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THE EFFECT OF MINERAL NPK AND ORGANIC FERTILISATION ON THE CONTENT OF NUTRITIVE COMPONENTS AND MICROBIOLOGICAL QUALITY OF THE FIRST REGROWTH OF MEADOW SWARD

Summary

Studies were carried out in the years 2011-2013 in the field experiment on permanent meadow. The aim was to assess the effect of various forms and doses of fertilisers on nutritive value and microbiological quality of the first regrowth of meadow sward. Six experimental plots were established on the meadow and fertilised with mineral NPK, cattle liquid manure and manure applied in two doses corresponding to 60 and 120 kg N ha^{-1}. First regrowth of meadow sward was collected for analyses. The number of selected microorganisms and the content of nutritive components were analysed in these samples. Applied organic fertilisation, especially that with manure, increased the content of crude ash, decreased the concentration of simple sugars and the sugar to protein ratio. Moreover, manure fertilisation increased the concentration of potassium and decreased the concentration of sodium, magnesium and calcium in meadow sward. Higher doses of fertilisers increased the content of potassium and decreased that of calcium in the sward. Applied organic fertilisation did not result in unfavourable changes in epiphytic microflora of the sward.
Key words: *liquid manure, NPK, macroelements, epiphytic microflora, manure, botanical composition, nutritive value*

WPŁYW NAWOŻENIA MINERALNEGO NPK I NAWOZAMI NATURALNYMI NA ZAWARTOŚĆ SKŁADNIKÓW POKARMOWYCH I JAKOŚĆ MIKROBIOLOGICZNĄ PIERWSZEGO ODROSTU RUNI ŁĄKOWEJ

Streszczenie

Badania prowadzono w latach 2011–2013 w doświadczeniu łanowym na łące trwałej. Celem badań była ocena wpływu stosowania różnych form i dawek nawozów na wartość pokarmową i jakość mikrobiologiczną pierwszego odrostu runi łąkowej. W ramach badań na łące wydzielono 6 łanów doświadczalnych, które nawożono nawozami mineralnymi NPK oraz gnojówką bydlęcą i obornikiem stosowanymi w dwóch dawkach, odpowiadających dwóm poziomom nawożenia azotem: 60 i 120 kg·ha^{-1}. Do analiz pobierano ruń łąkową z pierwszego odrostu. W próbach zielonki oceniano liczebność wybranych mikroorganizmów, a także zawartości składników pokarmowych. Zastosowane nawożenie nawozami naturalnymi łąki, zwłaszcza obornikiem, spowodowało wzrost zawartości popiołu surowego oraz spadek koncentracji cukrów prostych i pogorszenie stosunku cukrowo-białkowego. Ponadto nawożenie obornikiem powodowało wzrost zawartości w runi łąkowej potasu przy równoczesnym spadku koncentracji sodu, magnezu i wapnia. Wzrost dawki nawożenia powodował wzrost zawartości potasu i spadek wapnia w runi. Stosowane nawożenie nawozami naturalnymi nie powodowało niekorzystnych zmian w mikroflorze epifitycznej runi.
Słowa kluczowe*: gnojówka, NPK, makroelementy, mikroflora epifityczna, obornik, skład botaniczny, wartość pokarmowa*

1. Introduction

Due to high prices of mineral fertilisers, an increasing interest in organic fertilisers has been observed recently in Poland. The number of organic farms, where organic fertilisers are the only allowable ones, increases respectively.

Manure, liquid manure and slurry are the organic fertilisers most often applied on permanent grasslands [1]. Appropriate meadow fertilisation determines to a large extent the floristic and chemical composition of sward and improves its nutritive value and palatability [2, 3, 4]. Nutritive value of fodder from grasslands depends on proportions of particular mineral components, which ensure normal physiological processes in animals and on the content of organic matter and its digestibility, which determines the energetic values of fodder i.e. the productive potential of animals fed that fodder [5, 6].

A lack of toxic and counter-nutritive substances is important for final effect of animal production and health. Only the whole set of mentioned factors determines real nutritive value of each fodder. Qualitative requirements put on milk as a raw material for further processing necessitates the production of fodder of high nutritive value but also of high microbiological quality. This is particularly important for fodder from grasslands, which is often the basic or exclusive fodder eaten by cattle.

The aim of this study was to assess the effect of various forms and doses of fertilisers on nutritive value and microbiological quality of the first regrowth of meadow sward.

2. Materials and methods

Studies were carried out in the years 2011-2013 on permanent meadow (proper dry ground) of the Experimental Farm, Institute of Technology and Life Sciences in Falenty. Field experiment was set up on mineral soil (black degraded soil) of size fraction of light silty loam.

Six plots of an area of 0.3 ha each were established on the meadow and fertilised with mineral NPK, liquid manure and manure. Fertilisers were applied in two doses corre-

sponding to two levels of nitrogen fertilisation. At the first level (N-60) annual nutrient input was 60 kg N, 30 kg P and 60 kg K per ha, at the second (N-120) the input was 120 kg N, 60 kg P and 120 kg K per ha. Mineral fertilisers included ammonium saltpetre, ground rock phosphate and potassium sulphate. They were applied in spring (1/3 of annual dose of N and K and the whole dose of P) and after the first and second cut (the remaining two thirds of annual dose of N and K). Phosphorus deficits in plots fertilised with liquid manure were supplemented with ground phosphate rock. Depending on N content in manure and liquid manure, 24,0 to 30,0 t ha^{-1} of manure or 24,0 to 28,0 m^3 ha^{-1} of liquid manure were applied at fertilisation level N-60. At the higher intensity of fertilisation (N-120) annual doses of organic fertilisers were doubled. Manure (20% DM) was applied once in autumn or spring with manure spreader. Liquid manure was applied to soil with special spreaders in two equal doses, one in spring and one after the first cut.

Botanical composition of meadow sward was estimated every year before the first cut with the Klapp's method [7]. Whole plots were mown with a rotary mower three times a year. The first cut was harvested between 19 and 28 May. Sward samples for chemical and microbiological analyses were taken during the first cut. In the year 2011 the total number of aerobic bacteria, bacteria of the family *Enterobacteriaceae*, yeasts and moulds was estimated from cultures on Petrifilm™ 3M. Every year the content of nutritive components: total protein, crude fibre, crude ash and soluble sugars was determined after drying and grinding plant material with the NIRS method [8] using NIRFlex N-500 apparatus and ready for use calibrations for hay (INGOT®). In samples from 2012-2013 the content of macrocomponents (P, K, Ca, Mg, Na) was determined in the sward. Inorganic components were determined in plant material after mineralization in a mixture of nitric, perchloric and sulphuric acids. Potassium concentration was determined with the emission method, phosphorus – with colorimetric method and the concentrations of calcium, magnesium and sodium – with the atomic absorption spectrophotometry.

Obtained results were statistically processed using two-factorial ANOVA with the form of fertilisation (mineral NPK, manure, liquid manure) and the dose (N-60 and N-120) as factors. The significance of differences was checked with Tukey HSD test at $p < 0.05$. Calculations were performed with Statistica 6 (Statsoft Poland) software.

3. Results and discussion

Botanical composition of sward. Nutritive value of fodder from permanent grasslands is a reflection of botanical composition of sward i.e. of the proportion of grass, legume and herb species, which differ in chemical composition [2]. The share of the main plant groups and of particular species in the sward of studied plots was similar. No significant changes in botanical composition were observed in subsequent years. Grasses contributed most to plant yield (tab. 1). Their mean share varied from 74 to 82.3% on plots fertilised with lower doses of fertilisers and from 84.3 to 87% on those fertilised with higher doses. The meadow foxtail (*Alopecurus pratensis* L.) dominated among grasses on all plots. Its percentage share was from 41% (liquid manure N-120) to 54% (manure N-120). Less frequent were the meadow grass (*Poa pratensis* L.) and Italian ryegrass (*Lolium multiflorum* L.) Dicotyledons classified as herbs and weeds were the next numerous plant group. Their mean share in meadow sward was smaller on plots fertilised with higher doses of fertilisers (from 8.7 to 12%). On plots fertilised with lower doses their share in plant yield was from 13 to 19.3%. Main species in this group were: *Taraxacum* spp. and *Rumex acetosa* L. Participation of legumes, represented mainly by the white clover (*Trifolium repens* L.), was small and ranged from 3.7 to 6.7%.

Total protein. Protein is the main component of fodder from meadow sward given to farm animals. Serving as the built-up of tissues and organs it is indispensable for animals. Both the deficit and excess of protein in fodder affect animal productivity. Total protein content in bulk fodder from grasslands may vary greatly from 100-120 to 160-180 g kg^{-1} DM [9]. Minimum content of total protein in fodder that determines appropriate digestion in alimentary tract of highly efficient dairy cows is 150-170 g·kg^{-1} DM [9; 10]. The content of total protein in analysed samples did not differ much (from 96.7 to 127,3 g/kg DM) and did not depend on the form and dose of applied fertilisers (tab. 3). A high content of structural carbohydrates, the so-called crude fibre is a characteristic feature of bulk fodder. It contains many substances, which modify digestion and determine the nutritive value of bulk fodder. Too high content of crude fibre is a factor limiting nutritive value and the usefulness of plants for feeding highly efficient animals. On the other hand, ruminants need fibre for proper functioning of the digestive system.

Table 1. Proportion of plant groups in sward in the Ist regrowth in the following years of study
Tab. 1. Udział grup roślin w runi pierwszego odrostu w kolejnych latach badań

Plant groups (%)	Year of study	Fertilisation					
		NPK		Manure		Liquid manure	
		N-60	N-120	N-60	N-120	N-60	N-120
Grasses	2011	74	86	76	85	79	84
	2012	75	86	78	86	81	87
	2013	73	89	77	82	87	87
	Mean	**74.0**	**87.0**	**77.0**	**84.3**	**82.3**	**86.0**
Legumes	2011	7	3	5	3	5	6
	2012	6	5	4	4	5	5
	2013	7	3	6	4	4	5
	Mean	**6.7**	**3.7**	**5.0**	**3.7**	**4.7**	**5.3**
Others	2011	19	11	19	12	16	10
	2012	19	9	18	10	14	8
	2013	20	8	17	14	9	8
	Mean	**19.3**	**9.3**	**18.0**	**12.0**	**13.0**	**8.7**

Source: own study / Źródło: badania własne

Table 2. Percentage of more important species in Ist regrowth 2013
Tab. 2. Udział ważniejszych gatunków roślin w runi pierwszego odrostu w 2013 roku

Species	Fertilisation					
	NPK		Manure		Liquid manure	
	N-60	N-120	N-60	N-120	N-60	N-120
Alopecurus pratensis L.	44	51	43	54	48	41
Poa pratensis L.	12	12	15	10	11	8
Lolium multiflorum L	6	18	8	8	22	25
Dactylis glomerata L.	4	4	3	4	3	2
Bromus inermis Leyss.	2	1	2	2	1	0
Taraxacum spec.	9	4	7	5	5	5
Rumex acetosa L	4	1	3	2	1	1
Trifolium repens L.	5	2	4	2	3	4
Others	14	7	15	13	6	14

Source: own study / Źródło: badania własne

Table 3. Content of nutritive components in Ist regrowth of meadow sword fertilized with NPK fertilisers, manure and liquid manure
Tab. 3. Zawartość składników pokarmowych w I odroście runi łąkowej nawożonej nawozami mineralnymi NPK, obornikiem i gnojówką

Examined paramtere	Year of study	NPK		Manure		Liquid manure		Significance		
		N-60	N-120	N-60	N-120	N-60	N-120	fertilisation	dose	fertilisation x dose
Total protein, g·kg^{-1} DM	2011	106.0	102.7	117.7	106.0	100.9	112.5	ns	ns	ns
	2012	118.6	120.5	127.3	119.2	113.9	110.0	ns	ns	ns
	2013	115.9	107.5	112.4	110.2	116.5	96.7	ns	**	ns
	Mean	**113.5**	**110.3**	**119.1**	**111.8**	**110.5**	**106.4**	ns	ns	ns
Crude fibre, g·kg^{-1} DM	2011	323.7	332.9	308.2	320.6	317.0	314.4	**	ns	*
	2012	273.8	294.1	285.4	296.1	276.6	271.8	ns	ns	ns
	2013	328.1	355.3	340.2	353.2	332.0	322.5	**	**	*
	Mean	**308.5**	**327.4**	**311.3**	**323.3**	**308.5**	**302.9**	ns	ns	ns
Crude ash, g·kg^{-1} DM	2011	78.4	79.1	97.4	89.2	88.0	102.1	**	ns	*
	2012	65.6	68.8	75.8	84.1	69.7	77.1	*	**	*
	2013	102.5	99.3	106.4	118.3	104.8	105.3	**	ns	*
	Mean	**82.1**	**82.4**	**93.2**	**97.2**	**87.5**	**94.8**	*	ns	ns
Water soluble sugars content, g·kg^{-1} DM.	2011	107.2	102.7	94.7	105.4	117.3	106.9	ns	ns	ns
	2012	165.1	146.5	130.6	118.5	168.9	174.5	**	ns	*
	2013	73.9	73.4	66.0	53.8	85.8	116.1	**	ns	*
	Mean	**115.4**	**107.6**	**97.1**	**92.5**	**124.0**	**132.5**	*	ns	ns
Sugars/protein ratio	2011	1.02	1.00	0.81	1.00	1.17	0.97	ns	ns	ns
	2012	1.39	1.25	1.03	1.00	1.48	1.59	**	ns	*
	2013	0.64	0.69	0.59	0.49	0.74	1.21	**	**	*
	Mean	**1.02**	**0.98**	**0.81**	**0.83**	**1.13**	**1.26**	*	ns	*

Source: own study / Źródło: badania własne

Optimum content of crude fibre in fodder for ruminants is 200-250 g·kg^{-1} DM and it should not exceed 280 g·kg^{-1} DM [9, 10]. Fodder from experimental plots fulfilled the norm for ruminants only in the year 2012 since the mean content of crude fibre was slightly above 282 g·kg^{-1} DM. In other years the norm of crude fibre content was exceeded (tab. 3). Statistical analysis revealed significant effect of applied fertilisers on the content of crude fibre in the first and third year of studies. In 2011 the sward from NPK fertilised plots contained significantly more crude fibre (328.3 g·kg^{-1} DM) than from those fertilised with manure (314.4 g·kg^{-1} DM) or liquid manure (315.7 g·kg^{-1} DM). In the last study year the least content of crude fibre was found in sward fertilised with liquid manure (327.3 g·kg^{-1} DM). The effect of fertiliser dose was significant only in the last study year. Sward from plots fertilised with higher nutrient doses contained more fibre (343.7 g·kg^{-1} DM) than that fertilised with lower doses (333.4 g·kg^{-1} s.m).

Obtained low concentrations of protein at a high concentration of crude fibre in sward, particularly visible in the first and second study year, are characteristic for grasses at the end of spiking and the beginning of flowering phase [11, 12, 13] and evidence that the sward was mown in a period later than the optimum.

Crude ash. Crude ash is a sum of mineral components and possible inorganic impurities in fodder, which manifested itself in its high concentration exceeding 80 g·kg^{-1} DM. The content of crude ash in analysed plant material significantly depended on the form of applied fertilisation (tab. 3). Sward fertilised with mineral NPK fertilisers contained significantly less ash (82.25 g·kg^{-1} DM) than that fertilised with manure (95.2 g·kg^{-1} DM) or liquid manure (91.15 g·kg^{-1} DM).

Sugar to protein ratio. Nutritive value of meadow sward is determined not only by absolute water-soluble carbohydrates content but rather by the ratio to protein [14]. The ratio is an indicator of the assimilability of protein from plants by animal organisms and should not be lower than 0.4 and its optimum value for ruminants should fall within the range from 0.8 and 1.5 [15, 16]. The ratio in ana-

lysed plant material varied between 0.64 and 1.59, so it did not exceed the feeding norms. Statistical analysis showed significant effect of applied fertilisation on the ratio (tab. 3). Meadow sward from plots fertilised with liquid manure had, on average, a higher ratio of these components (1.19) than the sward fertilised with manure (0.82) or NPK (1.00). The difference resulted from diverse content of simple sugars in sward from particular plots: the highest in plots fertilised with liquid manure (mean 128.3 g·kg^{-1} DM) and the lowest in sward fertilised with manure (mean 94.8 g·kg^{-1} DM). Lower content of simple sugars in meadow vegetation fertilised with manure was also found by Kacorzyk and Szewczyk [2]. They explained this result by accumulation of large amounts of ammonium ions in soil due to ammonification, which is associated with the expenditure of energy and decrease in the content of simple sugars.

Phosphorus. Phosphorus is one of the more important macroelements in animal fodder. Its concentration in meadow plants varies from 1 to 8 g·kg^{-1} DM and depends on plant species. Optimum P content in bulk fodder for cattle is between 2.8 and 3.6 g·kg^{-1} [5]. Animals fed fodder with phosphorus deficit show decreased feed uptake and, therefore, limited growth and development and lower milk efficiency. In both study years phosphorus content in sward from all plots was relatively high (3.6–4.2 g·kg^{-1} on average) and exceeded the optimum content for animals. Similar contents of phosphorus in meadow sward and in grass-legume mixtures were observed by other authors [17, 18]. Phosphorus content above 3.0 g·kg^{-1} is an evidence of its appropriate supply to meadow sward [19]. Despite the fact that the type of fertilisation had no significant effect and the effect of fertilisation was only significant in 2012, a tendency was noted for a higher P content in sward from plots fertilised with manure (tab. 4). Positive effect of manure fertilisation on P concentration in plant biomass was found also by Kacorzyk and Kasperczyk [20], who explained this by a higher share of dicotyledons (legumes and herbs) in meadow sward.

Potassium. Potassium content in meadow plants varies greatly (from 6 to 80 g·kg^{-1} DM) and rapidly in the effect of fertilisation, especially with slurry. Some grasses (*Dactylis glomerata*, *Lolium multiflorum*) and herbs show higher content of this element. Potassium content in analysed meadow sward was differentiated (from 14.3 to 30.0 g·kg^{-1}, tab. 4) and depended on both form and dose of fertiliser. The lowest content of potassium was found in sward from plots fertilised with mineral NPK (mean of both levels of fertilisation was 17.2 g K kg^{-1} DM) and the highest – in sward from manure fertilised plots (mean 28.0 g·kg^{-1}). The opposite relationship was noted by Kacorzyk and Szewczyk [2], who found that mineral fertilisation facilitated higher potassium content in plants in comparison with manure or mixed fertilisation. Irrespective of the form of fertiliser, the dose of applied fertiliser was the factor significantly differentiating potassium content in sward. Sward from plots fertilised with higher doses was richer in potassium (mean 24.1 g·kg^{-1} DM) than sward fertilised with lower doses (mean 19.8 g·kg^{-1} DM). Sward from most of the plots contained potassium in concentrations exceeding the range of 17.0-20.0 g·kg^{-1} considered as the optimum for grassland fodder [5, 21]. The excess of potassium in fodder for cattle was often described in the literature [5, 18, 22, 23, 24] and explained by unlimited, the so-called „luxury K uptake" from soil. High K content in sward is facilitated by fertilisation with nitrate-nitrogen, intensive use, large atmospheric precipitation and species diversity of plants [4, 5, 18, 25]. Too high K concentration is undesired for animals since it limits assimilation of Mg, Ca and Na.

Calcium. Calcium plays an important role in animal feeding since it affects digestibility and palatability of plants. Good fodder for ruminants should contain 7.0 g Ca kg^{-1} [5]. Feeding animals with fodder of low calcium content may result in insufficient fertility and productivity. However, more often is hypercalcemia, which is an effect of the excess of calcium in fodder. There is a relationship between calcium and potassium, whose excess may result in calcium losses. The content of calcium in analysed meadow sward varied from 0.9 to 1.9 g·kg^{-1} (tab. 4) and depended on the form of applied fertiliser. The lowest calcium content was typical for sward fertilised with manure (1.1 g·kg^{-1} as a mean from two levels of fertilisation). Significantly more calcium was found in plants fertilised with mineral NPK (1,49 g·kg^{-1} DM) and liquid manure (1.6 g·kg^{-1} DM). All plants showed calcium deficit, which probably resulted from low calcium content in and acidic pH of soil.

Magnesium. Deficits of this element are often recorded in fodder from permanent grasslands. Assumed optimum concentration in animal feeding is 2 g·kg^{-1} DM of plants. [5, 21]. Concentrations of magnesium in analysed plants exceeded this standard during the whole study period and depended on the form of applied fertiliser. The richest in magnesium was the sward from plots fertilised with mineral NPK (mean for both levels of fertilisation was 3.6 g·kg^{-1} DM), the least plant magnesium was found in plots fertilised with liquid manure (mean 2.8 g·kg^{-1} DM). There was also a significant effect of nutrient doses on magnesium content in fodder. Sward fertilised with lower doses exhibited on average higher Mg content (3.4 g·kg^{-1} DM) than that fertilised with higher doses (2.9 g·kg^{-1} sm.). Higher Mg content in sward from less fertilised plots and from plots fertilised with mineral NPK was probably caused by a greater share of herbs, mainly *Taraxacum* spp. (tab. 1 and 2) which are able to accumulate more magnesium [26].

Sodium. Fodder should contain from 1.5 to 2.5 g Na per kg DM [5]. The richness of sward in sodium was very low in all study years and depended on the form of applied fertiliser. Poorest in sodium was the sward from plots fertilised with manure (0.21 g·kg^{-1} - a mean from both levels of fertilisation) and the richest – that from plots fertilised with liquid manure (mean 0.83 g·kg^{-1} DM). No effect of fertilisation doses on sodium content in sward was found. So low concentration of sodium could be a result of a large per cent of *Alopecurus pratensis* (41-54%) in sward. This species is characterised by a poor ability to accumulate sodium. Because of negative correlation between potassium and sodium, it is important to maintain appropriate K:Na ratio, which should be equal to 5:1. In analysed plant samples this ratio was much higher, which indicates the need of supplementing animals' diet with mineral fodder.

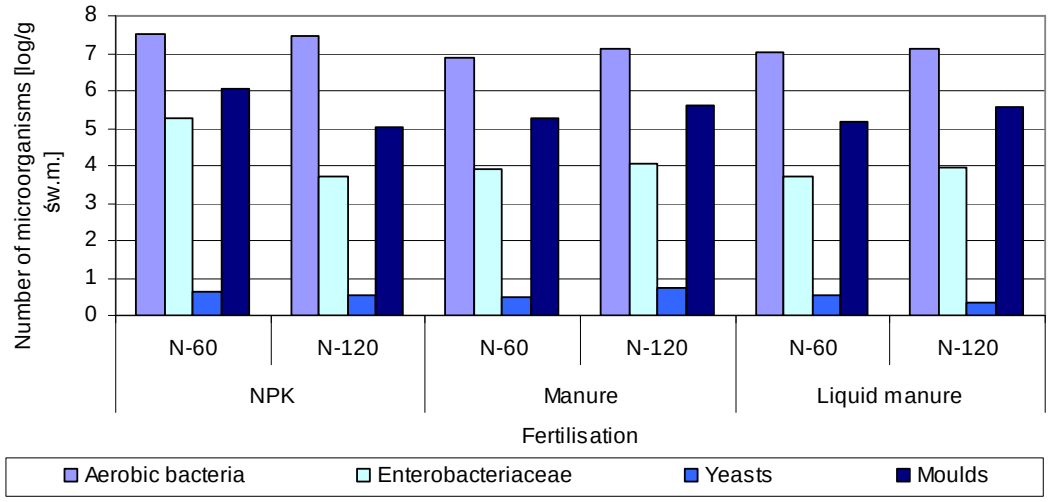
Microbiological quality of meadow sward. Organic fertilisers may contain various parasites, pathogens harmful for people and animals and other microorganisms negatively affecting the quality of milk and its usefulness for further processing [27]. Faecal bacteria including pathogenic strains may be present in less fermented faeces and urine, especially when ill animals without any visible symptoms are present in the herd. Pathogenic bacteria in-

troduced in fertilisers may survive in soil and on plants thus contaminating green fodder and eventually produced silage [28]. In experiment presented here, organic fertilisers (both manure and liquid manure) did not affect microbiological quality of meadow sward intended for ensilage. Mean total number of aerobic bacteria of the family Enterobakteriaceae, yeasts and mould fungi on plants fertilised with organic fertilisers was similar to that on plants fertilised with mineral NPK (fig. 1). However, studies performed in small organic farms of an area of 10 – 20 ha and breeding 6 – 10 animals, which produced organic fertilisers (liquid manure and slurry) used to fertilise permanent grasslands showed the presence of pathogenic bacteria (e.g. *Salmonella* sp. and *Escherichia coli*) in fertilisers, soil, mown sward and in silage [29].

Table 4. Content of macroelements in Ist regrowth of meadow sword fertilized with NPK fertilisers, manure and liquid manure
Tab. 4. Zawartość makroelementów w I odroście runi łąkowej nawożonej nawozami mineralnymi NPK, obornikiem i gnojówką

Examined paramtere	Year of study	NPK		Manure		Liquid manure		Significance		
		N-60	N-120	N-60	N-120	N-60	N-120	fertilisation	dose	fertilisation x dose
P	2012	3,8	4,2	4,3	4,3	3,8	3,7	*	ns	ns
	2013	3,4	3,7	3,8	4,1	3,7	3,7	ns	ns	ns
	Mean	**3,6**	**3,9**	**4,1**	**4,2**	**3,7**	**3,7**	ns	ns	ns
K	2012	15.8	19.1	25.9	28.8	17.6	24.6	**	**	*
	2013	14.3	19.7	27.4	30.0	17.8	22.4	**	**	*
	Mean	**15.0**	**19.4**	**26.7**	**29.4**	**17.7**	**23.5**	**	**	*
Ca	2012	1.6	1.3	0.9	1.1	1.4	1.4	ns	ns	ns
	2013	1.9	1.2	1.2	1.2	1.8	1.8	*	ns	ns
	Mean	**1.7**	**1.3**	**1.1**	**1.1**	**1.6**	**1.6**	****	**ns**	*****
Mg	2012	3.8	3.4	2.9	2.9	3.0	2.5	**	ns	*
	2013	4.2	3.0	3.2	3.1	3.3	2.3	**	**	**
	Mean	**4.0**	**3.2**	**3.1**	**3.0**	**3.2**	**2.4**	**	**	**
Na	2012	0.5	0.6	0.1	0.2	0.8	0.4	**	ns	*
	2013	1.0	0.5	0.2	0.3	1.0	1.1	**	ns	*
	Mean	**0.8**	**0.5**	**0.2**	**0.3**	**0.9**	**0.7**	**	ns	*

Source: own study / Źródło: badania własne



Source: own study / Źródło: badania własne

Fig. 1. The number of selected microorganisms (log jtk·g^{-1} FM) in I regrowth of meadow sword fertilized with NPK fertilisers, manure and liquid manure (2011)
Rys. 1. Liczebność poszczególnych grup mikroorganizmów (log jtk·g^{-1} św. m.) w I odroście runi łąkowej nawożonej obornikiem, gnojówką i nawozami mineralnymi

4. Conclusion

Fertilising meadows with organic fertilisers, particularly with manure increased the content of crude ash, decreased the concentration of simple sugars and worsened the sugar to protein ratio. Moreover, in comparison with other forms of fertilisers, application of manure increased the concentration of potassium in meadow sward with a parallel decrease in the concentration of sodium, magnesium and calcium. An increase of doses of applied fertiliser, irrespective of its type, increased potassium content and decreased calcium content in meadow sward. Applied fertilisation of meadow sward with organic fertilisers in conditions of described experiment was not followed by unfavourable changes in epiphytic microflora of analysed sward.

5. References

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