Soil Biotechnology and Intensive Agricultural Production in Soils of the Southern Ukraine

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Intensive use, like the application of large doses of fertilizers and pesticides, together with other meliorative treatments, considerably increases the anthropogenic effect on soils.

The expression, soil biotechnology, is far from being clear in its meaning as is currently used in various publications. In our opinion it means the conscious influence exercised by man on the microbiological processes going on in the soil to preserve actual and potential soil fertility. The intensive and exclusive production of a single crop increases the anthropogenic effects that burden the soil, which may in the long run have a harmful influence on the microbiological processes going on in the soil, eventually affecting its productivity. Large doses /1500 kg/ha/ of nitrogen fertilizers are applied, for example, combined with intensive irrigation to the grey semi-desert /Sierozem/ soils in Soviet Central Asia, in the course of growing certain industrial plants, first of all cotton. Under monocultural conditions the use of this production technology for years on end will result in diminishing soil fertility and in salinization, all the more because little attention is paid to the salt content of the irrigation water which, being obtained from the Lake Aral, carries rather high amounts of this substance.

We think that, when elaborating agrotechnical methods for the intensive production of certain plants, their expectable effects on the microbiological processes that will influence in turn the intensity of the decomposition and synthetization of organic matters must be taken into consideration.

The Department for General and Soil Microbiology of the Institute of Microbiology of the Ukrainian Academy of Sciences has been studying, for several years, the composition of microbial communities and the influence of intensive land use on their structural and functional connections. It has been stated that in the irrigated dark chestnut soils of the Southern Ukraine the proportion of the microorganisms that utilize organic nitrogen is whereas the number of those feeding on mineral nitrogen only is on the increase. In these soils the composition of microbial associations is shifting in favour of the oligotroph species /Table 1/. At the same time, considerable changes can be observed in the chemical composition of the humus contents of such soils. The proportion of humic acids decends from 29.5 to 28% and that of fulvic acids ascends from 57.7 to 59.1% in the humus molecules. As a consequence, the solubility of the organic matters in the

Table 1

The ratio of the number of microorganisms of some ecological-trophical groups in dark-chestnut soil

Variant of experiment	Index of mineralization and immobilization x/	Coefficient of oligotrophity xx/
Non-cultivated area	1.02	2.5
Non-irrigated soil	1.30	1.8
Irrigated over a long time	1.70	3.5

x/ The ratio of microorganisms developed in a culture medium containing yeast and ammonium sulphate, compared to the number of colonies developed in MPA /meat-peptone agarplate/

xx/ The ratio of microorganisms /oligotrophes/ developed in water-agarplate containing no nutrient, compared to the ratio of colonies developed in culture media of total value

soil increases. Processes like this were especially well detectable in soils under wheat in a monoculture. When the results of examinations were evaluated by regression analysis it turned out that significant connections can be demonstrated between the quantity of microorganisms and the humic fraction easily mobilizable. In contrast to the above mentioned, the humin fraction is highly resistant to decomposition by microorganisms /IUTINSKAYA et al., 1986; ANDREYUK et al., 1988/.

The application of high doses of fertilizers /420-840 kg N/ha, 300-600 kg P_2O_5/ha/ to irrigated soils will radically change the composition of microorganism colonies. The total quantity of microorganisms will be about four times as large, the number of cellulose decomposers two times and that of the humus decomposers ten times as high. At the same time there will be less ammonifying and nitrogen fixing microorganisms /Fig. 1/. The latter will completely stop fixing nitrogen and switch over to utilizing the nitrogen content of the soil. Cellulose decomposers will be all the more active. Applying 140 kg N/ha, 45-50% of the test cellulose introduced will decompose in 90 days. If the dose is increased to 420 kg/ha the intensity of decomposition will be as high as 97-100%. The soil will produce twice as much carbon dioxide, and its humus content will decrease by 5-7% as against the control /DULGEROV et al., 1982; DULGEROV and SERAYA, 1987/.

The results of experiences show that the application of high fertilizer doses to irrigated lands is not always justifiable because it may result in changes in the composition of microbial communities, in the acceleration of decomposition processes and eventually the decrease of humus content. The humus content of certain soils in the Southern Ukraine has decreased in the past 30 years by as much as 50%.

The humus content of soils can be preserved under the conditions of intensive land use through appropriate agrotechnical methods. It is borne out by the fact that in the course of experiments on certain crop rotations the humus content of dark chestnut soils to which 100 kg N fertilizer and 50 t manure were added, did not decrease but went up by 0.22%.

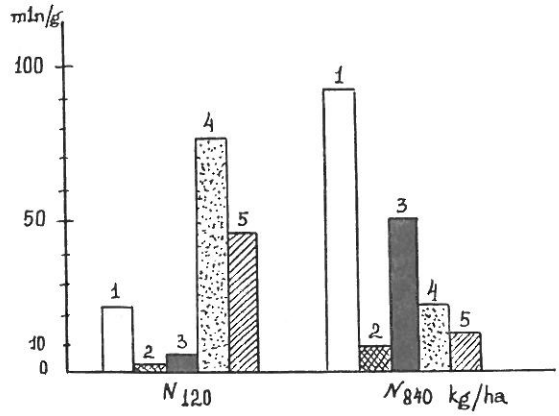

Fig. 1
The effect of high doses of nitrogen fertilizers on the number of microorganisms in the soil. 1. General number of microorganisms; 2. Cellulolytic microorganisms; 3.Humate-decomposing microorganisms; 4. Ammonifying microorganisms; 5. N fixing microorganisms

Summary

The author studied the structural and functional relationships of microbial communities in dark chestnut soils in the Southern Ukraine as well as the changes in the organic matter content of soils under the conditions of intensive agricultural production.

The application of high fertilizer doses resulted in significant shifts in the composition of the various physiological groups of microorganisms. Also the decomposition of organic matters in the soil accelerated. At the same time, under the conditions of an experiment on crop rotations, the simultaneous application of moderate amounts of nitrogen fertilizers /100 kg/ha/ and farmyard manure /50 t/ha/ did not decrease but increased the organic matter content of soils.

References

ANDREYUK, E. I., IUTINSKAYA, G. A. and DULGEROV, A. N., 1988. Soil microorganisms and intensive land use /in Russian/. Nankova Dumka. Kiev.

DULGEROV, A. N. and SERAYA, L. I., 1987. Microbiological activity and the decomposition of organic remnants in biogeocoenoses. Debate on the subject of soil microbiology. Abstract of Papers. 362. Moscow.

DULGEROV, A. N., SERAYA, L. I. and STASHCHUK, G. A., 1982. The effect of large fertilizer doses on the biological activity of irrigated soils in the Southern Ukraine. The structures and functions of microbial colonies under various anthropogenic effects. Proceedings of the USSR Symposium, Alma-Ata, 1982. Abstracts of Papers. 162-163. Nankova Dumka.

IUTINSKAYA, G. A., KIGEL, N. F. and IVANOVA, N. I., 1986. The effect of crop rotation and monoculture on the microflora of irrigated soils. The factors that define the way to intensifying agricultural production /in Russian/. Proceedings of the Republican Conference, Kaunas, 1986. 144-146.