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THE INFLUENCE OF MINERAL FERTILIZER AND COW MANURE ON THE DISTRIBUTION OF MICROFLORA IN PEAT SOIL UNDER MEADOW*

A description is given in this study of research on the effect of mineral fertilizers and cow manure on the state of microflora in peat soil under meadow. The results obtained show that basic fertilization and micro-elements act chiefly on the preservation of the proper structure of the soil, and the slight variations in the abundance of microflora were caused by the intensified development of the plant cover.

The influence of fertilization on macroflora has been investigated repeatedly and is generally well known, but research workers have been interested to a lesser extent in the microbiological variations caused by fertilization of meadow soils. Investigations of this problem have been made in Poland by Gołębiowska and Falkowski (1952) and Chwastek (1957).

The problem of increasing the productivity of Polish grasslands, as regards both mass and value of hay, is one which is always current. Considerable sums of money are invested in land improvement and water management, and in the cultivation and utilization of grasslands. Complete cultivation of meadows and pastures by fully ploughed cultivation is extremely expensive, and not necessary everywhere. In this connection the question arises as to what direction will be taken by microbiological variations when grasslands are cultivated by the method of exclusively mineral or stable manure fertilization.

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The aim of the present study was to trace the changes taking place in the microflora system of peat soil under permanent meadow as the result of fertilization by mineral fertilizer (macro- and micro-fertilizers) and stable manure.

1. STUDY AREA

Investigations were carried out in the permanent drained meadow on the "Biel" bog near Otwock, outside Warsaw. The area is fenland which has formed in the ancient valley of the River Vistula. Until 1959 the area was excessively wet, but water relations were regulated by drainage operations. The peat deposits are of medium thickness, from 1.50 to 1.80 m. The upper layers are formed of sedge peat, the middle and lower layers of reed peat. On the site of the experiment the initial vegetation was an association with a floristic composition similar to the association *Caricetum appropinquatae* Tx. 1947, with a considerable percentage of true mosses.

The experiments in fertilization were initiated in 1959 by R. Moraczewski[1] by means of the method of random blocks in five belts and five repeats – the author of the present study made use of these experiments in his microbiological investigations. Preparation for the investigations consisted in removal of the mossy layer from the plots chosen. The vascular plants were subjected to the exclusive effect of fertilizers. The following combinations were used in the experiments with fertilizers: 1) control – C, 2) K, 3) KP, 4) KPN, 5) KPCa, 6) KPZn, 7) KPMn, 8) KPCu, 9) KPB, 10) KPMo, 11) KPCo, 12) manure. A diagram and details of the amounts used of each fertilizer are given in the study (Zimny 1964).

2. MATERIAL AND INVESTIGATION METHODS

Investigations of the changes taking place under the influence of fertilization were carried out over a four-year period from 1959 to 1962 inclusively. Mean samples of soil were taken, with the exception of 1959, three times during the growing season: in May, July and September. The soil was placed in sterilized jars with ground stoppers and taken to the Division of Plant Ecology of Warsaw Agricultural University in Warsaw. Microbiological analyses were made immediately after the samples had reached the laboratory. Soil samples were taken only from the turf horizon. The following were determined each time in the soils: 1) The total amount of bacteria, *Actinomycetes* and fungi, 2) activity of

[1] R. Moraczewski was interested in the nitrogen transformations in the soil and the cropping of plants. The results of his investigations will form the subject of a publication by him.

the soil in process of ammonification, 3) activity of the soil in process of denitrification.

The total amount of bacteria, *Actinomycetes* and fungi was defined by the plate method, using an agar medium with a soil extract (fertile peat soil). The medium for fungi was acidified by means of lactic acid to pH 3.5 – 4.5. The pH of the medium for bacteria and *Actinomycetes* was established on the level of pH = 7.

Intensification of the ammonification process was examined by means of the method of dilutions in an agar medium with addition of pepton, and that of denitrification in a fluid medium with addition of KNO_3.

3. RESULTS OF INVESTIGATIONS

a. Influence of fertilization on the general state of bacteria

The initial state before the experiment was begun was from 1.3 to 2.3 million bacteria calculated per 1 g of fresh mass of peat (Tab. I). On the control unfertilized plot the amount of bacteria did not exhibit any tendency to increase, but rather a certain degree of stability.

The influence of basic fertilizers KPN, Ca and manure was different. This was most marked in the summer of 1961 in the case of Ca and manure. The amount of bacteria on these plots distinctly increased. The action of phosphorus, potassium and nitrogen was variable. In one year these fertilizers caused a great increase in bacteria and in another a relatively slight increase (Tab. I). Micro-fertilizers particularly Zn, have a stimulating effect on increase in abundance of bacteria. The amount of these micro-organisms constantly and systematically increased, and in the summer of 1962 attained the maximum abundance obtained in the experiments, of 12 million organisms per 1 g of fresh peat mass. Borium caused a similar effect, but to a lesser extent. The action of Cu was somewhat negative on the total amount of bacteria in the peat soil under permanent grassland. The remaining micro-elements did not cause significant changes in the amount of bacteria.

The variations found in the total amount of bacteria should be considered only as certain tendencies to increase in abundance of these micro-organisms under the influence of doses of fertilizers, since it did not prove possible to demonstrate these variations statistifically by an analysis of variances.

During the investigations the bacteria were found to exhibit certain tendencies to increase their activity depending on climatic conditions. The period most favourable to their development was the spring and summer, Influence of fertilization on the development of bacteria in the peat soil (thousands of microorganisms per 1.0 g of fresh soil)

Tab. I

Fertilizing combinations	Vegetative season	Not fertilized	Fertilized		
		1959	1960	1961	1962
Control	spring summer autumn	1700	1900 2000 1400	2300 2900 1600	2100 1500 1400
K	"	1300	2100 2700 1700	1600 2300 2300	5100 2300 2900
KP	"	1500	2300 2400 2100	2100 3500 1400	4600 1300 2300
KPN	"	1600	1200 3200 2400	2200 2700 2100	6900 4600 1800
KPCa	"	1800	2300 3000 2000	2500 5500 2400	7900 1600 3300
KPZn	"	1500	3700 4200 2900	3100 3800 4200	8300 12700 2300
KPMn	"	1900	3600 2800 2800	2500 3200 4700	3700 2600 1600
KPCu	"	2100	2700 3400 4000	1600 3300 2700	3200 1700 2200
KPB	"	2300	2700 2400 2600	2100 2900 1300	6300 4800 5700
KPMo	"	2100	2800 2400 5400	2000 4100 3100	7000 3900 2100
KPCo	"	2200	2600 2800 2400	1700 5400 2700	5100 1700 3000
Manure	"	2000	3300 2700 3300	3200 5300 3600	4900 3600 2300

relatively few bacteria being found in the autumn. The effect of climatic conditions is also evident in the different years, when the amount of these micro-organisms was differently formed despite the application of the same fertilizing operations.

b. Influence of fertilization on the state of *Actinomycetes*

Before the experiments were begun the amount of *Actinomycetes* in the peat soil of the study area was from 0.5 to 0.9 million per 1 g of fresh peat mass. The unfertilized (control) plot exhibited a constant and systematic increase in the amount of *Actinomycetes* (Tab. II). A change in the soil structure was also exhibited on this plot. The peat became less compact, fluffy and spongy in structure – the process of rotting constantly progressed.

The action of fertilizers on the abundance of *Actinomycetes* was relatively faintly marked. The effect of fertilization was rather to inhibit their rapid increase, and it was instrumental in the preservation of the proper structure of the soil. The rapid increase of *Actinomycetes* should be considered as a somewhat negative phenomenon, since soil *Actinomycetes* are eminently oxygen organisms and in the event of a change of the system in an association of microflora, in their favour, fairly important changes may take place in microbiological processes, since the majority of *Actinomycetes* create antibiotics, which have not only a positive, but also a negative, effect on the development of other microorganisms. Certain tendencies to increase were found as the result of fertilization with potassium, phosphorus, calcium and manure, particularly in 1961. Of the micro-elements cobalt, borium, and less strongly, manganese, had a favourable effect on the increase in the abundance of *Actinomycetes*. The remainder did not cause variations in the abundance of these micro-organisms (Tab. II).

It was found that *Actinomycetes* developed best during the summer and autumn, when the humidity of the soil decreased and temperature rose. They always occurred in the smallest amounts in the spring. Different years can also be favourable to or less productive of these micro-organisms, the most favourable year being 1961.

c. Influence of fertilization on the state of fungi in peat soil

Fungi are micro-organisms with ecological requirements (especially in regard to humidity and aeration) similar to those of *Actinomycetes*, although they can exist equally well under conditions in which oxygen is absent; they then create fermentation processes. They never attain in peat soils the maximum abundance of their occurrence which they have in acid or sandy soils.

Influence of fertilization on the development of *Actinomycetes* in the peat soil (thousands of microorganisms per 1.0 g of fresh soil)

Tab. II

Fertilizing combinations	Vegetative season	Not fertilized	Fertilized		
		1959	1960	1961	1962
Control	spring summer autumn	900	900 100 100	400 900 5500	300 1900 3500
K	"	800	800 300 300	500 2000 1500	1400 3100 1800
KP	"	500	1100 100 100	500 4400 1000	900 400 2500
KPN	"	700	400 600 200	200 1600 2500	1500 2800 2300
KPCa	"	500	500 100 100	1100 2800 1600	1900 300 3300
KPZn	"	600	400 500 300	1600 2400 2100	2900 2700 2800
KPMn	"	700	1100 300 100	300 3500 1300	800 700 1600
KPCu	"	600	700 600 100	300 2200 700	900 600 1400
KPB	"	500	600 200 300	200 3900 300	800 2200 3100
KPMo	"	700	900 200 200	100 1900 1500	600 1700 1100
KPCo	"	500	1200 200 100	300 6300 1200	1200 1000 1700
Manure	"	600	500 400 100	600 3200 2100	700 2900 1900

Influence of fertilization on the development of fungi in the peat soil (thousands of microorganisms per 1.0 g of fresh soil)

Tab. III

Fertilizing combinations	Vegetative season	Not fertilized	Fertilized		
		1959	1960	1961	1962
Control	spring	0.2	0.1	0.4	0.4
	summer		0.2	0.6	3.0
	autumn		2.0	17.5	16.7
K	"	0.2	0.2	0.3	3.6
			0.2	1.9	5.9
			7.5	4.0	8.3
KP	"	0.3	0.1	0.1	1.3
			0.4	0.5	0.7
			3.0	1.9	6.0
KPN	"	0.2	0.2	0.1	1.3
			0.3	0.5	5.5
			2.4	6.9	11.0
KPCa	"	0.2	0.1	0.8	2.1
			0.2	1.5	0.6
			3.3	2.2	4.2
KPZn	"	0.2	0.1	0.1	8.2
			0.3	0.8	3.5
			7.4	3.6	2.5
KPMn	"	0.1	0.1	0.1	2.3
			0.1	1.5	2.1
			3.7	20.0	15.7
KPCu	"	0.1	0.2	0.2	2.2
			0.1	0.3	0.9
			3.8	2.3	1.0
KPB	"	0.2	0.1	0.1	0.3
			0.2	1.2	4.1
			3.2	4.9	1.8
KPMo	"	0.2	0.1	0.1	0.7
			0.2	0.2	6.2
			4.3	2.4	1.4
KPCo	"	0.2	0.1	0.1	3.2
			0.3	7.7	0.4
			4.6	0.9	6.4
Manure	"	0.1	0.1	0.3	2.1
			0.1	0.5	4.8
			10.2	3.5	13.5

The participation of fungi in the soil microflora as a whole was negligible in the study area. During the initial period of the investigations scarcely a few hundreds of these organisms per 1 g of soil were found (Tab. III). On the control plots, as the result of the changes in the physical conditions, the amount of these micro-organisms rose very considerably. In addition to the control soil the amount of fungi was observed to increase as the result of fertilization with potassium, nitrogen and manure. These micro-organisms attained an abundance in 1962 of 4.8 to 5.9 thousands per 1 g of fresh peat mass. Fertilization with calcium had an unfavourable effect on the abundance of fungi.

The effect of micro-elements varied. Increase in abundance was found on plots fertilized with molybdenum, borium, zinc and magnesium. Changes were not found due to the effect of the remaining micro-fertilizers. The amount of fungi also varied depending on the vegetation period. Fungi occurred in the greatest abundance in the autumn, and in the smallest amounts in the spring, with the exception of the plot fertilized with zinc, where the amount of fungi found was fairly considerable (Tab. III). The curve of development of fungi exhibits its minimum in the spring, rises in summer and attains its maximum level in the autumn.

d. Influence of fertilization on the processes of ammonification and denitrification in peat soil

The productive value of soils depends on the biological processes taking place in them. One of the basic processes is that of decomposition of organic mass, owing to which there is constant circulation of matter in nature. The processes of decomposition of organic mass are positive processes in the assessment of soils from the aspect of their productive capacity. Other processes such as denitrification lead to degradation of soils. Increase in the denitrification process is therefore evidence of the decreasing productive capacity of the given soils.

Ammonification in the peat soil under permanent grassland proceeded fairly intensively on the plots fertilized with nitrogen and calcium. Of the micro-elements borium, cobalt and copper increased the activity of the soils. The ammonification process was weakest on the control plot. The effect of climatic conditions on the activity of the ammonificators was not uniform in all the combinations (Tab. IV).

Denitrification in peat soil, under the conditions of the experiment, is an indicator of soil degradation. The process was most active on the unfertilized control plot. On the other hand it was fairly active, particularly in the third study year, on the plot with zinc. The denitrification process was relatively weakly active in the soils on plots fertilized with nitrogen, potassium, phosphorus, manure, manganese and cobalt (Tab. V).

The lowest quantity of fresh peat causing ammonification (in mg)

Tab. IV

Fertilizing combinations	Vegetative season	Not fertilized	Fertilized		
		1959	1960	1961	1962
Control	spring summer autumn	0.01	0.1 0.1 0.01	0.01 0.01 0.001	0.01 0.1 0.01
K	"	0.1	0.01 0.1 0.001	0.1 0.01 0.001	0.01 0.01 0.1
KP	"	0.1	0.01 0.01 0.001	0.1 0.001 0.001	0.01 0.01 0.01
KPN	"	0.1	0.1 0.1 0.001	0.1 0.01 0.1	0.001 0.01 0.1
KPCa	"	0.1	0.1 0.01 0.01	0.1 0.01 0.001	0.1 0.001 0.001
KPZn	"	0.01	0.01 0.01 0.01	0.01 0.1 0.001	0.01 0.01 0.01
KPMn	"	0.01	0.1 0.01 0.01	0.1 0.1 0.01	0.01 0.01 0.01
KPCu	"	0.01	0.01 0.01 0.001	0.1 0.001 0.001	0.0001 0.001 0.01
KPB	"	0.1	0.01 0.01 0.1	0.1 0.001 0.1	0.01 0.01 0.001
KPMo	"	0.01	0.01 0.1 0.01	0.1 0.01 0.01	0.01 0.01 0.1
KPCo	"	0.01	0.1 0.1 0.01	0.01 0.01 0.001	0.001 0.01 0.01
Manure	"	0.01	0.001 0.01 0.1	0.01 0.1 0.01	0.01 0.01 0.1

The lowest quantity of fresh peat causing denitrification (in mg)

Tab. V

Fertilizing combinations	Vegetative season	Not fertilized	Fertilized		
		1959	1960	1961	1962
Control	spring		0.1	0.001	0.0001
	summer	0.01	1.0	0.1	0.001
	autumn		0.01	0.01	0.01
K			0.001	0.01	0.001
	"	0.01	1.0	0.1	0.01
			0.001	0.1	0.01
KP			0.01	0.01	0.001
	"	0.1	1.0	0.001	0.01
			0.001	0.001	0.01
KPN			0.1	0.01	0.01
	"	0.01	0.01	0.1	0.01
			0.01	0.1	0.01
KPCa			0.001	0.001	0.001
	"	0.1	0.01	0.1	0.1
			0.01	0.1	0.001
KPZn			0.001	0.01	0.001
	"	0.01	0.01	0.1	0.001
			0.01	0.01	0.001
KPMn			0.01	0.001	0.01
	"	0.01	0.1	0.001	0.01
			0.01	0.1	0.01
KPCu			0.1	0.01	0.01
	"	0.01	0,01	0.1	0.1
			0.001	0.01	0.001
KPB			0.1	0.1	0.01
	"	0.01	1.0	0.1	0.01
			0.01	0.1	0.01
KPMo			0.001	0.1	0.001
	"	0.01	1.0	0.1	0.01
			0.01	0.01	0.1
KPCo			0.01	0.1	0.01
	"	0.01	1.0	0.1	0.01
			0.01	0.1	0.1
Manure			0.01	0.1	0.001
	"	0.01	0.01	0.1	0.001
			0.001	0.1	0.001

e. Total amount of micro-organisms and numerical relations of each of the systematic groups

The investigations showed that before fertilization was begun the total amount of micro-organisms was from 2.0 to 2.8 million organisms per 1 g of fresh peat mass (Tab. I, II, III, VI). Bacteria, the percentage of which varied from 62 to 82%, were the most abundantly represented of these micro-organisms. The second component was formed by *Actinomycetes*, which composed from 18 to 38% of the whole of the microflora found. The percentage of fungi was minimal during this period, forming a mere fraction of percentage. The general state of the microflora on the control plot exhibited a tendency to increase throughout the whole study period of four years. The ratio of each of the systematic groups markedly varied. The amount of bacteria and their percentage in the microflora decreased, while the activity of *Actinomycetes* rose, and they became the most important component. The percentage of fungi also increased, but these organisms remained third in order of importance in the system of microflora as a whole (Tab. VI).

Variations in the general system of microflora on the plots fertilized with basic fertilizers and manure consisted in the increase in the amount of micro-organisms, particularly in the second and third year of experimentation. The percentage of each group of micro-organisms in the microflora as a whole points to the distinct domination of bacteria over the other micro-organisms on the plots fertilized with NPK, Ca and manure. The percentage of fungi was very small here, being scarcely 0.4% of the total amount of micro-organisms.

Micro-elements had varying effects on the ratios of the micro-organisms. The predominance of bacteria over the other groups of micro-organisms was clearly evident in the first study year. In 1961, under the influence of manganese, borium and cobalt, and in the spring of 1962 on the plot with zinc, *Actinomycetes* predominated (Tab. VI). The percentage of fungi increases very slightly under the influence of micro-elements, but it in any case it is scarcely 0.6% of the whole microflora.

In general it must be stated that undegraded peats with good production potential were characterized by the predominating percentage of bacteria. The percentage of *Actinomycetes* and fungi increased most in degraded peat in which a distinct rotting process was taking place.

4. DISCUSSION OF RESULTS

Peat soils, as hydromorphic formations, are distinguished by different physico-chemical properties from those of mineral soils. They owe their existence to excessive humidity, and the character of the formations is

The per cent composition of microorganisms in peat soil correlated with fertilization and vegetative season

Tab. VI

Fertilizing combinations	Vegetative season	Number in per cent											
		bacteria				*Actinomycetes*				fungi			
		1959*	1960	1961	1962	1959*	1960	1961	1962	1959*	1960	1961	1962
	spring	—	67.8	85.2	87.5	—	32.2	14.8	12.5	—	0.0	0.0	0.0
Control	summer	65.4	95.2	76.3	44.1	34.6	4.8	23.7	55.8	0.0	0.0	0.0	0.1
	autumn	—	93.2	22.5	28.5	—	6.6	77.3	71.2	—	0.2	0.2	0.3
		—	72.4	76.2	78.4	—	27.6	23.8	21.5	—	0.0	0.0	0.1
K	"	61.9	90.0	53.5	42.5	38.1	10.0	46.5	57.3	0.0	0.0	0.0	0.2
		—	84.7	60.5	61.6	—	14.9	39.4	38.2	—	1.4	0.1	0.2
		—	67.6	80.8	83.6	—	32.4	19.2	16.3	—	0.0	0.0	0.1
KP	"	75.0	96.0	44.3	76.4	25.0	4.0	55.7	23.5	0.0	0.0	0.0	0.1
		—	95.3	58.3	47.9	—	4.5	41.6	52.0	—	0.2	0.1	0.1
		—	75.0	91.7	82.1	—	25.0	8.3	17.8	—	0.0	0.0	0.1
KPN	"	69.5	84.2	62.8	62.1	30.5	15.8	37.2	37.8	0.0	0.0	0.0	0.1
		—	92.2	45.6	43.7	—	7.7	54.3	55.9	—	0.1	0.1	0.4
		—	82.2	69.4	80.6	—	17.8	30.5	19.3	—	0.0	0.1	0.1
KPCa	"	78.2	96.8	66.2	84.2	21.8	3.2	33.2	15.8	0.0	0.0	0.1	0.0
		—	95.1	60.0	59.9	—	4.7	40.0	49.9	—	0.2	0.0	0.2
		—	90.2	66.0	74.0	—	9.8	34.0	25.9	—	0.0	0.0	0.1
KPZn	"	71.4	89.4	60.0	82.4	28.6	10.6	40.0	17.5	0.0	0.0	0.0	0.1
		—	90.4	57.5	45.0	—	9.3	42.4	54.9	—	0.7	0.1	0.1
		—	76.6	89.3	82.2	—	23.4	10.7	17.7	—	0.0	0.0	0.1
KPMn	"	73.1	90.3	47.7	78.7	26.9	9.7	52.2	21.0	0.0	0.0	0.1	0.1
		—	96.4	78.1	49.7	—	3.4	21.6	49.7	—	0.2	0.3	0.6
		—	79.4	84.2	78.0	—	20.6	15.8	22.0	—	0.0	0.0	0.0
KPCu	"	77.8	85.0	60.0	73.9	22.2	15.0	40.0	26.0	0.0	0.0	0.0	0.1
		—	97.5	79.4	61.1	—	2.4	20.5	38.8	—	0.1	0.1	0.1
		—	81.8	91.3	88.7	—	18.2	8.7	11.3	—	0.0	0.0	0.0
KPB	"	82.1	92.3	42.6	68.5	17.9	7.7	57.3	31.4	0.0	0.0	0.1	0.1
		—	89.4	81.0	64.7	—	10.3	18.7	35.2	—	0.3	0.3	0.1
		—	75.7	95.2	92.1	—	24.3	4.8	7.8	—	0.0	0.0	0.0
KPMo	"	75.0	92.3	68.3	69.6	25.0	7.7	31.7	30.3	0.0	0.0	0.0	0.1
		—	96.3	67.3	65.6	—	3.6	32.6	34.3	—	0.1	0.1	0.1
		—	68.4	85.0	80.9	—	31.6	15.0	19.0	—	0.0	0.0	0.1
KPCo	"	81.5	93.3	46.1	62.9	18.5	6.7	53.8	37.1	0.0	0.0	0.1	0.0
		—	95.8	69.2	63.7	—	4.0	39.7	36.1	—	0.2	0.1	0.2
		—	86.8	84.2	87.5	—	13.2	15.8	12.5	—	0.0	0.0	0.0
Manure	"	76.9	87.1	62.3	55.3	23.1	12.9	37.7	44.6	0.0	0.0	0.0	0.1
		—	96.7	63.0	54.6	—	3.0	36.9	45.1	—	0.3	0.1	0.3

* Starting point without fertilizing.

connected with the type of irrigation. It is generally well known that valley peats – fen peats – are more fertile than transitional peats and sphagnum bogs. Every bog, however, requires constant attention after the regulation of water relations. Even the most fertile bog undergoes degradation after a certain time if neglected. The opinion has been generally accepted that marshes and fens are rich in nitrogen compounds and management instructions recommended fertilization exclusively with potassium, with a very slight addition of phosphorus. The soils of the "Biell" bog reacted strongly not only to fertilization with potassium, phosphorus but very distinctly to nitrogen fertilization, particularly manure. This is proved by the enclosed diagram of relative crops for the study period (Fig. 1). The crop on the plots fertilized with $(NH_4)_2SO_4$ in 1961 was 750% in comparison with the control plot, and the crop of green mass on the plot fertilized with manure was as much as 1100% at the same time, that is, 11 times as much. The use of fertilizers altered the species composition of plants on the study plots. The initial type of vegetation – sedge and moss, was replaced by grassy plants, and when manure was used for fertilization there was a greater percentage of papilionaceous plants, white clover (*Trifolium repens* L.), meadow clover (*T. pratense* L.) and *Lotus uliginosus* Schk.

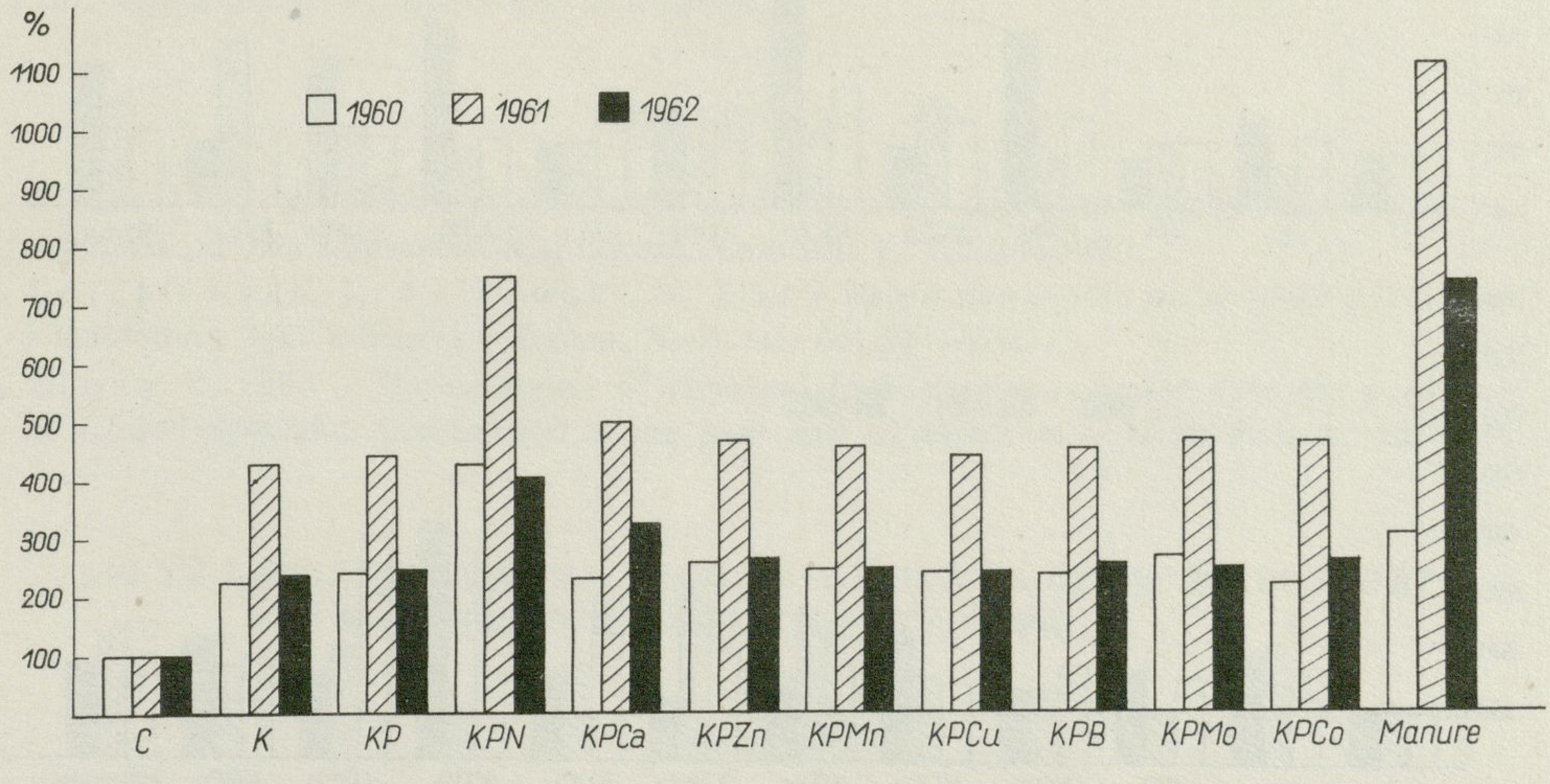

Fig. 1. The relative crop from the first and second mowing of green mass in relation to the control combination (according to the unpublished study by Moraczewski on the dynamics of nitrogen compounds and ultilization of nitrogen in a drained bog)

The basic fertilizers used had a favourable effect on the state of soil microflora. Of the micro-elements zinc, molybdenum, cobalt, and more rarely manganese or copper, are indicated. Copper had a harmful effect on the microflora system – particularly bacteria (Fig. 2), *Actinomycetes* and anaerobic assimilators of free nitrogen (Zimny 1964).

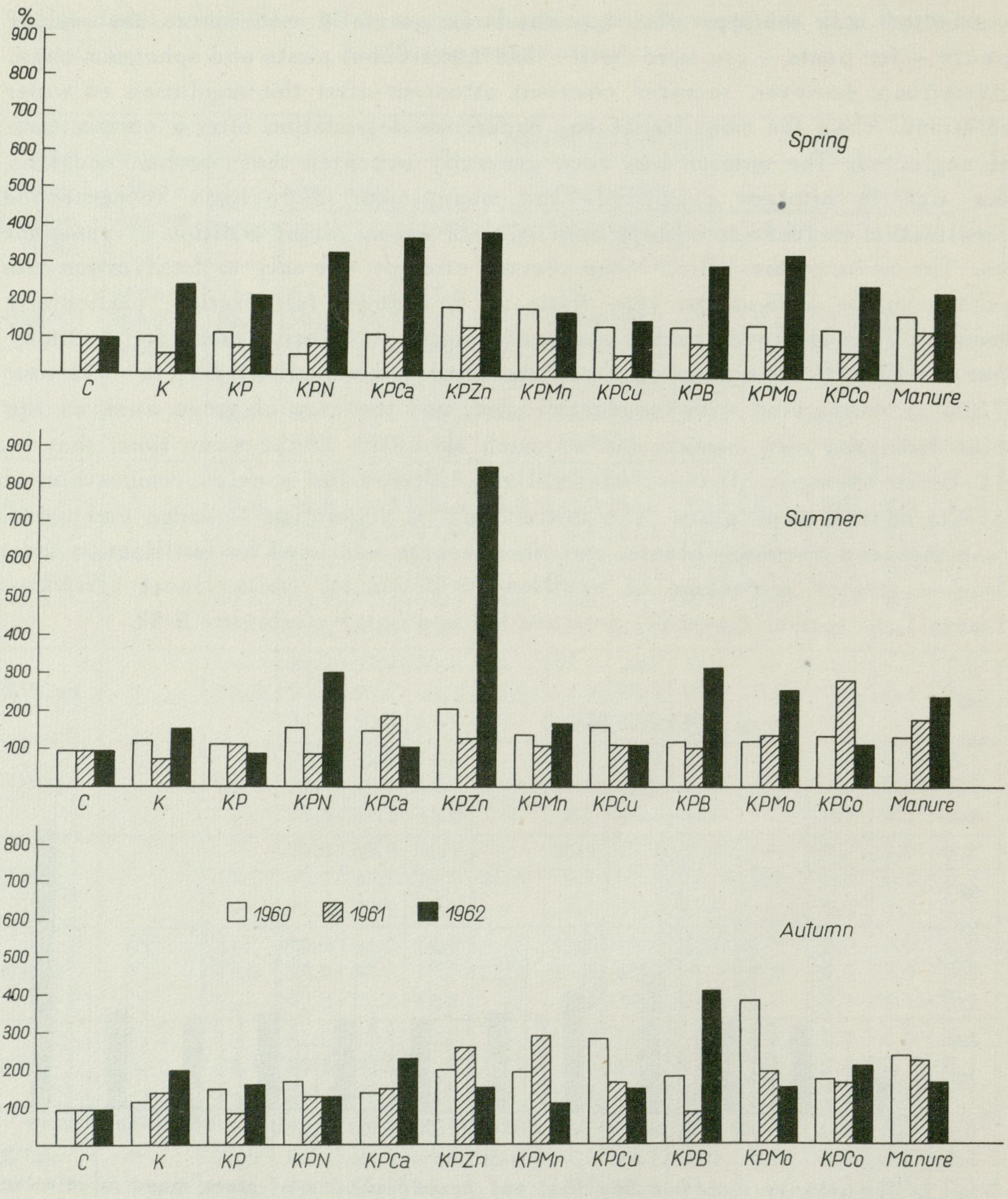

Fig. 2. Relative amount of bacteria expressed in percentages in relation to the control combination

Fertilization with basic fertilizers and micro-elements induces decrease in the denitrification process, and increase in the ammonification process. In comparing the soils of the "Biel" bog with soils examined by other research workers it must be stated that the peat soil under permanent grassland on the fertilized plots exhibits a good productivity value. Unfertilized soils exhibit rapid degradation, increase in the denitrification process, increase in the amount of *Actinomycetes* and fungi. This state is generally considered characteristic of degraded peats (Gołębiowska, Falkowski 1952).

5. CONCLUSIONS

As the result of the investigations carried out on the effect of fertilization on microflora systems in peat soil under permanent grassland it may be stated that:

1. The action of basic fertilizers and certain micro-elements consists in a tendency to gradual increase in the amount of micro-organisms without any distinct change in the domination of each systematic group.

2. The addition of copper as a micro-fertilizer resulted in inhibition of the activity of micro-organisms, particularly of bacteria and *Actinomycetes*.

3. The production capacity of soil on the plot left unfertilized decreased markedly while the amount of *Actinomycetes*, fungi and micro-organisms active in the denitrification process, increased.

REFERENCES

1. Chwastek, M. 1957 — Obserwacje nad zmianami mikroflory gleby łąkowej w zależności od orki i nawożenia — Roczn. Nauk rol. F, 72: 843–850.
2. Gołębiowska, J., Falkowski, M. 1952 — Wpływ nawożenia na zespoły mikroflory i makroflory łąki torfowej — Roczn. Nauk rol. 61: 211–232.
3. Zimny, H. 1964 — The influence of chemical fertilizers and manure upon the presence of *Clostridium* and *Azotobacter* in the peat soil of meadows — Ekol. Pol. A, 12: 1–9.

WPŁYW NAWOZENIA MINERALNEGO I OBORNIKA NA UKŁAD MIKROFLORY W GLEBIE TORFOWEJ POD ŁĄKĄ TRWAŁĄ

Streszczenie

W latach 1959—1962 przeprowadzono badania nad wpływem nawożenia mineralnego i obornika na układy mikroflory w glebie torfowej pod łąką trwałą torfowiska „Biel" koło Otwocka. Doświadczenie założono metodą bloków losowych w pięciu pasach i w pięciu powtórzeniach, uwzględniając następujące kombinacje: 1) kontrolna — C, 2) K, 3) KP, 4) KPN, 5) KPCa, 6) KPZn, 7) KPMn, 8) KPCu, 9) KPB, 10) KPMo, 11) KPCo, 12) obornik. W roku 1959 zbadano stan wyjściowy. Począwszy od 1960 r. zastosowano nawozy[2].

[2] W badaniach tych skorzystano z poletek doświadczalnych założonych przez R. Moraczewskiego z Katedry Uprawy Łąk i Pastwisk SGGW, który badał wpływ nawożenia na plonowanie łąk i przemiany azotowe w glebie.

Próbki gleb do badań mikrobiologicznych pobierano w warunkach antyseptycznych, jako próbki średnie, wyłącznie z darniowej warstwy. W roku 1959 pobrano próbki jednorazowo. W pozostałych latach pobierano próbki trzy razy w każdym roku: w maju, w lipcu i we wrześniu. W glebach tych określano każdorazowo ogólną ilość bakterii, promieniowców i grzybów oraz aktywność gleby w procesie amonifikacji i denitryfikacji. Badania przeprowadzono ogólnie przyjętymi metodami. Wyniki zestawiono w tabelach I-VI.

W wyniku przeprowadzonych badań stwierdzono, że:

1. Działanie nawozów podstawowych i niektórych mikro-elementów powoduje tendencję do powolnego wzrostu drobnoustrojów, bez wyraźnego protegowania poszczególnych grup systematycznych.

2. Dodatek miedzi, jako nawozu, uważać należy za niekorzystny dla mikroflory; zwłaszcza bakterie i promieniowce zmniejszają swą aktywność.

3. Na poletkach nie nawożonych obniżyła się wyraźnie moc produkcyjna gleby, a wzrastała natomiast liczba promieniowców, grzybów i drobnoustrojów czynnych w procesie denitryfikacji.

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