

Long-term Monoculture of Maize Versus Biological Properties of Soil

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Monoculture of crops may be the cause of the phenomenon defined as soil "sickness". Its factors are, among others: changes in the species composition, number of soil microorganisms and in their activity, as well as the accumulation of biologically active substances of different origin.

Relatively few works are concerned with the biological activity of soil under maize monoculture.

Materials and methods

Samples for laboratory investigations were collected from a static random-block field experiment in 6 replications established in 1981 on a soil developed on heavy loamy sand, underlaid with light silty loam. The 25-30 cm humus layer had a slightly acid reaction, 11% total N content, 91% organic C content and was rich in P and K and poor in Mg. The investigations were carried out in 1985-1988.

Soil samples were taken from the arable layer, from the middle row of each plot, at three dates: a/ in spring before sowing, b/ in full growth at the time of appearance of male inflorescences, c/ at harvest /milky and wax ripeness/.

Treatments of the experiment were: from soil under maize cultivated in crop rotation /z/ and in short-term /2-4 years/ and long-term /5-8 years/ monoculture.

Standard methods were used in laboratory investigations.

Results

The results obtained prove that the maize monoculture does not affect the number of fungi, ammonifiers and cellulolytic microorganisms. Changes occurring in the growing season /its subsequent terms/ and in particular years depend on weather conditions /soil moisture and temperature/. On the other hand, changes in the numbers of heterotrophic bacteria /Table 1/ occur due to the long-term monoculture. The largest numbers of the above microorganisms were found in soil under maize cultivated in crop rotation

Table 1
Effect of maize monoculture on the number of heterotrophic bacteria, mineralizing potential of nitrite compounds, activity of dehydrogenases and the activity catalase

Treatment	Years			LSD
	1987	1988	1989	
<u>A. Number of heterotrophic bacteria</u>				
	/numbers x 10 ⁵ .g ⁻¹ dry soil/			
Long monoculture	344	291	276	34
Short monoculture	343	262	275	
Crop rotation	439	324	376	
LSD		44		
<u>B. Mineralizing potential of nitrate compounds</u>				
	/mg NH ₃ -N x 100 ⁻¹ dry soil/			
Long monoculture	0.90	1.58	0.83	0.28
Short monoculture	1.00	1.17	0.59	
Crop rotation	1.55	1.89	1.37	
LSD		0.37		
<u>C. Activity of dehydrogenases</u>				
	/mg formazan x 10 ⁻¹ g dry soil/			
Long monoculture	0.35	0.38	0.29	0.05
Short monoculture	0.36	0.36	0.27	
Crop rotation	0.44	0.67	0.60	
LSD		0.07		
<u>D. Activity of catalase</u>				
	/cm ² 0.1 N KMnO ₄ x 10 ⁻¹ g dry soil/			
Long monoculture	159.3	94.8	155.3	18.5
Short monoculture	153.8	103.3	147.8	
Crop rotation	234.8	224.7	264.3	
LSD		23.4		

and the smallest values in that under the long-term monoculture. Similar changes were found in the numbers of actinomycetes.

The numbers of each microflora group under study underwent considerable fluctuations in the growing season /its particular terms/ and in subsequent years of the investigations. This was in connection with the course of meteorological factors /soil moisture and temperature/.

The obtained results concerning the release of NH_4-N , NO_3-N and activity of CO_2 dehydrogenases and catalases seem to bear evidence of the consequences

of the maize monoculture. The respective processes ran more intensively in soil from the maize monoculture /Tables 1 and 2/.

Changes occurring in the soil medium can be estimated on the basis of the content of phenolic compounds determined in water and ethanol extracts.

Table 2
Effect of the maize monoculture on the nitrifying intensity of soil
/mg NO₃-N x 100⁻¹ dry soil/ and on soil respiration /mg CO₂ x 100⁻¹ g
dry soil/

Treatment	NO ₃ -N*		CO ₂	
	1987	1988	1987	1988
Long monoculture	$\frac{3.47}{9.83}$	$\frac{5.73}{4.34}$	22.7	38.0
Short monoculture	$\frac{3.20}{10.67}$	$\frac{5.67}{5.52}$	22.3	39.5
Crop rotation	$\frac{5.47}{29.75}$	$\frac{8.40}{11.67}$	30.0	47.3
LSD	$\frac{0.32}{3.64}$	$\frac{1.05}{3.90}$	3.6	4.9

before incubation

after incubation

* Numbers in the numerator are values measured before incubation, while those in the denominator are values gained after incubation

Table 3
Changes of the total content of phenolic compounds in ethanol
/extracts of soil/ /in percent of crop rotation/

Treatments	Year	
	1987	1988
Long monoculture	142	149
Short monoculture	128	110
Crop rotation	100	100

The content of these compounds in water extracts was not as distinctly connected with the maize monoculture as it could be observed in case of ethanol extracts /Table 3/.

The hitherto results allow to presume that the maize monoculture would lead to changes in biological activity of soil, in the dry matter yield and in the share of cobs.