality standards [21]. According to the above-mentioned decrees heavy metal concentrations in the researched deposit did not exceed the values admissible for the spoil [19] and for soil or B group soil [21]. In IUNG assessment which comprises 6 degree soil classification with respect to heavy metal content, considering the reaction and granulometric structure, the researched deposit, like mentioned above, revealed their natural contents (degree 0). The test plant was maize (*Zea mays*), "Bora" c.v. During the vegetation period the plants were watered with de-mineralized water and constant moisture of the substratum was maintained, initially on the level of up to 50 % and then up to 60 % of maximum water capacity. After the harvest the plant material was dried at 65 $^{o}$C in a dryer with forced air flow and the amount of dry mass yield was determined (the shoots and roots). Subsequently the plant material was crushed in a laboratory mill and subjected to chemical analysis. The mineral contents in the plant material were assessed after dry mineralization and ash dissolving in $HNO_3$ (1:3). The concentrations of potassium, magnesium and calcium were assessed in the obtained extracts using AAS method, and phosphorus using ICP-AES method. Nitrogen content was determined using Kjeldahl distilling method. Plant material analyses were conducted in four replications. The above-mentioned macroelement uptake with maize yield was computed as well as interrelations between them. The paper presents: K:Mg, K:Ca, K: (Mg + Ca) molar ratios and Ca : P and Ca : Mg weight ratios.

The obtained results were verified statistically by means of one factor ANOVA and Tukey test at significance level $\alpha = 0.05$ using Statistica 7.1 programme.

## Results

Maize yields were on a similar level in individual years of investigations, therefore they were presented in the paper as total for the 2006–2007 experiment period (Table 3).

Table 3

Yield of maize dry mass (total for two years)

| Treatment | Shoots | Roots | Whole plant |
|---|---|---|---|
| | [g · pot$^{-1}$] | | |
| Soil without sediment | 294.17$^{b*}$ | 34.32 | 328.49$^{a}$ |
| Soil+ 5 % sediment | 320.25$^{c}$ | 35.20 | 355.45$^{b}$ |
| Soil +10 % sediment | 298.44$^{b}$ | 30.48 | 328.92$^{a}$ |
| $LSD_{0.05}$ | 9.87 | n.s. | 12.88 |

* Homogenous groups according to Tukey test, $\alpha = 0.05$, n.s. – statistically non-significant.

The data show that irrespective of the plant part and year of the research, the greatest biomass was produced on the treatment with a 5 % bottom sediment supplement. On this treatment maize was characterized by about 7 % (shoots) and 8 % (roots) greater biomass production in comparison with the yields from the other treatments. On treatments with a 10 % bottom sediment admixture to the soil, maize yields were approximate to the ones obtained on the control (Table 3). The presented experiment also assessed the effect of bottom sediment supplement to the soil on macroelement content because their concentration in plants is the basic criterion of plant fodder destination. Both macroelement content and interrelations between them may considerably change plant chemical composition. According to literature [22–24] the following quantities are considered the optimal amounts, meeting plant requirements for individual elements: 3.0 g P; 17–20 g K; 2.0 g Mg; 7.0 g Ca; 1.5–2.5 g Na · kg$^{-1}$ d.m. of fodder. Table 4 shows weighted average macroelement contents for the whole period of investigations. Total nitrogen content in maize yields ranged from 6.81 to 9.96 g · kg$^{-1}$ d.m. The highest content of nitrogen both in maize shoot and root biomass was noted on the treatment with a 10 % supplement of bottom deposit in the substratum (Table 4). On this treatment maize contained almost 20 % more nitrogen (shoots) and 2 % more (roots) in comparison with the treatment receiving a 5 % sediment admixture, and by 32 % more (shoots) and 9 % more (roots) in relation to the treatment without the added sediment. On the treatments where bottom deposit was added in both doses, root biomass contained on average by 11 % less nitrogen than shoots. Phosphorus content in the test plant ranged from 1.16 to 2.26 g · kg$^{-1}$ d.m. (Table 4). Bottom sediment added to

Table 4

Macroelement content in maize

| Treatment | N | P | K | Mg | Ca |
|---|---|---|---|---|---|
| | [g · kg$^{-1}$ d.m.] | | | | |
| Shoots | | | | | |
| Soil without sediment | 6.81$^{a*}$ | 2.26$^{b}$ | 14.53$^{a}$ | 1.80 | 1.10$^{a}$ |
| Soil + 5 % sediment | 8.01$^{ab}$ | 1.65$^{a}$ | 14.09$^{a}$ | 1.70 | 1.95$^{b}$ |
| Soil + 10 % sediment | 9.96$^{b}$ | 172$^{a}$ | 18.34$^{b}$ | 1.62 | 2.11$^{b}$ |
| $LSD_{0.05}$ | 1.72 | 0.25 | 2.42 | n.s. | 0.30 |
| Roots | | | | | |
| Soil without sediment | 7.25 | 2.05$^{b}$ | 9.82$^{ab}$ | 1.90$^{a}$ | 1.87$^{a}$ |
| Soil + 5 % sediment | 7.79 | 1.16$^{a}$ | 7.89$^{a}$ | 1.83$^{a}$ | 6.00$^{b}$ |
| Soil + 10 % sediment | 7.97 | 1.23$^{a}$ | 12.40$^{b}$ | 2.20$^{b}$ | 7.65$^{c}$ |
| $LSD_{0.05}$ | n.s. | 0.16 | 2.64 | 0.20 | 1.27 |

* Homogenous groups according to Tukey test, $\alpha$ = 0.05, n.s. – statistically non-significant.

the soil had a notable effect on a decrease in this element content in maize biomass in comparison with the treatment without this deposit. It also caused a decline in phosphorus content by about 25 % in the shoots and by 55 % in maize roots as compared with the control. Relatively greater phosphorus contents in the test plant shoots and roots were registered on treatments with a 10 % supplement of bottom sediment than on treatments with a 5 % addition, however the differences were not statistically significant (Table 4). Maize on all experimental treatments revealed greater phosphorus content in shoot biomass in comparison with the roots. Bottom sediment admixture to light soil worsened the quality of obtained biomass from the viewpoint of its use for forage because of diminished phosphorus content as regards its optimal concentrations in forage plants. Maize abundance in potassium fluctuated between 7.89 and 18.34 g · kg$^{-1}$ d.m. (Table 4). Significantly highest content of this macroelement, similarly as for nitrogen, was assessed in maize grown in the soil with a 10 % supplement of bottom sediment. On this treatment maize contained almost 22 % more of potassium (shoots) and 29 % (roots) in comparison with the other experimental variants. Plants on treatments with a 5 % sediment addition revealed the lowest content of potassium both in their shoots and roots. Considering the variant with a 10 % sediment supplement, maize on this treatment contained by 23 % less of potassium in shoots and by 36 % less in roots. Like in case of phosphorus, plants contained more potassium in their shoots than roots. According to the previously mentioned criterion, potassium content in maize shoot biomass on treatments with a 10 % addition of bottom sediment was on the optimal level. Investigations conducted by various authors [25] show that in plants this element occurs in excess and in most cases no apparent deficiencies for plants are noted. High contents of potassium and deficient amounts of magnesium and calcium most frequently change the quality of plants destined for ruminants [26]. Depending on the treatment, calcium content in maize ranged from 1.10 to 7.65g · kg$^{-1}$d.m. (Table 4). Bottom sediment supplement to the soil significantly affected the increase in calcium content in maize biomass as compared with the soil without the sediment. It was also found that maize roots on treatments containing bottom sediment accumulated between 3 and 3.5 times more Ca in comparison with shoots on these treatments. Both in shoot biomass and in maize roots the greatest calcium content was registered on variant with a 10 % share of the sediment. In comparison with the treatment with a 5 % sediment admixture, on this treatment maize contained 7 % more of calcium (shoots) and by 22 % more in roots. On the other hand, considering the control plants, maize on a substratum with a 10 % sediment supplement revealed almost 48 % (shoots) and 76 % (roots) higher contents calcium. Calcium content in maize shoot biomass was on a very low level in comparison with the optimal values. Because of too high decrease in this macroelement content, the obtained biomass did not meet the criteria for good quality fodder. Magnesium content in the test plant fluctuated between 1.62 and 2.20g Mg · $kg^{-1}$d.m. and admixture of bottom sediment to the soil had no unanimous influence on maize biomass abundance in this element. The highest magnesium content in shoots was detected in plants on the control treatment but the differences between the experimental objects were not statistically significant (Table 4). On the other hand in roots the greatest quantity of magnesium was determined on the treatment with a 10 % share of bottom sediment in the soil. In comparison with the other experimental variants roots on this treatment accumulated over 15 % more of magnesium. Moreover it is worth noticing that both maize shoots and roots on the treatment with a 5 % sediment addition revealed the lowest magnesium content. Close to optimal magnesium content was assessed in maize from the treatments without the sediment added to the soil, whereas its supplement negatively affected the quality of obtained biomass visible as gradual decline in magnesium content with increasing sediment admixture to the soil.

The amount of elements taken up with the maize yield depended on the crop yield and contents of individual minerals (Table 3 and 4). Total uptake of individual macroelements by maize, depending on the experimental treatment, was presented in Table 5. The greatest quantities of potassium, calcium and nitrogen absorbed by maize were assessed on treatments with a 10 % supplement of bottom sediment. Significantly smaller amounts were absorbed on the control treatment (Table 5). A reverse relationship was demonstrated for magnesium and phosphorus. The greatest amounts of magnesium and phosphorus were taken up with maize biomass on the variant without the sediment, whereas on treatments with a 10 % share of bottom sediment the amounts of absorbed magnesium and phosphorus were smaller by over 11 % (Mg) and 25 % (P). Irrespective of the sediment share in the soil, N, P, K, Mg and Ca uptake by maize shoot biomass was bigger than by roots (Table 5). The structure of the above mentioned element uptake by the plant shows that maize shoots were absorbing respectively: 89–92 % N; 90–93 % P; 93–95 % K; 86–92 % Mg and 73–84 % Ca.

An important measure of fodder feeding quality are interrelations between mineral components. Good quality forage should reveal the optimal proportions of: Ca:P (2:1); Ca:Mg (2–3:1); K:(Ca+Mg) (1.6–2.2); K:Mg (6:1) and K:Ca (2:1) [22, 23]. The interrelations of the above-mentioned elements in maize shoot biomass were presented in Table 6.

Table 5

Macroelement uptake (shoots + roots) by maize

| Treatment | Nitrogen | Phosphorus | Potassium | Magnesium | Calcium |
|---|---|---|---|---|---|
| | [g · pot$^{-1}$ d.m.] | | | | |
| Shoots | | | | | |
| Soil without sediment | 2.00$^{a*}$ | 0.66$^{b}$ | 4.27$^{a}$ | 0.55 | 0.32$^{a}$ |
| Soil + 5 % sediment | 2.56$^{ab}$ | 0.53$^{a}$ | 4.51$^{ab}$ | 0.53 | 0.63$^{b}$ |
| Soil + 10 % sediment | 2.97$^{b}$ | 0.51$^{a}$ | 5.48$^{b}$ | 0.48 | 0.63$^{b}$ |
| $LSD_{0.05}$ | 0.53 | 0.08 | 0.81 | n.s. | 0.10 |
| Roots | | | | | |
| Soil without sediment | 0.25 | 0.07$^{b}$ | 0.34$^{ab}$ | 0.07 | 0.06$^{a}$ |
| Soil + 5 % sediment | 0.26 | 0.04$^{a}$ | 0.26$^{a}$ | 0.06 | 0.20$^{b}$ |
| Soil + 10 % sediment | 0.24 | 0.04$^{a}$ | 0.37$^{b}$ | 0.07 | 0.23$^{b}$ |
| $LSD_{0.05}$ | n.s. | 0.01 | 0.07 | n.s. | 0.05 |
| Whole plant | | | | | |
| Soil without sediment | 2.25$^{a}$ | 0.73$^{b}$ | 4.61$^{a}$ | 0.62 | 0.39$^{a}$ |
| Soil + 5 % sediment | 2.82$^{ab}$ | 0.57$^{a}$ | 4.77$^{a}$ | 0.59 | 0.82$^{b}$ |
| Soil + 10 % sediment | 3.22$^{b}$ | 0.55$^{a}$ | 5.86$^{b}$ | 0.55 | 0.86$^{b}$ |
| $LSD_{0.05}$ | 0.51 | 0.08 | 0.77 | n.s. | 0.13 |

* Homogenous groups according to Tukey test; $\alpha = 0.05$, n.s. – statistically non-significant.

Table 6

Quantitative relations between macroelements in maize shoot biomass

| Treatment | Ca:P | Ca:Mg | K:(Ca+Mg) | K:Mg | K:Ca |
|---|---|---|---|---|---|
| Soil without sediment | 0.49$^{a*}$ | 0.63$^{a}$ | 2.32 | 4.3 | 10.07$^{b}$ |
| Soil + 5 % sediment | 1.18$^{b}$ | 1.17$^{b}$ | 2.20 | 2.99 | 5.63$^{a}$ |
| Soil + 10 % sediment | 1.24$^{b}$ | 1.33$^{b}$ | 2.65 | 4.27 | 6.84$^{ab}$ |
| $LSD_{0.05}$ | 0.12 | 0.15 | n.s. | n.s. | 4.25 |

* Homogenous groups according to Tukey test, $\alpha = 0.05$, n.s. – statistically non-significant.

Ca:P weight ratio in maize dry mass, irrespective of the treatment, assumed values lower than optimal (Table 6). The highest Ca:P ratio was characteristic for maize on the treatment with a 10 % supplement of bottom sediment, whereas the control plants had too low value of this ratio, therefore it may be assumed that bottom sediment added to the soil improved the quality of obtained plant biomass. However, it should be emphasized that the values of Ca:P ratio in maize on the treatments with bottom sediments oscillated within the admissible value limits, because beside the optimal values 2:1, Underwood [27] also stated ratios 1:1 and 7:1 as admissible. Because Ca:P proportion in osseous system is 2:1, many authors consider it as the right one. Ca and Mg antagonism is commonly known, therefore the optimal ratio of these macroelements in fodder for ruminants should fluctuate between 2–3:1 [22]. The value of Ca:Mg ratio in the test plant was between 2 and 5 times lower than stated optimal value (Table 6). However, like in case of Ca:P relation the test plants had very low Ca:Mg ratio, so bottom sediment added to the soil, particularly in a 10 % dose improved the quality of obtained plant biomass. An important criterion of feed quality assessment is K:(Ca+Mg) relation and its value should not exceed 2.2. From the perspective of the obtained biomass use for forage, plants from all experimental treatments revealed over the norm value of this ratio, and a 10 % sediment admixture to the soil caused the highest almost two-fold increase in the value of K: (Ca+Mg) ratio. Ionic ratios: K:Mg and K:Ca are considerably important for feeding reasons. Bottom sediment applied to light soil did not reveal a unanimous effect on K:Mg ratio value, because the 10 % sediment share in the substratum caused a widening, whereas the 5 % admixture led to a narrowing of K:Mg relation in maize in relation to the optimal value 6:1. Data compiled in Table 6 show that K:Ca proportion in the analyzed plant was above the assumed optimum. On the treatment with added bottom sediment the value of K:Ca ratio in maize biomass was about between 3.5 and 4.5 times bigger than the optimal value. The maximum value for this ratio was registered in maize from the control treatment. The control plants were characterized by almost 7 times higher value of K:Ca ratio, which in good quality feeds should be 2:1. Undoubtedly, relatively high content of potassium in maize shoot biomass but deficient amounts of calcium and magnesium (Table 4) noted in the presented experiment caused a disadvantageous change of relations between the above-mentioned macroelements. Research conducted by other authors also demonstrated that an excess of potassium changes K:Ca and K:Mg ratio [22, 25]. According to the above-mentioned authors at an excess of potassium K:Ca and K:Mg ratios may reach the value of between 9:1 and 20:1, whereas K:Mg relation is 5:1.

## Discussion

Investigations conducted by Niemiec [11] showed than a supplement of sediment dragged from the Roznow Reservoir to very acid soil favourably affected the amount of biomass produced by plants (barley, maize, faba bean and lupine). The author demonstrated that only the highest dose of sediment, between 14 and 16 % added to the substratum caused an apparent decline in yield of the above-mentioned plants. Additionally, the same research demonstrated that under the influence of increasing share (0–10 %) of the sediment in the substratum, maize was the plant which most strongly responded by an increase in yield. A positive effect of bottom sediment on biomass production was also registered in the presented experiment and the greatest maize yield was obtained on the treatment with a lower – 5 % dose of bottom sediment. A positive effect of the substrata prepared from soil and bottom sediments originating from the reservoirs Maranhao and Monte Novo (Portugal) was also noted by Fonesca et al [4, 5], while investigating their influence on growth and development of tulips and paprika. Presented research demonstrated that increasing share of bottom sediment supplement to light soil affected a decrease in the contents of magnesium and phosphorus but an increase in the contents of potassium, calcium and nitrogen in maize biomass. Niemiec [11] obtained similar results. The author revealed that with increasing share of bottom sediment in the substratum phosphorus content in plants was decreasing but calcium content was increasing. Rahman et al [16, 28] revealed that bottom sediment originating from fish ponds may be a potential source of nitrogen, phosphorus and potassium for fodder plants. The author [28] demonstrated that bottom sediment originating from fish ponds supplied about 62 %N, 67 % bioavailable P and 64 % bioavailable K to plants. Presented research results show that bottom sediment applied to light soil caused worsening of Ca:P; Ca:Mg; K:Mg (narrowing) and K:Ca (widening) ratios in maize shoot biomass. Also Niemiec [11] who analyzed the effect of sediment with different shares in relation to soil (0–100 %) found generally worsening values of Ca:P and Ca:Mg relations.

## Conclusions

1. Bottom sediment added to light soil had a positive effect on maize biomass yield.
2. Plant shoot biomass did not meet the criteria for fodder with respect to quality because of too small contents of most macroelements.
3. The analyzed bottom sediment, due to considerable proportions of clay and silt fractions in its composition, alkaline reaction and low content of heavy metals, may be used as a supplement to light and acid soils to improve their properties and productivity.
4. While using bottom sediment for plant cultivation one should apply supplementary mineral fertilization because of the sediment low concentrations of phosphorus and potassium.

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## WPŁYW DODATKU OSADU DENNEGO DO GLEBY NA PLON I SKŁAD CHEMICZNY KUKURYDZY

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**Abstrakt:** Celem dwuletniego doświadczenia wazonowego była ocena wpływu osadu dennego stosowanego jako dodatek do gleby lekkiej na plon i zawartość makroelementów w kukurydzy. Osad denny dodano do gleby lekkiej w ilości 5 i 10 %. Materiał ten zakwalifikowano do grupy utworów pyłowych zwykłych i charakteryzował się on odczynem zasadowym, zawartością materii organicznej wynoszącą 25,8 g $\cdot$ kg$^{-1}$, niską zawartością przyswajalnego fosforu i potasu oraz naturalną zawartością metali ciężkich. Po zakończeniu doświadczenia określono wielkość plonu suchej masy kukurydzy. Zawartość składników mineralnych w materiale roślinnym oznaczono po suchej mineralizacji i roztworzeniu popiołu w $HNO_3$ (1:3), techniką AAS (K, Mg, Ca, Na) oraz ICP-EAS (P). Zawartość N oznaczono metodą destylacyjną Kjeldahla.

Stwierdzono pozytywny wpływ osadu dennego dodanego do gleby lekkiej na plon biomasy kukurydzy. Największą biomasę rośliny uzyskano w obiekcie z dodatkiem osadu w ilości 5 %. Nadziemna biomasa roślinna nie spełniała jednak kryteriów dla paszy dobrej jakości, ze względu na zbyt małe zawartości większości makroelementów. Stwierdzono, że badany osad denny ze względu na duży udział frakcji pylastych i ilastych w swoim składzie, obojętny odczyn i małą zawartość metali ciężkich może być stasowany jako dodatek do gleb lekkich i kwaśnych w celu poprawy ich produkcyjności. W rolniczym wykorzystaniu osadu dennego należy jednak zastosować uzupełniające nawożenie mineralne z powodu niskiej zawartości pierwiastków nawozowych w osadzie oraz biomasie kukurydzy.

**Słowa kluczowe:** osad denny, gleba lekka, plon, makroelementy