6. Lukow O.M. and McVetty P.B.E. (1991). Effect of cultivar and environment on quality characteristics of spring wheat. Cereal Chem. 68. 597 - 601.
7. Masauskiene A., Gaurilcikiene I., Masauskas V. (2002). Effects of plant protecting substances applied individually or in combination with the nitrogen fertilizers on the quality of winter wheat grain and the quality of dough. Maisto scemija ir technologija: LMaI ir Mokslo darbai. – Kaunas, Lithuania, 74 - 81.
8. Mladenov N., Przulj N., Hristov N., Djuric V., Milovanovic M. (2001). Cultivar - by environment interactions for wheat quality traits in seminar conditions. American Association of Cereal Chemists, Vol. 78, 3. 363 - 367.
9. Linina A. and Ruza A. (2004). Variety and environment effects on quality traits in Latvian - grown winter wheat. Proceedings of the 4th International Crop Science Congress, Brisbane, Australia. 6 pp: www.cropscience.org.au.
10. Peterson C.J., Grabosch R.A., Baezinger P.S., Grombacher A.W. (1992). Genotype and environment effects on quality characteristics of hard red winter wheat. Crop Sci. 32. 98 - 103.
11. Roze M. Kviešu kvalitāte (1994) // Latvijas Lauksaimnieks, Nr.10.-5. - 6.
12. Singh, M., Ceccarelli.S., Hamblin J. (1993). Estimation of heritability from trials data. Theor. Appl. Genet. 86. 437 - 441.
13. Sip V., Skorpik M, Chrpova J., Sottnikova V., Bartova S. Effect of cultivar and cultural practices on grain yield and bread- making quality of winter wheat. (2000) Rostlinna Vyroba. 46. 159 - 167.
14. Strazdina V., Malecka S., Krotovs M., Ruza A, Kreita Dz., Linina A., Katamadze M. (2002) Winter wheat productivity and grain quality in Latvian agro-climatical conditions. Agriculture Research works of biomedical sciences, agronomy. Lithuanian University of Agriculture. 35 - 41.
15. Tanacs L. Matuz J. Hampel G. Nagy M. (1999) Effect of pesticide treatment on the gluten content and falling number of the grain yield in wheat varieties / Novenytermeles, Hungary 48 (5), 485 - 496.

## INFLUENCE OF POTASSIUM, MAGNIUM AND SULFUR FERTILIZERS ON ECOLOGICALLY CULTIVATED PERENNIAL GRASSES

**Pekarskas J., Spruogis V.**
Lithuanian University of Agriculture, Studentu 11, Akademija, Kaunas distr., LT-53O61
phone: +370 67103749, e-mail: juozas.pekarskas@lzuu.lt

### Abstract

Investigations carried out over the period of 2000-2005 on the ecological farm of the Center of Agroecology at the Lithuanian University of Agriculture have shown that fertilizing with a $K_{90}S_{51}Mg_{30}$ rate of potassium magnesia increased the harvest of hay from 0.73 to 1.30 t $ha^{-1}$ or 16.5 – 33.8 per cent, the amount of green protiens increased from 0.71 to 1.16, the amount of fats increased from 0.31 to 0.43. Fertilization with a $K_{90}S_{32.4}$ rate of potassium sulphate significantly increased the harvest of perennial herbage hay from 0.98 to 1.27 t $ha^{-1}$ or from 23.7 to 32.9 per cent, while fertilization with $K_{30}S_{10.8}$ – $K_{90}S_{32.4}$ caused an additional increase in the amount of green proteins. Potassium magnesia and potassium sulphate did not have an essential influence on the amounts of green fibre and green ashes in perennial grasses. Inverstagation has determined that kieserite did not have any significant influence on the harvest of hay of perennial herbage, amount of green fats, fibre and ashes, however it essentially increased the amount of green proteins in the hay of perennial herbage. Fertilizing with potassium magnesia and potassium sulphate increased the share of grasses in the botanical composition of perrenial herbage, however, it decreased the amount of legumes, while fertilization with kieserite had a contrary effect: it increased the amount of legumes and decreased the share of grasses.

### Key words

Perennial grasses, fertilizers, chemical composition, botanical composition.

### Introduction

Potassium is of great importance to legumes. When legumes lack potassium, it makes it more difficult for them to hold themselves in the sward, quality of forage deteriorates, clover falls

ill with fungal diseases. On an ecological farm fertilizers of potassium and phosphonus increase the pastures' harvest in one third. (Кутузова, Привалова, 1982; Blagoveschensky, 2000).

There are varying opinions about potassium fertilizers' rates during the period of vegetation. In Russia, it is recommended to scatter the annual rate of potassium in two or three goes when it outgrows 60 kg $ha^{-1}$. German scientists think that scattering the annual rate in two or three goes is not superior to that of one go (Daugėlienė, 1995; Csatho *et al.*, 2000). Investigations carried out in Lithuanian soils of different genesis demonstrated that potassium rate could be extended to 120 kg $ha^{-1}$ of active matter. There is no need to increase potassium rate any further as an undesirable amount of potassium accumulates in plants. Research on divisions of the annual rate of potassium fertilizers determined that it is not worth scattering the annual rate in several goes. Scattering fertilizers in spring before the period of plant vegetation starts or in autumn proved the most useful (Vasiliauskienė, Brunienė et *al.*, 1986, Daugėlienė, 1995).

It is as important to determine the effect of different fertilizers on the harvest of perennial herbage and its chemical composition. Such investigations carried out under conditions of ecological farming are very few. This has been much researched under conditions of intensive farming. It was found that amounts of feeding matters as well as chemical elements mostly depend on perennial herbage's phase of vegetation of. As perrenial herbage mature, the amount of green proteins, ashes and fats decreases and the amount of fibre grows. Amount of green proteins, ashes and fats decreases even more after blooming and the amount of fibre increases (Juraitis, 1997, 1998). Investigations carried out under the conditions of intensive farming have shown that nitrogen fertilizers were the ones to increse the amount of green proteins in perrenial herbage most. Effects on potassium on the harvest of perennial herbage depended on the amount of potassium in soil. Potassium did not significantly influenced chemical composition of herbage (Daugėlienė, Arlauskienė, 1989; Vasiliauskienė et *al.*, 1996).

Investigation carried out under the conditions of intensive farming determined that botanical composition of perennial herbage was mostly influenced by application of nitrogen fertilizers. Under the influence of nitrogen the amount of clover in sward decreased and the greater rates of nitrogen exterminated clover at all. Phosphorus fertilizers helped legumes hold themselves in a sward. The botanical composition of the sward deteriorated mostly due to the lack of phosphorus fertilizers and onesided fertilization with nitrogen and potassium fertilizers. (Daugėlienė, Arlauskienė, 1989; Vasiliauskienė, Dapkus, 1990; Vasiliauskienė et *al.*, 1996; Daugėlienė, 2002).

Fertilization with mineral potassium, magnium and sulphur fertilizers as follows: potassium salt, potassium chloride, potassium magnesia, and potassium sulphate as well as a fertilizer of magnium and sulphur (kieserite) is allowed on Lithuanian ecological farms (Pekarskas, 2005).

Objectives of this research are to investigate the effect of potassium magnesia, potassium sulphate, and kieserite fertilizers on the harvest of perennial herbage, its chemical and botanical composition.

## Materials and Methods

Influence of potassium, magnium and sulphur fertilizers on the harvest and quality of ecologically cultivated perennial herbage was investigated in 2000, 2001 and 2005 on the ecological farm of Agroecology center at the Lithuanian University of Agriculture. The soil of investigation was *Endohypogleyi-Eutric Planosols – PLe-gln-w*. The soil was neutral $pH_{KCl}$ 6.8, 2.27 % of hummus, it contained 161.6 mg $kg^{-1}$ of phosphorus and 140.2 mg $kg^{-1}$ of potasium, 495.5 mg $kg^{-1}$ of magnium and 0.160 % of total nitrogen

Investigation was carried out with potasium magnesia, potassium sulphate, kisteritas fertilizers of natural origin. A mix of perennial grasses was composed of 50 % timothy "Gintaras" and 50 % red clover "Liepsna". A seed rate was 16 kg $ha^{-1}$. Fertilization took place in the third decade of April and the first decade of May in the beginning of perennial herbage's vegetation period and they were harvested in the first decade of June.

pH of the soil was determined by potesiometric method 1 N KCl extract and humus was determined with the apparatus of Chereus, amounts of $P_2O_5$ and $K_2O$ A-L, and total nitrogen were determined by Kjeldahl method. Amount of dry materials was determined by drying them in

thermostat in the temperature of 105 °C, exposure of hay was calculated with 15 % humidity, chemical composition of perennial herbage was determined with a computer infrared ray analyser.

Investigation was carried out in four repetitions. The total area of a test site was 48 $m^2$ (4×12), area of the calculated site was – 15 $m^2$ (3×5). Data of investigation was mathematically assessed by method of dispearse analysis with a programme ANOVA.

## Results

The biggest part of the harvest of the first year's perennial herbage was obtained by fertilizing the sward with a $K_{90}S_{51}Mg_{30}$ rate of potassium magnesia. Essential increase in the amount of hay was achieved 0.73 – 1.30 t $ha^{-1}$ or 16.5 – 33.8 per cent when compared to perennial herbage with no fertilizers applied or the ones fertilized with $K_{30}S_{17}Mg_{10}$. The rate being increased from $K_{60}S_{34}Mg_{20}$ to $K_{120}S_{68}Mg_{40}$, no significant increase in the amount of hay was observed. Most green proteins and fats accumulated when a rate of $K_{90}S_{51}Mg_{30}$ was applied. Essential increase in green proteins (0.71 – 1.16 per cent) and fats (0.31 – 0.43 per cent) was obtained compared to unfertilized herbage and the one fertilized with $K_{30}S_{17}Mg_{10}$. Fertilization with potassium magnesia caused a slight decrease in green fibre and increase in green ashes. Fertilization with potassium magnesia slightly increased the amount of grasses and decreased the amount of legumes in a botanical composition of the sward (see Table 1 and 2).

Table 1. Effect of potassium magnesia rates on the harvest and chemical composition of perrenial herbage

| No. | Index | $K_0S_0Mg_0$ | $K_{30}S_{17}Mg_{10}$ | $K_{60}S_{34}Mg_{20}$ | $K_{90}S_{51}Mg_{30}$ | $K_{120}S_{68}Mg_{40}$ | $LSD_{05}$ |
|---|---|---|---|---|---|---|---|
| 1. | Harvest of hay, t $ha^{-1}$ | 3.85 | 4.42 | 4.71 | 5.15 | 5.12 | 0.64 |
| 2. | Green proteins, % | 11.73 | 12.18 | 12.54 | 12.89 | 12.43 | 0.59 |
| 3. | Green fats, % | 0.82 | 0.94 | 1.17 | 1.25 | 1.19 | 0.24 |
| 4. | Green fibre, % | 30.04 | 29.77 | 29.34 | 29.97 | 29.96 | 1.25 |
| 5. | Green ashes, % | 2.05 | 2.23 | 2.32 | 2.28 | 2.31 | 0.39 |

Table 2. Effect of potassium magnesia rates on botanical composition of perennial herbage

| No. | Index | $K_0S_0Mg_0$ | $K_{30}S_{17}Mg_{10}$ | $K_{60}S_{34}Mg_{20}$ | $K_{90}S_{51}Mg_{30}$ | $K_{120}S_{68}Mg_{40}$ | $LSD_{05}$ |
|---|---|---|---|---|---|---|---|
| 1. | Clover, % | 85.08 | 86.14 | 85.25 | 84.36 | 83.83 | 5.20 |
| 2. | Grasses, % | 13.81 | 12.61 | 13.32 | 14.46 | 14.82 | 2.41 |
| 3. | Other herbage, % | 1.11 | 1.25 | 1.43 | 1.18 | 1.35 | 0.53 |

The greatest harvest of the first year's perennial herbage was obtained by fertilization with a rate of potassium sulfate $K_{90}S_{32.4.}$ Essential increase of the harvest was achieved 0,98 - 1,27 t $ha^{-1}$ or 23,7 – 32.9 per cent. When the rate was increased from $K_{60}S_{21.6}$ to $K_{120}S_{43.2}$, no significant increase in the amount of harvest was observed. Most green proteins accumulated with a fertilization rate of $K_{60}S_{21.6}$, and the greatest amount of green fats accumulated when the rate of $K_{90}S_{32.4}$ was applied. Increasing the rate of potassium sulphate even further caused a decrease in these indexes of perennial herbage. When rates of $K_{30}S_{10.8}$ – $K_{90}S_{32.4}$ were applied, the amount of green proteins increased comparing to $K_{120}S_{43.2}$, the greatest rate of potassium sulphate and the herbage with no fertilizers applied. The amount of green fats essentially increased only compared to herbage with no fertilization applied, and there were no significant differences between separate treatments. Fertilization with potassium sulphate caused a slight decrease in the amount of green fibre and an increase in the amount of green ashes. Fertilization also had an effect on the botanical composition of the sward, causing an increase in the amount of grasses and a decrease in legumes (see Table 3 and 4).

Table 3. Effect of potassium sulphate rates on the harvest and chemical composition of perrenial herbage.

| No. | Index | $K_0S_0$ | $K_{30}S_{10.8}$ | $K_{60}S_{21.6}$ | $K_{90}S_{32.4}$ | $K_{120}S_{43.2}$ | $LSD_{05}$ |
|---|---|---|---|---|---|---|---|
| 1. | Harvest of hay, t $ha^{-1}$ | 3.85 | 4.14 | 4.59 | 5.12 | 4.82 | 0.69 |
| 2. | Green proteins, % | 11.74 | 13.11 | 13.15 | 12.64 | 11.98 | 0.41 |
| 3. | Green fats, % | 0.86 | 1.04 | 1.21 | 1.27 | 0.94 | 0.37 |
| 4. | Green fibre, % | 31.14 | 30.36 | 29.85 | 29.91 | 31.29 | 2.32 |
| 5. | Green ashes, % | 2.08 | 2.14 | 2.21 | 2.43 | 2.31 | 0.62 |

Table 4 Effect of potassium sulphate rates on botanical composition of perennial herbage

| No. | Index | $K_0S_0Mg_0$ | $K_{30}S_{10,8}$ | $K_{60}S_{21,6}$ | $K_{90}S_{32,4}$ | $K_{120}S_{43,2}$ | $LSD_{05}$ |
|---|---|---|---|---|---|---|---|
| 1. | Clover, % | 85.08 | 85.48 | 85.03 | 84.74 | 84.41 | 6.42 |
| 2. | Grasses, % | 12.81 | 12.76 | 13.46 | 13.60 | 14.14 | 2.07 |
| 3. | Other herbage, % | 2.11 | 1.76 | 1.51 | 1.66 | 1.45 | 0.72 |

The greatest harvest of the first year's perennial herbage was obtained by fertilizing herbage with a $Mg_{120}S_{32.4}$ rate of kieserite. Kieserite fertilizers did not have essential effect on the harvest of first year's perennial herbage. Fertilization with kieserite caused an essential increase in the amount of green proteins but there was no essential effect on the amount of green fats, fibre and ashes in the hay of perennial herbage. Fertilization caused a slight decrease of grasses, however there was a slight increase in legumes in the botanical composition of the sward (see Tables 5-6).

Table 5 Effect of kieserite rates on the harvest and chemical composition of perrenial herbage

| No. | Index | $Mg_0S_0$ | $Mg_{30}S_{24}$ | $Mg_{60}S_{48}$ | $Mg_{90}S_{72}$ | $Mg_{120}S_{96}$ | $LSD_{05}$ |
|---|---|---|---|---|---|---|---|
| 1. | Harvest of hay, t $ha^{-1}$ | 4,33 | 4,34 | 4,35 | 4,46 | 4,51 | 0,42 |
| 2. | Green proteins, % | 11,75 | 12,43 | 12,55 | 12,41 | 12,47 | 1,13 |
| 3. | Green fats, % | 1,22 | 1,28 | 1,26 | 1,36 | 1,22 | 0,28 |
| 4. | Green fibre, % | 30,11 | 28,51 | 28,91 | 29,14 | 28,67 | 2,34 |
| 5. | Green ashes, % | 3,27 | 2,58 | 2,66 | 3,12 | 3,20 | 1,12 |

Table 6 Effect of kieserite rates on botanical composition of perennial herbage

| No. | Index | $Mg_0S_0$ | $Mg_{30}S_{24}$ | $Mg_{60}S_{48}$ | $Mg_{90}S_{72}$ | $Mg_{120}S_{96}$ | $LSD_{05}$ |
|---|---|---|---|---|---|---|---|
| 1. | Clover, % | 82,94 | 84,22 | 83,63 | 83,96 | 84,68 | 7,12 |
| 2. | Grasses, % | 16,50 | 15,24 | 15,87 | 15,45 | 14,68 | 2,64 |
| 3. | Other herbage, % | 0,56 | 0,54 | 0,50 | 0,59 | 0,64 | 0,18 |

## Discussions

Investigating the effect of potassium magnesia, potassium sulphate and kieserite on the harvest of perennial herbage, we found that when optimum rates $K_{60-90}$ of fertiliazers were applied the harvest increased 32.9 – 33.8 per cent. Similar results were obtained in Russia (Blagoveschensky, 2000). It was determined in the way of investigation that for the soils of the ecological farms medium in potassium the optimum potassium rate would be $K_{60-90}$ and there is no need to increase it. According to the research carried out by different authors, the optimum rate of potassium under the circumstances of intensive farming is $K_{100-150}$ or $K_{60-120}$ (Кутузова, Привалова, 1982; Vasiliauskienė V. *et al.*, 1986).

Under the influence of plant feeding with potassium magnesia and potassium sulphate the amount of green proteins and green fats essentially increased in ecologiacally cultivated perennial herbage and kieserite feeding caused an essential increase only in green proteins. In the conditions of intensive farming, nitrogen fertilizers are known to increase the amount of green proteins most. The effect of potassium on the harvest of perennial herbage and its quality mostly depended on the amount of potassium in soil. Potassium had little effect on the chemical composition of herbage (Daugėlienė, Arlauskienė, 1989; Vasiliauskienė *et al*., 1996).

Fertilization with potassium magnesia, potassium sulphate and kieserite did not have effect on the botanical composition of ecologically cultivated perennial herbage. Under the circumstances of intensive production it was found that botanical composition on the sward deteriorates as a result of onesided fertilization with nitrogen and potassium fertilizers (Vasiliauskienė, Dapkus, 1990; Vasiliauskienė *et al*., 1996).

## Conclusions

Fertilizing with a $K_{90}S_{51}Mg_{30}$ rate of potassium magnesia , essentially increased 0.73 – 1.30 t $ha^{-1}$ or 16.5 – 33.8 per cent the harvest of hay, 0.71 – 1.16 per cent the amount of green proteins, and 0.31 – 0.43 per cent the amount of green fats, compared to herbage with no fertilizers applied and to fertilization with a rate of $K_{30}S_{17}Mg_{10}$. Fertilization with a $K_{90}S_{32.4}$ rate of potassium sulphate essentially 0.98 – 1.27 t $ha^{-1}$ or 23.7 – 32.9 per cent increased the hay harvest compared to unfertilized herbage and fertilization with $K_{30}S_{10.8}$.

Fertilization with rates of $K_{30}S_{10.8}$ – $K_{90}S_{32.4}$ essentially increased the amount of green proteins compared to the greates rate of potassium sulphate of $K_{120}S_{43.2}$ and unfertilized herbage. The amount of green fats essentially increased only compared to unfertilized perennial herbage. Kieserite fertilizers did not have effect on the harvest of perennial herbage, however it increased the amount of green proteins in it.

Fertilization with potassium magnesia and potassium sulphate slightly incresed the amount of grasses in the botanical composition of perennial herbage, however they decreased the amount of legumes. On the contrary, kieserite caused an increase in legumes and a decrease in the amount of grasses.

## Referentes

1. Blagoveschensky G.V. (2000) The productivity of grasslands in Russia, Conventional and ecological grassland management: Procceedings of the international sumposium, 49-55.
2. Csatho P., Debreczeni K., Sardi K. (2000) Correlation between soil K and winter wheat K contents in a network of Hungaria National long-term fertilization trials, Communications in soil Science and Plant Anglysis, 31, 2081-2092.
3. Daugėlienė N., Arlauskienė E. (1989) Skirtingų įvairiai azotu tręšiamų ganyklų žolynai, Žemdirbystė, 37, 107-122.
4. Daugėlienė N. (1995) Agrocheminių savybių kitimas įvairios reakcijos velėniniame jauriniame dirvožemyje, priklausomai nuo ganyklos tręšimo, LŽI mokslo darbai, 48, 145-153.
5. Daugėlienė N. (2002) Žolininkystė rūgščiuose dirvožemiuose, Lietuvos žemdirbystės institutas, 261.
6. Juraitis V. (1997) Daugiamečių varpinių žolių maisto medžiagų ir cheminių elementų kiekio kitimas vegetacijos laikotarpiu, Veterinarija ir zootechnika, 3 (25), 90-93.
7. Juraitis V. (1998) Maisto medžiagų ir cheminių elementų kiekio kitimas daugiametėse ankštinėse žolėse per vegetaciją, Veterinarija ir zootechnika, 5 (27), 98-100.
8. Pekarskas J. (2005) Ekologinio ūkininkavimo įtaka dirvožemio agrocheminėms savybėms ir augalų mitybos problemų sprendimas, 107.
9. Vasiliauskienė V., Brunienė L., Butkuvienė E. (1986) Metinės kalio trąšų normos paskirstymas ganiavoms skirtingų dirvožemių ganyklose, Žolių ūkis: mokslo darbai, 34, 23-33.
10. Vasiliauskienė V., Dapkus R. (1990) Rates of Nitrogen and their distribution duribg the vegetation of pasture swards of different earliness, Soil – Grassland – Animal Relationships, 267-271.
11. Vasiliauskienė V., Kadžiulis L., Daugėlienė N. (1996) Dirvožemio ir mineralinių trąšų įtaka ganomų ir šienaujamų žolynų derliui ir kokybei, Žemės ūkio mokslai, 2, 77-84.
12. Кутузова А.А., Привалова К.Н. (1982) Эффективнось калийных удобрений, Кормпроизводство, 3, 14-15.