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The Number of Actinomycetes and Soil Fungi in Mineral and Organic Fertilisation Conditions

Marijana Pesakovic, L. Mandic, D. Djukic
Faculty of Agronomy, Cacak, Serbia and Montenegro

Abstract: At the Experimental Field of the Faculty of Agronomy in Cacak over the 1996-1997 period investigations were carried out on the effect of increasing nitrogen rates (N_1-30 kg/ha, N_2-60 kg/ha and N_3-90 kg/ha), standard P and K amounts (75 kg/ha) and organic fertilisers (solid manure – 45 t/ha and liquid manure – 80 t/ha) on the number of actinomycetes and fungi in the soil under spring oats. The trial was set up in a randomised block design with three replications.

The investigations showed that the applied fertilisation variants, sampling periods and study years had affected the number of microorganisms examined.

Mineral fertilisers had caused a reduction in the number of actinomycetes. The N_3 variant had the highest inhibitory effect of all the variants of the mineral fertilisers studied. The inhibitory effect of the fertilisers used was more pronounced in the second sampling period. As opposed to that, the total number of soil fungi grew as the mineral nitrogen rate increased, particularly in initial phases of the growth season.

Furthermore, the organic fertilisers used caused a reduction in the number of actinomycetes, with the exception of the variant with liquid manure in the first sampling period. As opposed to that, the application of these fertilisers brought about an increase in the fungi number.

The number of actinomycetes was higher during 1996 and that of fungi was reported to be greater during 1997.

Key words: soil, microorganisms, actinomycetes, fungi, fertilisers, oats.

Introduction

In intensive agricultural production conditions numerous problems occur regarding the uncontrolled use of mineral fertilisers, chemical meliorants, microelements, nitrification inhibitors, pesticides etc. Control over these materials being lost, primarily due to their too frequent and excessive use and the emergence of toxic, mutagenic, carcinogenic and teratogenic preparations, they return to man, again, in the

cycle of matter, through a food chain. A great number of toxic substances are being consciously produced and used for different purposes, and many of them are industrial by-products.

Nitrogen fertilisers are the biggest danger, due to high nitrate-nitrogen mobility, bringing about surface and underground water pollution (*Byerly*, 1975, *Commoner*, 1975, *Schaessler*, 1986). This results in an excessive growth of algae that are, having died out, subjected to anaerobic degradation, which owing to an oxygen deficiency leads to death of fish and other aquatic animals. In addition, excessive levels of nitrates accumulate also in plants (*Govedarica et al.*, 1991 a) – both in those used in human nutrition and in those used as feed for livestock consumption (*Seiz*, 1986; *Marinkovic and Grcic*, 1993). The danger associated with nitrates is that they are easily converted into nitrites and nitrosamines, which have carcinogenic effect (*Commoner*, 1975, *Hoffman*, 1986).

The problems concerned can be overcome by partial replacement of these fertilisers by microbiological and organic ones, in order to inhibit or stimulate certain cellular processes, including mineralisation ones, thus leading to the improvement of physico-chemical and biological soil properties.

Having in mind the importance of microorganisms as indicators of soil biological productivity, the aim of these investigations was to examine the effect of different rates and combinations of mineral and organic fertilisers on the number of actinomycetes and fungi in smonitza under spring oats.

Material and Method

The investigations were carried out over the 1996-1997 period at the Experimental Field of the Faculty of Agronomy in Cacak. Field, laboratory and mathematical-statistical methods of scientific research were used. The experiment was set up on the smonitza soil under spring oats in a randomised block design with three replications. The experimental plot size was 21.25 m^2.

The soil the trial was set up on was characterised by acid reaction (pH – 5.01), good potassium supply (26.38 mg/100 g soil) and poor readily available phosphorus supply (1.78 mg/100 g soil).

The following fertilisation variants were used in the trial:

- N_1PK (30 kg/ha);
- N_2PK (60 kg/ha);
- N_3PK (90 kg/ha);
- solid manure (45 t/ha);
- liquid manure (80 t/ha).

Phosphorus and potassium fertilisers were used at the rate of 75 kg/ha each.

All fertilisers used were added prior to sowing and their effect was examined during two spring oats growing seasons.

The data obtained were analysed by the analysis of variance method, and the significance of differences between the variants investigated was compared by the LSD test.

Results and Discussion

Based upon the study results, it could be concluded that the number of actinomycetes and fungi in the soil depended on the fertilisation variants used, sampling period and study year.

The analysis of the experimental data showed that the applied fertilisers, excepting liquid manure, had an inhibitory effect on the development of actinomycetes in the soil during both sampling periods (tab. 1). The effect was more pronounced in the second sampling period. Similar depressive effect on the development of actinomycetes in the soil was registered by *Djukic et al.* (1997). The organic fertilisers, as opposed to the mineral ones, had a stimulative effect on the development of this physiological group of microorganisms. However, a highly significant increase in the number of actinomycetes was determined in the first sampling period only, in the variant with liquid manure used. The use of physiologically acid fertilisers in the soil resulted in Al compound entering into the soil solution that as such became toxic to microorganisms as well as cultivated plants (*Emtsev, Djukic,* 2000). Actinomycetes had a good tolerance to these conditions due to their strongly developed enzymic system capable of inactivating even chemical compounds that degrade with greater difficulty such as pesticides, heavy metals, phenols etc.

Tab. 1. Average number of actinomycetes (10^5/1.0 g absolutely dry soil) in the soil depending on the fertilisers used (A), sampling period (B) and study year (C)

Fertiliser (A)			Ø	N_1	N_2	N_3	Solid manure	Liquid manure	$\overline{X}$
Year (C) 1996	Periods (B)	I	39.25	25.83	17.39	16.00	27,67	38,84	25,50
		II	29.17	15.66	12.34	12.00	34,50	37,33	
1997	Periods (B)	I	19.53	18.00	15.00	13.00	26,50	42,83	22,68
		II	48.67	26.34	21.50	3.00	15,50	22,33	
$\overline{X}$		I	29,39	21,92	16.20	14.50	27.09	40.84	24,99
		II	38,92	21,00	16.92	7.50	25.00	29.83	23,20
$\overline{X}$			34,15	21,46	16,56	11.00	26.04	35.33	24.09

lsd	lsd A	B	C	AxB	AxC	BxC	AxBxC
0.05	2.95	1.70	1.70	4.17	4.17	2.41	5.89
0.01	3.93	2.27	2.27	5.56	5.56	3.21	7.87

There are, also, certain differences in terms of the distribution of this group of microorganisms in the soil by study years. Based upon the data obtained it can be concluded that higher number of actinomycetes in the soil was recorded during 1996

than 1997, due to the cumulative effect of mineral elements on soil microorganisms, which was in accordance with the results obtained by *Suhovickaja and Miljto* (1982).

Through comparison of the number of actinomycetes by sampling periods and study years, it can be concluded that the higher number was recorded in the first sampling period during 1996 (28.00 x 10^5), whereas in the second sampling period of the same year a statistically highly significant decrease in the number of this group of microorganisms (23.50 x 10^5) was registered, being most likely the result of unfavourable precipitation distribution (tab. 2).

Tab. 2. Precipitation amount (1/m^2) for the period 1996-1997

Month	Year		Average
	1996	1997	1965-1994
I	14.2	20.5	50.2
II	63.5	35.1	44.8
III	50.5	54.7	53.8
IV	61.4	64.8	57.8
V	138.3	45.8	88.6
VI	46.5	22.9	98.2
VII	10.2	129.9	76.0
Average $_{III-VII}$	306.9	318.1	374.4

Namely, dry periods with high temperatures during summer months also resulted in a considerable decrease of biological productivity of the soil (*Mrkovacki*, 1979). Owing to considerably better distribution of precipitations in the second sampling period, during 1997, there was a statistically insignificant increase in the number of actinomycetes (22.48 x 10^5 and 22.89 x 10^5 in the first and second sampling period, respectively).

The experimental data obtained (tab. 3) also indicate the significant effect of the fertilisers used on the number of soil fungi.

As a whole, in both study years, the most pronounced stimulative effect on soil fungi was produced by liquid manure, which was likely the result of increased amount of organic matter in the soil as well as of its improved water-air and feed regime (*Jarak et al*., 1991). A statistically significant effect was produced by mineral fertilisers as well, particularly the high nitrogen rate (90 kg/ha). This was in accordance with the results by *Solovev et al.* (2001), who associated the increase in the number and activity of most microorganisms in the soil, in mineral fertilisation conditions, with narrowing of the C:N ratio and increased mineralisation processes in it as well as with their redistribution in the microbe cenoses complex favouring soil fungi (*Sirskaya et al.,* 1989).

Tab. 3. Average number of fungi (10^5/1.0 g absolutely dry soil) in the soil depending on the fertiliser used (A), sampling period (B) and study year (C)

Fertiliser (A)			Ø	N_1	N_2	N_3	Solid manure	Liquid manure	$\overline{X}$
Year (C) 1996	Periods (B)	I	14.25	14.59	15.67	38.34	20.34	53,75	14,86
		II	2.33	2.50	4.00	4.84	2.50	5,17	
1997	Periods (B)	I	1.17	8.84	8.92	18.33	8.67	103,73	23,03
		II	9.50	14.17	14.17	18.00	12.50	58,33	
$\overline{X}$		I	7,71	11,72	12.30	28.34	14.51	78.74	25.55
		II	5,92	8,34	9.09	11.42	7.50	31.75	12.33
$\overline{X}$			6.81	10.02	10.69	19.88	11.00	55.25	18.94

lsd	A	B	C	AxB	AxC	BxC	AxBxC
0.05	6.03	3.48	3.48	8.53	8.53	4.92	12.06
0.01	8.05	4.65	4.65	11.39	11.39	6.58	16.11

In general, the fertilisers applied exerted a more stimulative effect in the first sampling period and so their effect was statistically highly significantly more pronounced in this period compared to the other one. These results are logical having in mind the fact that soil moisture in this period was far higher compared to the other sampling period. Similar effects were recorded by *Mihnovskaya* (1982) in studies of the effect of N, K and complete mineral fertiliser on the number of fungi in different soil moisture and temperature conditions.

Based upon the results obtained a statistically highly significantly greater effect of the fertilisers used was registered in 1997 (23.03 x 10^5) compared to the previous year 1996, which was associated with the values and characteristics of climatic factors in the study years. The decline in the number of soil fungi towards the end of the growing season of oats in 1996 resulted from increased precipitation amounts in these phases, which in soils with a high clay content produces unfavourable conditions for the development of all groups of aerobic microorganisms (*Derkacev and Balog*, 1979).

Conclusion

Based upon the study results on the effect of mineral and organic fertilsers on the number of actinomycetes and fungi in the soil under oats, the following conclusions could be inferred:

- the number of microorganism groups examined depended on the type and rate of fertilisers, the sampling period and the study year;
- by the use of mineral fertilisers, the number of actinomycetes decreased, particularly in the variant with the highest N rate used (90 kg/ha), which was not the case with the soil fungi the total number of which increased with the mineral N rate increase;
- the use of liquid manure brought about an increase in the total number of systematic microorganism groups examined, whereas solid manure, in the first study year, had a depressive effect on soil actinomycetes;
- the fertilisers used had a special stimulative effect at the onset of the growing season and a marked inhibitory effect at the end;
- the total number of fungi and actinomycetes was higher in 1997 and 1996, respectively.

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BROJNOST AKTINOMICETA I ZEMLJIŠNIH GLJIVA U USLOVIMA PRIMENE MINERALNIH I ORGANSKIH ĐUBRIVA

- originalni naučni rad -

Marijana Pešaković, L. Mandić, D. Đukić
Agronomski fakultet Čačak

Rezime

Na oglednom polju Agronomskog fakulteta u Čačku u periodu 1996-1997. godine proučavan je uticaj rastućih doza azota (N_1-30 kg/ha, N_2-60 kg/ha i N_3-90 kg/ha), standardnih količina P i K (75 kg/ha) i organskih đubriva (čvrsti stajnjak -45 t/ha i tečni stajnjak - 80 t/ha) na brojnost aktinomiceta i gljiva u zemljištu pod jarim ovsem. Ogled je postavljen po sistemu slučajnog blok rasporeda u tri ponavljanja.

Istraživanja su pokazala da su na brojnost proučavanih mikroorganizama uticale primenjene varijante đubrenja, periodi uzimanja uzoraka i godine istraživanja.

Mineralna đubriva izazvala su sniženje brojnosti aktinomiceta. Od svih ispitivanih varijanti mineralnih đubriva najizraženiji inhibitorni uticaj pokazala je N_3 varijanta. Inhibitorni uticaj primenjenih đubriva bio je izraženiji u drugom periodu. Suprotno navedenom, brojnost zemljišnih gljiva je rasla sa povećanjem doze mineralnog azota, naročito u početnim vegetacionim fazama.

Primenjena organska đubriva su, takođe, delovala u pravcu sniženja brojno-sti aktinomiceta, izuzimajući varijantu sa tečnim stajnjakom u prvom periodu uzima-nja uzoraka. Nasuprot tome, primena ovih đubriva uslovila je povećanje brojnosti gljiva.

Brojnost aktinomiceta bila je veća tokom 1996. godine, a gljiva tokom 1997. godine.