Microbial Biomass in Various Agroecosystems

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In cultivated soils anthropogenic effects have a considerable influence on the quality and quantity of soil organic matter. The microorganisms actively involved in the synthesis of humus and in the transformation of plant and animal residues represent an important component of soil organic matter. From the point of view of soil processes, any agricultural treatment should take into consideration the changes which will take place in the biomass and activity of soil microorganisms.

The objective of the present study was to determine the changes in the amount and activity of microorganisms connected with various types of cultivation in potatoes, barley and orchard field soils.

Materials and methods

The influence of cultivation on microbial biomass /MB/ and microbial activity /MA/ was observed in intensively cultivated potato field soil /rotation: maize - wheat - potatoes/ compared with untreated meadow soil of

Table 1
Soil characteristics

Soils	Layer /cm/	pH	C_{org} /%/	Total N /%/	Mean annual Precipitation /mm/	Mean annual Temperature /°C/
Potato field	0- 5	5.7	1.5	0.13	522	7.6
	5-10	5.8	1.3	0.13		
Untreated meadow	0- 5	5.3	2.9	0.29	522	7.6
	5-10	5.5	1.9	0.18		
Barley field	0-10	5.9	1.1	0.12	594	8.3
Apple orchard	5-10	5.6	2.6	0.16	589	7.3

the same soil type. The effect of different doses of N fertilizer /30, 60 and 120 kg N. ha^{-1}/ on MB and MA was studied in a barley field soil and the effect of the herbicide Zeazin /effective component Atrazine/ in an apple orchard soil. Soil characteristics are summarized in Table 1. MB was measured using the chloroform fumigation incubation method /JENKINSON and POWLSON, 1976/ modified by CHAUSSOD and NICOLARDOT /1982/. MA was expressed as CO_2 production per unit microbial biomass and unit time.

Results and discussion

The mean values of MB in the potato field soil in the 0-5 and 5-10 cm layers were lower than those in the meadow soil /Table 2/. MB increased

Table 2

Microbial biomass /MB/, microbial activity /MA/ and percentage of microbial biomass in soil organic C /SOC/ in potato field soil and untreated meadow soil /mean values from April 1987 to April 1988/

Soils	Layer /cm/	MB	V^+ /%/	MA	V^+ /%/	MB as % of SOC
Potato field	0- 5	0.41	26	0.047	31	2.8
	5-10	0.39	28	0.049	27	2.9
Meadow	0- 5	0.64	34	0.068	39	2.2
	5-10	0.51	21	0.036	48	2.7

+ coefficient of variation

MB = mg C · g^{-1}, MA = mg CO_2-C · /mg C ·d/$^{-1}$

parallel with an increasing content of soil organic C /SOC/. Only slight differences in MB and MA were noted between the two investigated layers in the potato field soil. In the meadow soil both MB and MA were lower in the deeper layer by 20 and 47%, respectively. These results confirm the general decrease in MB and SOC and the change in the distribution of MB in the soil profile as the result of cultivation /CARTER and KUNELIUS, 1986; TESAROVÁ, 1988/.

Increasing doses of mineral N fertilizers in the barley field soil caused a decrease in MB from 0.18 to 0.09 mg C. g^{-1} and in the percentage of MB in SOC from 1.6 to 0.8. In contrast, MA increased by 48%. The seasonal variations in both MB and MA, characterized by the coefficient of variation, increased with increasing doses of N /Table 3/. A similar negative effect of N fertilization on bacteria was also observed by TESAROVÁ /1983/. SCHNÜRER et al. /1986/ recorded a lower quantity of active hyphae, flagellates and amoebae in barley field soil receiving 120 kg N·ha^{-1} than in an unfertilized one.

A single application of the herbicide Zeazin /20 kg.ha^{-1}/ had a negative effect on MB and MA. Compared with the untreated control, MB decreased on average from 0.56 to 0.49 mg C.g^{-1} in the first year following the application and from 0.46 to 0.40 in the second year. The MA of the untreated soil showed values of 0.050 and 0.062 mg CO_2- C. /mg C.d/$^{-1}$ in the first and

Table 3

The influence of N fertilization on microbial biomass /MB/, microbial activity /MA/ and percentage of microbial biomass in soil organic C /SOC/ in barley field soil /mean values from May 1983 to November 1983/

Doses of N /kg.ha^{-1}/	MB	V^{+}/%/	MA	V^{+}/%/	MB as % of SOC
30	0.18	30	0.034	56	1.6
60	0.16	37	0.031	65	1.4
120	0.09	59	0.071	73	0.8

+ coefficient of variation

MB = mg C · g^{-1}, MA = mg CO_2-C · /mg C ·d/$^{-1}$

second years, respectively; in treated soil it decreased by 11 and 32%, respectively. The character of the seasonal changes in treated and untreated soils was rather different /Fig. 1/. The above-mentioned changes indicate some kind of disturbance in the soil system.

The results obtained show a negative /statistically non-significant/ correlation between MB and MA /Fig.2/. The low significance is caused by the small number of points covered and by large differences between plots and layers in SOC, and thus in MB. MB and SOC are significantly correlated /r=0.86 for N=7/. When more extensive data sets were covered, a highly significant correlation resulted /SANTRUCKOVÁ, unpublished data/.

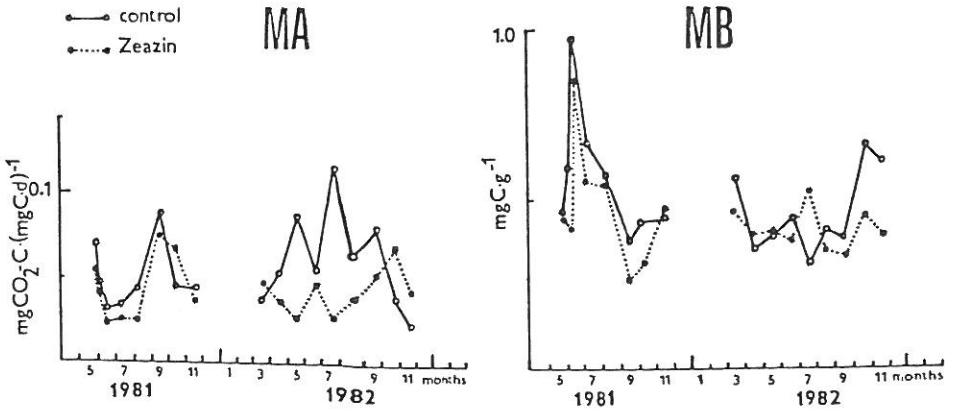

Fig. 1

Seasonal changes in microbial biomass /MB/ and microbial activity /MA/ in apple orchard soil non-treated /control/ and treated with the herbicide Zeazin

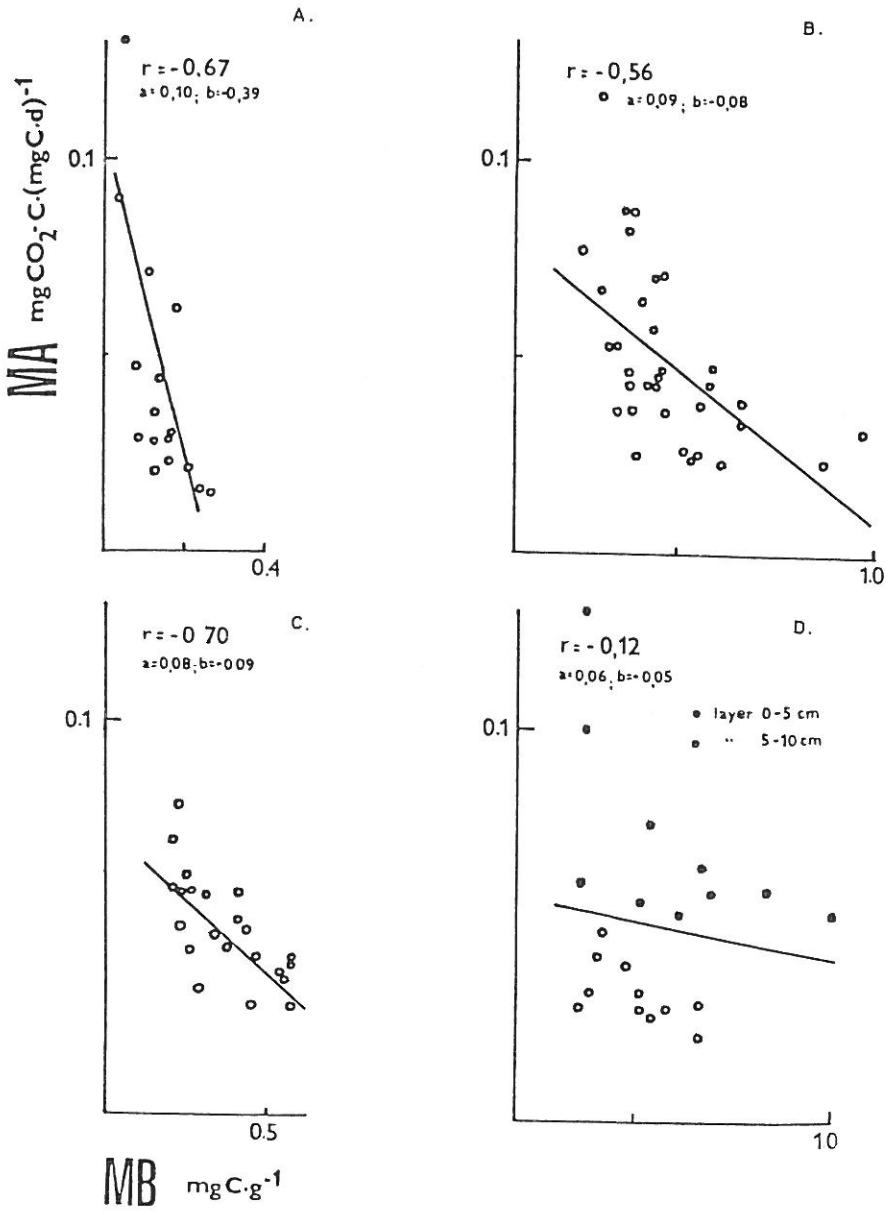

Fig. 2

Relationship between microbial biomass /MB/ and microbial activity /MA/ in the studied soils. Sampling points and regression curves fitted by equation $y = a + bx$ are shown. A. Barley field; B. Apple orchard; C. Potato field; D. Meadow

Summary

The influence of cultivation, N fertilization and herbicide application on microbial biomass and activity was studied in a potato field, barley field, meadow and apple orchard. All the agricultural treatments investigated resulted in a decrease in microbial biomass and changes in the microbial activity. These changes were connected with the soil organic C content.

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