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CHANGES OF NUTRIENT CONCENTRATION IN THE CROP RESIDUES DECOMPOSING IN THE SOIL

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Summary

The aim of this study was to estimate the changes of concentration of nitrogen, phosphorus, potassium and sulphur in crop top and root residues of winter and spring oilseed rape, winter wheat and red clover during their decomposition in the soil over the period of 27 months (808 days). Concentration of nutrients was determined in the dry matter of crop residues after harvest and after 98, 232, 444, 595, 808 days of decomposition period. Changes of relative concentrations of nutrients in these residues are presented.

It was established that in the crop residues of spring and winter rape and winter wheat a higher rate of nitrogen concentration increase (46-58 % in top residues, $P \leq 0.05$ and 48-84 % in roots, $P \leq 0.01$) takes place during the second warm period (from 232 to 444 d.). Most significant ($P \leq 0.01$) increase of nitrogen concentration in the red clover stubble (32 %) and roots (35 %) is reached earlier (during the first warm period, after 98 d.).

Most intensive increase of phosphorus concentration in the crop top residues takes place during the second warm period (232-444 d.) and in the roots – during the third warm period (595-808 d.). The highest increase of phosphorus concentration after 808 days of the decomposition takes place in the winter wheat residues (127 % in the top residues and 174 % in the roots ($P \leq 0.01$).

Significant ($P \leq 0.01$) increase of K concentration after decomposition period of 808 d. is reached in the winter oilseed rape threshing remains (34 %) and in the roots of winter (57 %) and spring (95 %) oilseed rape and winter wheat (233 %). Potassium concentration during this period significantly ($P \leq 0.01$) decreases in the residues of red clover and threshing remains of spring oilseed rape.

The highest significant increase of sulphur concentration occurs during the second warm period (232-444 d.) in all crop top residues (14-32 %; $P \leq 0.05$) and in the roots (41-62 %; $P \leq 0.01$), except for red clover. The highest increase of S concentration among crop top residues during investigated decomposition period (0-808 d.) takes place in the winter (68 %; $P \leq 0.01$) and spring rape (60 %; $P \leq 0.01$) stubble. During this period permanent decrease of S concentration occurs only in the roots of red clover.

Key words: crop residues, decomposition, nutrients, nitrogen, phosphorus, potassium, sulphur.

Introduction

Fertile soil is increasing fertility itself
Prof. P. Vasinauskas

Decomposition of crop residues in the soil is sustained and complicated mechanical, biological and chemical process. Soil invertebrates feeding on plant residues chop them and therefore prepare medium for the microorganisms activity. Fungi degrade lignin, actinomycetes – pectin, cellulose, fatty acids, bacteria – carbohydrates, cellular tissue /Lugauskas, 1997; Henriksen, Breland, 1999; Tripolskaja, 2005/. Research data of these processes could be used in modelling of permanent soil fertility /Nicolardot et al., 2001; Moran et al., 2005/. Decomposition of plant residue is determined by the content of nitrogen in it, which is essential for the synthesis of microorganisms cells /Agren et al., 2001; Adams, 2003/. Plant residues with high C : N insufficiently provide microorganisms with nitrogen, therefore their activity decreases. When readily metabolised nitrogen compounds run out, microorganisms start to use more carbon for the nutrition, therefore input of energy gets higher /Teit, 1999; Hadas et al., 2004/. Microorganisms are decomposing plant residues to simple compounds, part of which is mineralised, part becomes energy source for the microorganisms, part is humificated /Tejt, 1999; Moran et al., 2005/. During these processes dry matter content in plant residues is decreasing and content of nitrogen, phosphorus, and sulphur is increasing /Agren et al., 2001; Salas et al., 2003; Eriksen, 2005/. Most intensive mineralization of nutrients is during summer and warm autumn /Orlova et al., 2002/.

Investigations of the crop residues and their nutrient content released into the soil were conducted in different climatic zones in Lithuania. Usually routine crops such as cereals, potatoes, perennial grasses were used in these experiments /Vaišvila, 1996, Švedas, 2002; Janušienė, 2002; Tripolskaja, 2005. The results of the investigation carried out at the Lithuanian Institute of Agriculture (Dotnuva) on a light loam cambisol show that after growing winter oilseed rape with 3.01 t ha^{-1} seed yield, 5.02 t ha^{-1} of crop residues was left and soil was enriched with nitrogen 1.7 times, with phosphorus 2.5 times, with potassium 2.9 times more than it was enriched by cereal residues, but rape residues increased nitrogen and phosphorus content in the soil accordingly 1.9 times and 1.3 times less than perennial grasses residues /Magyla et al., 1997/. According to G. Šidlauskas (2002) there are 0.63 % of nitrogen, 0.005 % phosphorus and 1.61 % of potassium in the dry matter of spring oilseed rape residues. No data are available on decomposition rate and changes of chemical composition of these residues incorporated into soil.

In the research carried out at the Experimental Station of the Lithuanian University of Agriculture it was established that positive influence for the subsequent crops after growing oilseed rape is lasting for two years /Velička, 2002/. Despite the fact that in oilseed rape residues the ratio of C and N is more favourable for the decomposition than in cereal residues /Velička et al., 2006/, but supposedly, because of the higher than in other crops content of lignin, the mineralization of these residues is slower and lasting longer. The aim of our research is to estimate the changes of nitrogen, phosphorus, potassium and sulphur concentrations in the oilseed rape, wheat, and clover residues during their decomposition in the soil.

Materials and methods

The experiments of decomposition of crop residues were carried out at the Experimental Station of the Lithuanian University of Agriculture (54°53'N, 23°50'E) in a model field experiment during the period of 2003-2005. The soil of the experimental site according to the soil classification of the year 1999 (LTDK-99) is *Endocalcari-Epihypogleyic Cambisol* (*sicco*) (CMg-p-w-can). Soil humus content (0-20 cm layer) determined by the Tiurin method was 23.5-24.3 g kg^{-1}, base saturation – > 90%, pH_{KCl} determined by potentiometric method: 6.92-6.68, total N – by the Kjeldahl method: 1.30-1.47 g kg^{-1}, mobile phosphorus (P_2O_5) – 158-255 mg kg^{-1}, mobile potassium (K_2O) – 124-167 mg kg^{-1} determined by the Egner-Riem-Domingo (A-L) method (Egner et al., 1960), sulphur (SO_4^{-2}) determined turbidimetrically – 12.3-18.6 mg kg^{-1}. Granulometric composition of the soil was determined by the pipette method according to FAO/ ISRIC. In the top soil layer (0-20) dominated silt (0.05-0.002 mm) – 55.3 % and sand (2-0.05 mm) – 33.8 %, while clay particles (<0.002 mm) amounted to 10.9 %, $C_{org.}$: N was 9.2 (organic carbon determined by the Walkley-Black method), whereas in the layer under the plough horizon (32-42 cm) dominated clay particles (<0.002 mm) – 38.6 % and $C_{org.}$: N was highest among all horizons of the soil profile – 10.7. In the deeper than 50 cm layers clay particles amounted to 43.7-68.0 %, and $C_{org.}$: N was decreasing in line with depth from 7.6 to 5.7.

The experiment had a two-factor design: factor A – crop residues (1. Roots of winter oilseed rape; 2. Roots of spring oilseed rape; 3. Roots of winter wheat; 4. Roots of red clover; 5. Stubble of winter oilseed rape (30 cm from root collar); 6. Stubble of spring oilseed rape (30 cm from root collar); 7. Stubble of winter wheat (20 cm height); 8. Stubble of red clover (20 cm height); 9. Threshing remains of winter oilseed rape (stems with branches and siliques); 10. Threshing remains of spring oilseed rape (stems with branches and siliques) and factor B – decomposition periods (1. Initiation; 2. 98 days; 3. 232 days; 4. 444 days; 5. 595 days; 6. 808 days). The experiment was replicated four times.

Separated samples of roots, stubble and threshing remains were prepared after harvesting of winter oilseed rape (*Brassica napus* L. ssp. *oleifera biennis* Metzg.) and spring oilseed rape (*Brassica napus* L. ssp. *oleifera annua* Metzg.). Root and stubble samples of winter wheat (*Triticum aestivum* L.) after harvesting were taken. Sampling of roots and stubble of the second year red clover (*Trifolium pratense* L.) was done after first grass cut. Crop residues were chopped in 2-3 cm size chaffs and content of their dry matter was observed. Samples of natural humidity and 20 g weight were taken and put into the 9x12 cm size net polychlorvinyl bags with 0.05 mm mesh diameter. Bags with crop residues were incorporated in ploughed up furrow of black fallow at the 20 cm depth, in 20 cm distance. Samples of all crop residues were incorporated in five furrows for experimental periods (factor B). Initiation and end datum-point of every period (except initial stage of the experiment) was set up when average temperature in 20 cm soil depth for three successive days in spring was ≥ 5 °C and in autumn ≤ 5 °C. Bags with crop residues at the end of every research period were dug out, cleaned from soil and content of residues dry matter was established. The remaining part of the content in the bag was dried out until air dry weight, ground, sieved through 1 mm separator. Concentration of nutrients was determined in the dry matter of crop residues. The following analyses of samples were performed: dry matter content was determined by drying in a thermostat at 105 °C temperature, the content of nitrogen, by the Kjeldahl method, phosphorus, potassium and sulphur with infrared spectrometer PSCO/ISI IBM-PC 4250 according to calibrations data bank, made-up using vanate-molibdate method for P and K estimation, and for S – tubodimetric method. Data statistical analysis was performed using ANOVA for two-factor experiment.

Results and Discussion

Nitrogen concentration. Our research results show that changes of nitrogen concentration in decomposing crop residues depend on plant species and duration of decomposition (Fig. 1, Fig. 2). According to data of other researchers chemical composition of plant depends on its species, and duration of decomposition is determined by environmental conditions, C and N ratio, and content of lignin in the plant residues /Jenkinson et al., 1987; Tejt, 1999; Moran et al., 2005/.

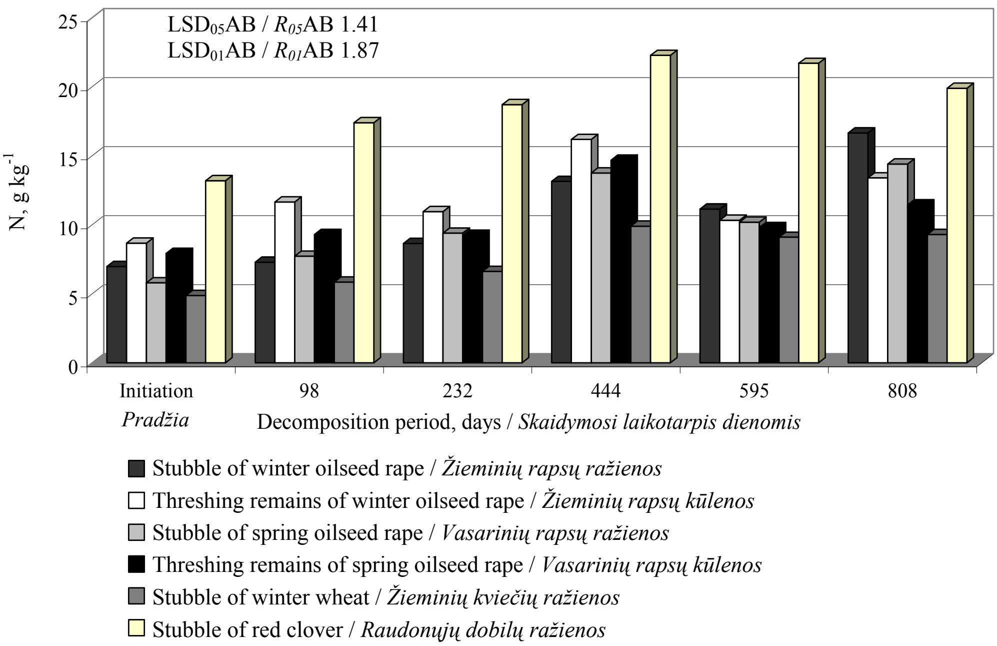

Figure 1. Total nitrogen concentration in the crop top residues decomposing in the soil
1 paveikslas. *Bendrojo azoto koncentracija augalų antžeminėse dalyse jų skaidymosi dirvožemyje metu*

The data of our experiment indicate (Fig. 1) that the highest concentration of nitrogen in the crop top residues after harvesting was in the stubble of red clover (13.2 g kg^{-1}) and the lowest – in the stubble of winter wheat (4.9 g kg^{-1}). Nitrogen concentration in the oilseed rape (except for spring rape stubble) residues is significantly ($P \leq 0.01$) lower than that in the red clover stubble and significantly ($P \leq 0.01$) higher than that in the winter wheat stubble. After 27 months (808 d.) period of decomposition the highest nitrogen concentration was also in the stubble of red clover (19.9 g kg^{-1}) and lowest in the stubble of winter wheat (9.3 g kg^{-1}). At the end of investigation period the concentration of this element was also significantly ($P \leq 0.01$) higher in the oilseed rape stubble and threshing remains as compared with that in winter wheat stubble and significantly lower as compared with that in the stubble of red clover. At the initial stage of the experiment nitrogen content in the oilseed rape threshing remains was significantly higher ($P \leq 0.05$) than that in the stubble. At the end of the investigation the opposite results were obtained: significantly higher concentration of nitrogen was in the oilseed rape stubble as compared with that in its threshing remains. Maximal N concentration in the rape threshing remains was reached at the end of the second warm period (after 444 d.) and was very close (no significant difference) to the highest values of it in the rape stubble at the end of the investigated decomposition period (after 808 d.).

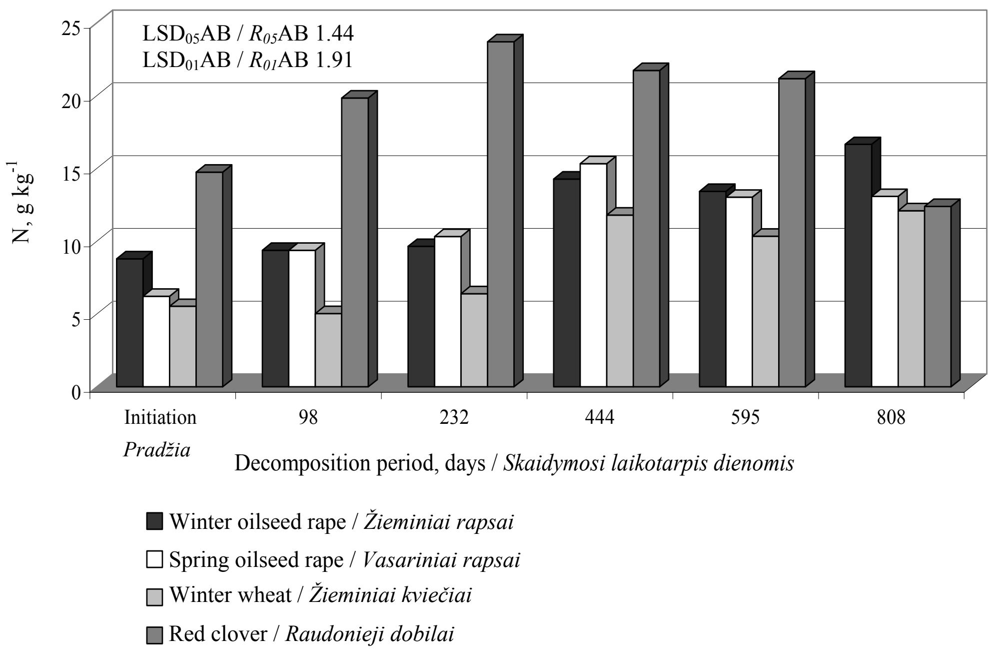

Figure 2. Total nitrogen concentration in the crop roots decomposing in the soil
2 paveikslas. *Bendrojo azoto koncentracija augalų šaknyse jų skaidymosi dirvožemyje metu*

According to the investigation results of Teit /Tejt, 1999/ mineralization of organic nitrogen starts when temperature is 1 °C and increases 2.5-3 times when temperature ranges from 10 to 30 °C at very different levels of soil moisture content (from 20 to 90 %). Our results show that the highest rate of nitrogen concentration increase took place during the second warm period (from 232 to 444 d.) in all top crop residues (46-58 %, $P \leq 0.05$), except for red clover stubble (19 %, $P \leq 0.05$). Most significant increase (32 %, $P \leq 0.01$) of nitrogen concentration in the red clover stubble took place during the first warm period (from initial stage to 98 d.). At the end of the last period of the investigation (after 808 d.) the highest nitrogen concentration increase was recorded in the stubble of spring oilseed rape (148 %), of winter oilseed rape (138 %) and of winter wheat (91 %). In other crop residues these changes range from 44 to 54 %. The experimental results indicate such consistent pattern: the lower nitrogen concentration is in the plant top residue after harvest, the higher its concentration increase is reached during decomposition process and vice versa.

Nitrogen concentration in the roots of the investigated crops is only slightly higher than that in the crop top residues. Data of figure 2 show that differences between nitrogen concentrations in the crop roots after harvest are of the similar character as they are between these concentrations in the crop top residues. Nitrogen concentration in the winter oilseed rape roots is significantly ($P \leq 0.01$) lower than that in the red clover roots and significantly higher than that in the winter wheat roots. At the end of the investigation period (after 808 d.) we recorded a decrease of nitrogen concentration in the red clover roots (16 %, $P \leq 0.01$). There was no significant difference between concentration of this element in the roots of spring oilseed rape, winter wheat and red clover. The highest content of nitrogen after 808 days of residue decomposition was in the roots of winter oilseed rape (16.7 g kg^{-1}). We can state also that the rate of nitrogen concentration changes during decomposition period is different in the roots of the investigated crops. Higher increase of nitrogen concentration in the roots of oilseed rape (48 %) and winter wheat (84 %) was recorded in the period from 232 to 444 d. but in the roots of red clover (35 %) – in the first period of the investigation ($P \leq 0.01$). Results of the nitrogen concentrations changes in the crop roots during the decomposition period also show consistent pattern: the lower nitrogen concentration is in the plant residue after harvest, the higher its concentration increase is reached during decomposition process and vice versa.

Phosphorus concentration. P concentration in the crop top residues also was different after harvest. Significantly ($P \leq 0.01$) higher values of its concentration were determined in the spring rape stubble and threshing remains of spring and winter rape than those in the red clover and winter wheat stubble (Fig. 3). The lowest phosphorus concentration at the beginning stage of the experiment was in the winter wheat stubble (1.1 g kg^{-1}). More intensive increase of phosphorus concentration in the crop top residues took place during the first three periods (0-98, 98-232, 232-444 d.) of the investigation. Later this increase was less intensive. After a 27-month (808 d.) period of residue decomposition the differences between P concentrations in the investigated crop top residues were of the same character as at the initial stage. Its concentrations in the oilseed rape residues were significantly higher ($P \leq 0.01$) as compared with those in the red clover and winter wheat stubble. Phosphorus concentration in the winter wheat stubble was the lowest (2.5 g kg^{-1}). The highest (127 %) increase of phosphorus concentration within all period of the investigation occurred in the winter wheat stubble. This increase in other crop top residues varied from 27 to 62 %.

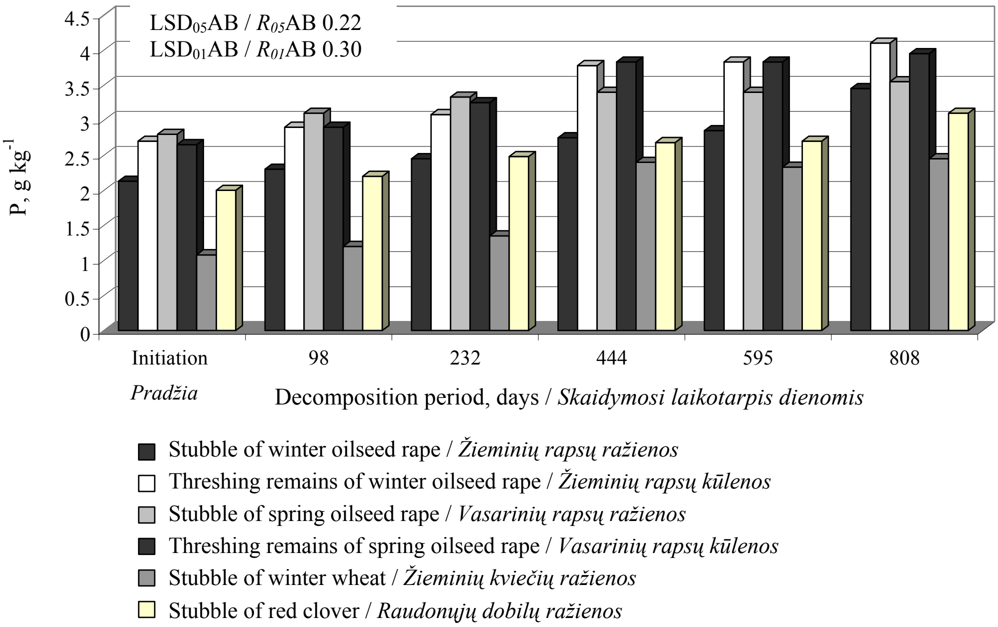

Figure 3. Phosphorus concentration in the crop top residues decomposing in the soil
3 paveikslas. *Fosforo koncentracija augalų antžeminėse dalyse jų skaidymosi dirvožemyje metu*

Phosphorus concentration in the winter wheat roots after crop harvest as well as after 808 days of the decomposition period was also significantly ($P \leq 0.01$) lower than that in the roots of other plants (Fig. 4). The highest rate of P concentration increase in the winter wheat roots was established during all periods of the investigation as compared with that in the roots of other crops. P concentration values in the rape roots were close to those in the red clover roots during all investigated periods.

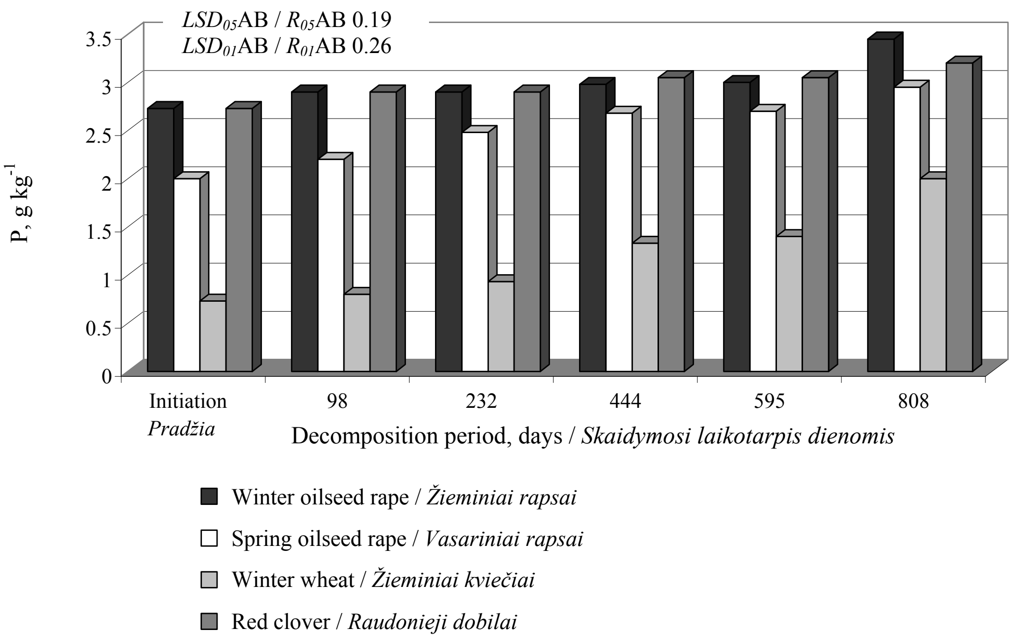

Figure 4. Phosphorus concentration in the plant roots decomposing in the soil
4 paveikslas. *Fosforo koncentracija augalų šaknyse jų skaidymosi dirvožemyje metu*

Potassium concentration. K concentration was different in the investigated crop top residues after harvest as well (Fig. 5). Significantly ($P \leq 0.05$) higher value of it was in the red clover stubble as compared with that in spring rape stubble, winter rape stubble and threshing remains. K concentration in the spring and winter rape residues was significantly higher ($P \leq 0.05$) than that in the winter wheat stubble. This means that K concentration (as N, P and S concentrations) was the lowest in the stubble of winter wheat. The rate of potassium concentration changes in the plant top residues during the decomposition period was completely different as compared with nitrogen and phosphorus concentration changes in those residues. Potassium concentration insignificantly decreased in all residues, except for red clover stubble, during the first two periods (first warm and second cool). Significant ($P \leq 0.01$) decrease (13 %) in K concentration in the red clover stubble occurred during the first period. Only after another two warm periods (after 444 and 808 d.) K concentration increase in some crop residues was recorded. During both periods (232-444 d. and 595-808 d.) significant ($P \leq 0.01$) increase in potassium concentration took place in the threshing remains of winter oilseed rape. K concentration in the red clover stubble significantly ($P \leq 0.01$) increased (18 %) in the decomposition period from 232 to 444 d. Later during cool period from 444 to 595 d. and during warm period from 595 d. to 808 d. significant ($P \leq 0.01$) K concentration decrease in it (18% and 49 % accordingly) was recorded. At the end of the investigation period (after 808 d.) potassium concentration in the winter and spring oilseed rape residues was significantly ($P \leq 0.01$) higher than that in the winter wheat and red clover stubble. Significant ($P \leq 0.01$) increase (34 %) in K concentration during all investigated occurred only in the winter oilseed rape threshing remains.

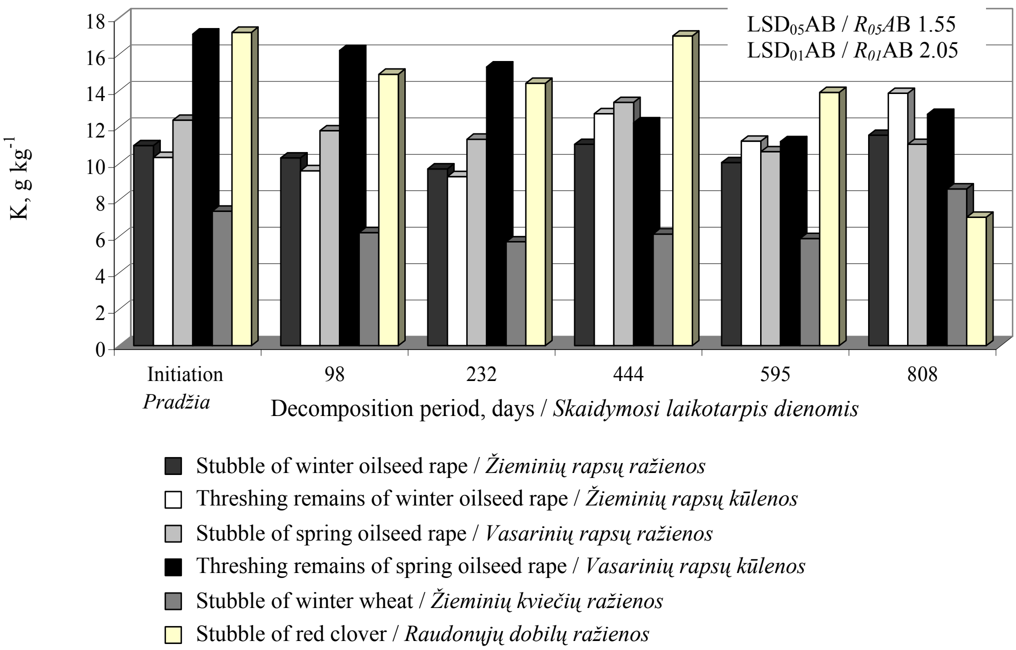

Figure 5. Potassium concentration in the crop top residues decomposing in the soil
5 paveikslas. *Kalio koncentracija augalų antžeminėse dalyse jų skaidymosi dirvožemyje metu*

After 27 months (808 d.) period potassium concentration in the spring oilseed rape threshing remains and in the red clover stubble was significantly ($P \leq 0.01$) lower (26 and 59 % accordingly) than that at initial stage of decomposition. After harvesting the highest K concentration was particularly in these residues and the highest decrease occurred in them during 808 days long decomposition period.

Significantly ($P \leq 0.01$) higher K concentration also was in the red clover roots after crop harvest as compared with that in the roots of spring rape, winter rape and winter wheat (52, 46 and 60 %, accordingly) (Fig. 6). Potassium concentration at initial stage of the experiment in the roots of winter wheat was significantly ($P \leq 0.05$) lower (26 %) than that in winter oilseed rape roots. Like in the crop top residues K concentration decreased (but not significantly) in all investigated plant roots during the first two periods (until 232 d.). During the second warm period (from 232 to 444 d.) potassium concentration significantly ($P \leq 0.01$) increased in roots of all crops. During the next cool period (from 444 to 595 d.) K concentration again significantly ($P \leq 0.05$) decreased in the roots of spring rape, winter wheat and red clover (20, 10 and 19 %, accordingly). At the end of the third warm period (from 595 to 808 d.) we recorded a significant increase in potassium concentration in the roots of winter rape, spring rape and winter wheat, but significant decrease in the roots of red clover. At the end of the investigated decomposition period (after 808 d.) the lowest K concentration was in the roots of red clover (at the initial stage it was the highest). During the whole period of study the highest increase (2.3 times) in potassium concentration was recorded in the roots of winter wheat where K concentration was the lowest at the initial stage.

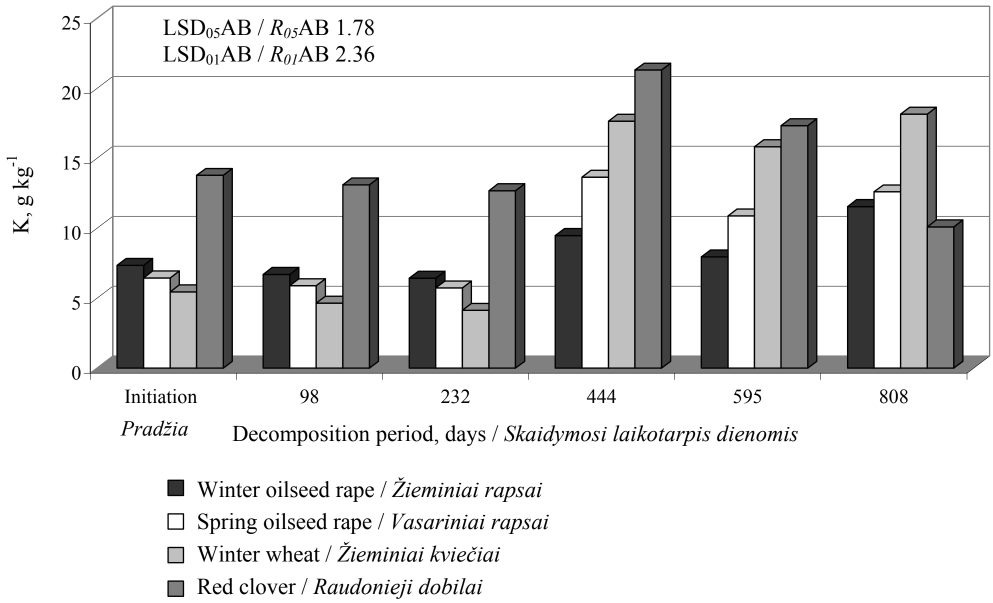

Figure 6. Potassium concentration in the plant roots decomposing in the soil
6 paveikslas. *Kalio koncentracija augalų šaknyse jų skaidymosi dirvožemyje metu*

Sulphur concentration. At the initial stage of the decomposition period the differences between sulphur concentrations in the investigated crop top residues were of the similar character as those between the concentrations of nitrogen and potassium (Fig. 1, 5 and 7). There were no significant ($P \geq 0.05$) differences between sulphur concentration in the winter and spring rape top residues after harvest. But its concentration in these residues was significantly higher ($P \leq 0.01$) than that in the winter wheat stubble and significantly ($P \leq 0.01$) lower as compared with that in the red clover stubble. There were no wide changes of S concentration in the decomposing residues during the first warm (1-98 d.) and successive cool (98-232 d.) periods. Significant increase (14-31 %) in sulphur concentration took place during the second warm period (232-444 d.) in all top residues of winter, spring rape ($P \leq 0.01$) and winter wheat ($P \leq 0.05$). Only slight, but significant ($P \leq 0.05$) increase (8 %) in S concentration was determined at the end of the third period (after 444 d.) in the stubble of red clover as compared with that at the initial stage of the experiment. During the next cool period (444-595 d.) sulphur concentration in this residue significantly ($P \leq 0.01$) decreased (15 %). There was no significant difference between S concentration in the red clover stubble at the end of the investigated period (808 d.) and its concentration in this residue after harvest. At the end of the investigated period of decomposition the highest concentration of sulphur was in the winter (3.1 g kg^{-1}) and spring rape (3.0 g kg^{-1}) stubble. These concentrations were significantly ($P \leq 0.01$) higher than those in the winter and spring rape threshing remains. So the highest increase in S concentration during investigated decomposition period took place in the winter (68 %; $P \leq 0.01$) and spring rape (60 %; $P \leq 0.01$) stubble. Significant ($P \leq 0.05$) increase in the concentration of this element was determined in the threshing remains of oilseed rape and stubble of red clover after the period of 444 days and in stubble of winter wheat after 808 d.

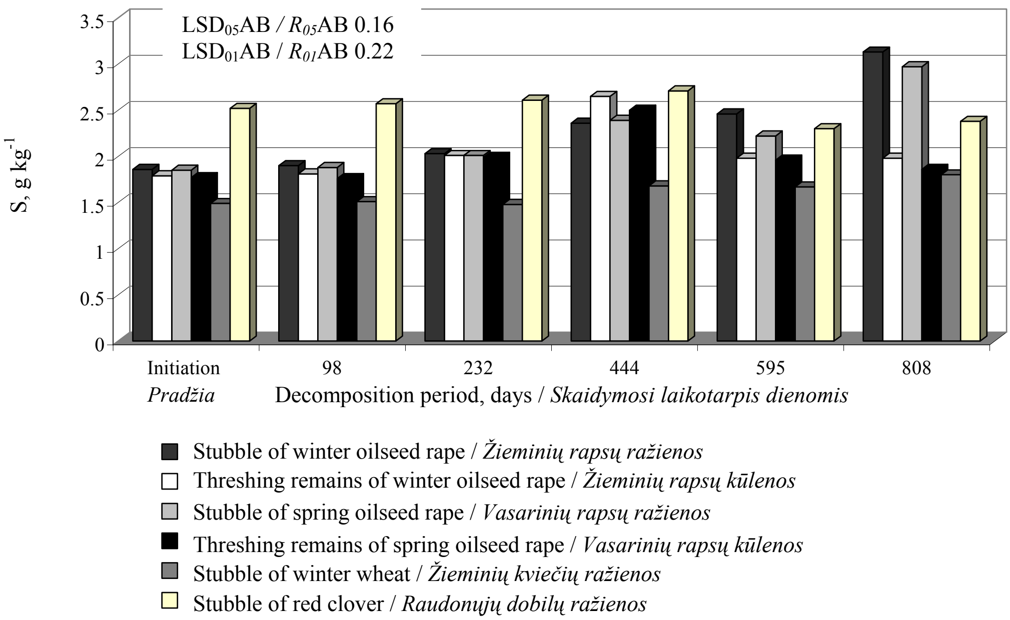

Figure 7. Sulphur concentration in the crop top residues decomposing in the soil
7 ***paveikslas.*** *Sieros koncentracija augalų antžeminėse dalyse jų skaidymosi dirvožemyje metu*

After crop harvest sulphur concentration in the roots of winter and spring rape was also significantly ($P \leq 0.01$) higher (54 and 73 %, accordingly) than that in the winter wheat roots and significantly ($P \leq 0.01$) lower as compared with its concentration in the red clover roots (Fig 8). During investigated decomposition period permanent decrease of S concentration took place in the roots of red clover. After 27 months (808 d.) its concentration diminished from 2.9 to 1.9 g kg^{-1} and was significantly ($P \leq 0.01$) lower than that in roots of other crops. Conversely, high significant ($P \leq 0.01$) increase in sulphur concentration during investigated period was determined in the roots of winter, spring rape and winter wheat (71, 105 and 117 %, accordingly). The most intensive increase (51-82 %) in S concentration in these residues took place during the second warm period (232-444) of the decomposition.

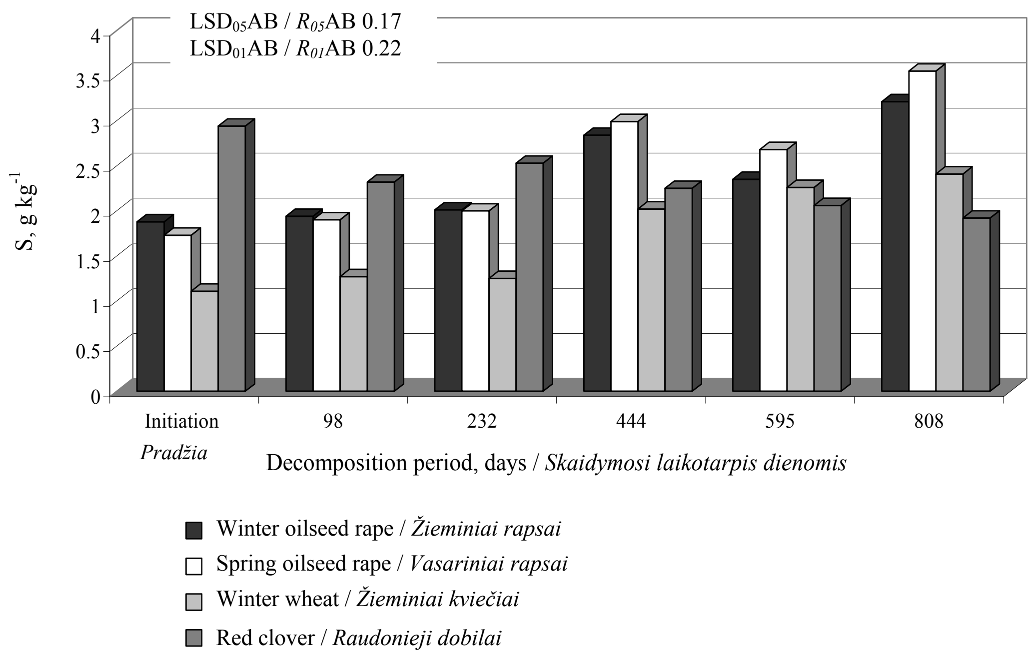

Figure 8. Sulphur concentration in the plant roots decomposing in the soil
8 paveikslas. *Sieros koncentracija augalų šaknyse jų skaidymosi dirvožemyje metu*

Results of our investigation show that the changes of nutrients concentration in different crop residues during their decomposition are of different character. All changes of nutrients concentration in the crop residues during the decomposition period are relative, because of the organic matter transformation: carbohydrates, proteins mineralization and leaching during the degradation of crop residues. Different changes of nutrients concentration in the decomposing residues mainly depend on the different chemical composition of these residues. Further research is needed to better understand the processes going on in the decomposing crop residues with different chemical composition.

Conclusions

Estimated concentration of nutrients in decomposing crop residues varied relatively as the outcome of organic matter transformation.

In the decomposing crop top residues of spring and winter rape and winter wheat the highest rate of nitrogen concentration increase (46-58 %, $P \leq 0.05$) took place during the second warm period (from 232 to 444 d.) Most significant increase (32 %, $P \leq 0.01$) in nitrogen concentration in the red clover stubble occurred earlier (during the first warm period, after 98 d.).

Higher increase in nitrogen concentration in the roots of oilseed rape (48 %) and winter wheat (84 %) was recorded in the warm period from 232 to 444 d. but in the roots of red clover (35 %) – in the first period (0-98) of the investigation ($P \leq 0.01$).

Such consistency in nitrogen concentration changes was established: the lower it was in the crop residues after harvest, the higher its concentration increase was reached during decomposition process and vice versa.

More intensive increase in phosphorus concentration in the crop top residues took place during the first three periods (0-98, 98-232, 232-444 d.). The highest (127 %) increase in phosphorus concentration after 808 days of the decomposition took place in the winter wheat residues. Increase of P concentration after this period in winter and spring rape residues was analogous to that in the red clover residues.

The rate of potassium concentration changes in the plant top residues during the decomposition period was completely different as compared with nitrogen and phosphorus concentration changes in those residues. Significant ($P \leq 0.01$) increase (34 %) of K concentration during all investigated period took place only in the winter oilseed rape threshing remains.

At the end of the investigated decomposition period (after 808 d.) the lowest K concentration was in the roots of red clover (at the initial stage it was the highest). During the whole study period the highest increase (2.3 times) in potassium concentration was recorded in the roots of winter wheat where K concentration was the lowest at the initial stage.

The highest increase in S concentration during investigated decomposition period took place in the winter (68 %; $P \leq 0.01$) and spring rape (60%; $P \leq 0.01$) stubble.

During investigated decomposition period permanent decrease of S concentration took place in the roots of red clover. After 27 months (808 d.) its concentration diminished from 2.9 to 1.9 g kg^{-1} and was significantly ($P \leq 0.01$) lower than that in roots of other crops. Conversely, high significant ($P \leq 0.01$) increase in sulphur concentration during investigated period was determined in the roots of winter, spring rape and winter wheat (71, 105 and 117 %, accordingly).

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MAISTO MEDŽIAGŲ KONCENTRACIJOS POKYČIAI AUGALŲ LIEKANOSE JŲ SKAIDYMOSI DIRVOŽEMYJE METU

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Santrauka

Tyrimų tikslas – nustatyti azoto, fosforo, kalio ir sieros koncentracijų pokyčius vasarinių ir žieminių rapsų, žieminių kviečių ir raudonųjų dobilų antžeminių dalių ir šaknų liekanose, jų skaidymosi dirvožemyje metu per 27 mėnesius (808 dienas). Maisto medžiagų koncentracija augalų liekanų sausosiose medžiagose nustatyta po derliaus nuėmimo ir praėjus 98, 232, 595 ir 808 dienoms nuo jų irimo pradžios. Aptariami ir augalų liekanose esančių maisto medžiagų santykiniai koncentracijų pokyčiai.

Nustatyta, jog vasarinių ir žieminių rapsų bei žieminių kviečių liekanose azoto koncentracija intensyviau didėja (46-58 % antžeminėse dalyse, $P \leq 0,05$ ir 48-84 % šaknyse, $P \leq 0,01$) antrojo šiltojo laikotarpio metu (232-444 d.). Raudonųjų dobilų ražienose ir šaknyse intensyviausiai koncentracija didėja (atitinkamai 32 ir 35 %; $P \leq 0,01$) anksčiau – pirmojo šiltojo periodo metu (0-98 d.).

Fosforo koncentracija antžeminių augalų dalių liekanose intensyviausiai didėjo antrojo šiltojo periodo metu (232-444 d.), o šaknyse – trečiojo šiltojo periodo metu (595-808 d.). Per 808 dienų skaidymosi laikotarpį P koncentracija labiausiai padidėjo žieminių kviečių liekanose (127 % ražienose ir 174 % šaknyse; $P \leq 0,01$).

Po 808 liekanų skaidymosi dienų kalio koncentracija padidėjo iš esmės ($P \leq 0,01$) žieminių rapsų kūlenose (34 %), žieminių (57 %) ir vasarinių (95 %) rapsų bei žieminių kviečių (233 %) šaknyse, o raudonųjų dobilų liekanose ir vasarinių rapsų kūlenose sumažėjo iš esmės ($P \leq 0,01$).

Sieros koncentracija intensyviausiai didėjo antrojo šiltojo periodo metu (232-444 d.) visose tirtų augalų antžeminių dalių liekanose (14-32 %; $P \leq 0,05$) ir šaknyse (41-62 %; $P \leq 0,01$), išskyrus raudonųjų dobilų liekanas. Tarp antžeminių dalių liekanų per 808 dienų skaidymosi laikotarpį daugiausiai sieros koncentracija padidėjo žieminių (68 %; $P \leq 0,01$) ir vasarinių (60 %; $P \leq 0,01$) rapsų ražienose. Sieros koncentracija per šį laikotarpį iš esmės (35 %; $P \leq 0,01$) sumažėjo tik raudonųjų dobilų šaknyse.

Reikšminiai žodžiai: augalų liekanos, skaidymasis, maisto medžiagos, azotas, fosforas, kalis, siera.