O.V. Yenkina, USSR

SOIL MICROBIOLOGICAL ACTIVITY UNDER SUNFLOWER CAUSED BY MINERAL FERTILIZER APPLICATION

Root nutrition of plants is closely connected with the soil microflora whose numbers and activities depend, among other things, on the farm crop and methods of its cultivation.

According to our data sunflower rhizosphere microflora consists of bacteria (over 90%) actinomyces (some 2%) moldy fungi (roughly 0.1-0.2%).

Bacteria are represented by various physiological groups. In terms of quantity they form the following order of diminution: ammonifying > mobilizing phosphorus from hardly accessible and inaccessible mineral and organic phosphates, denitrifying > nitrifying > cellulose destroying.

The oil root bed is most densely populated. There are much fewer microorganizms on roots and in the soil several mm away from the roots.

The general biogenicity of soil and its summative biological activity in sunflower is lower than in the rhizosphere of wheat winter. This makes it possible to believe that the use of soil nutrients formed as a result of the microorganizms activity proceeds more slowly in sunflower crops than in wheat plantings.

Different methods of sunflower cultivation substantially change the microbiological activity of its rhizosphere.

We studied the effect of systematic of mineral fertilizers application in our experiments conducted stationaraly and in crop rotation, during 1966-1968 (first rotation) and 1973-1975 (second rotation).

It has been established that the annual application of different doses of nitrogen-phosphoric fertilizers and full mineral fertilizer causes an intensive development of bacteria in the soil under sunflower, bacteria that are involved in nitrogen transformation, viz. ammonifying, nitrifying and denitrifying bacteria. Other physiological groups of microorganisms responded weakly or did not respond at all to fertilizer application.

The increase of the nitrogen cycle microorganisms (fertilized plots was accompanied by soil nitrification raising from 17 to 45% by an increase of free amino acids from 22 to 55% and by a quicker decomposition of the cellular tissue.

Hence systematic application of mineral fertilizer enhances the biological activity of soil in the case of leached, supper deep, little humus and heavy loamy chernozem.

Intensification of microbiological processes undoubtedly raises effective soil fertility but it also has some negative features.

The matter is that in farming the bulk of fertilizer is uncorporated under sunflower in autumn, mostly in the ammoniae or urea form.

In connection with this we deemed it necessary to trace changes of ammoniae nitrogen, applied in autumn, under the influence of soil microflora.

For this reason in 1972-1975 experiments were conducted in biometres - bottomless concrete boxes isolated from the lower soil horizon by the 10 cm ceramzite layer filled with thoroughly mixed soil brought from the field (Rakhno, 1964).

Experiments were started late in November or in December when the average soil temperature at the depth of 20 centimeters fell to 3-4 °C.

Such a late start was aimed at finding out whether ammoniac fertilizer can be affected by microflora in winter.

It turned out that incorporation of ammonium sulfate (N 180 kg/ha) even late in autumn and in winter caused an intensified development of nitrifying and denitrifying bacteria, which lasted during several months and then subsided (Fig. 1).

The increased number of nitrifying bacteria was paralleled by a gradual disappearance of the ammoniac form of nitrogen and accumulation of the nitrate form during winter and early in spring.

We defined potassium and nitrate nitrogen together with observing the dynamics of the nitrification ability of soil in conditions close to natural. For this purpose retorts with composted soil were kept not in the thermastat but in wooden casing placed into the soil at the depth of 25 cm.

It turned out that changes in the soil nitrification ability are in ful conformity with a curve showing the nitrate nitrogen content in soil. Despite low winter temperatures ammoniae nitrogen is at once nitrified at the increased rate up to May and then the nitrification rate decreases (Fig. 2).

The influence of different temperatures on nitrification process was also studied in laboratory conditions. It was established that nitrogen of ammonium sulfate 336 mg/kg of soil is being transformed into the nitrate form during three months - by 5% at 3°C, by 9% at 0°C, by 17% at +2°C, by 35% at +10°C and by 42% at +20°C.

In the central zone of the Krasnodar Territory there is mild winter with frequent thaws. According to data taken for many years, the average monthly temperature of soil at the depth of 20 cm in autumn, winter and early in spring ranges between 2.3 and 13.9°C. The data cited above and materials of other investigators (Krause, Batsch, 1968; Baldwin, Stevenson, 1968; Rakhno, 1971) give grounds to believe that such temperatures cannot halt the vital activity of soil microflora.

Consequently, nitrogen fertilizer incorporated in autumn are substantially transformed

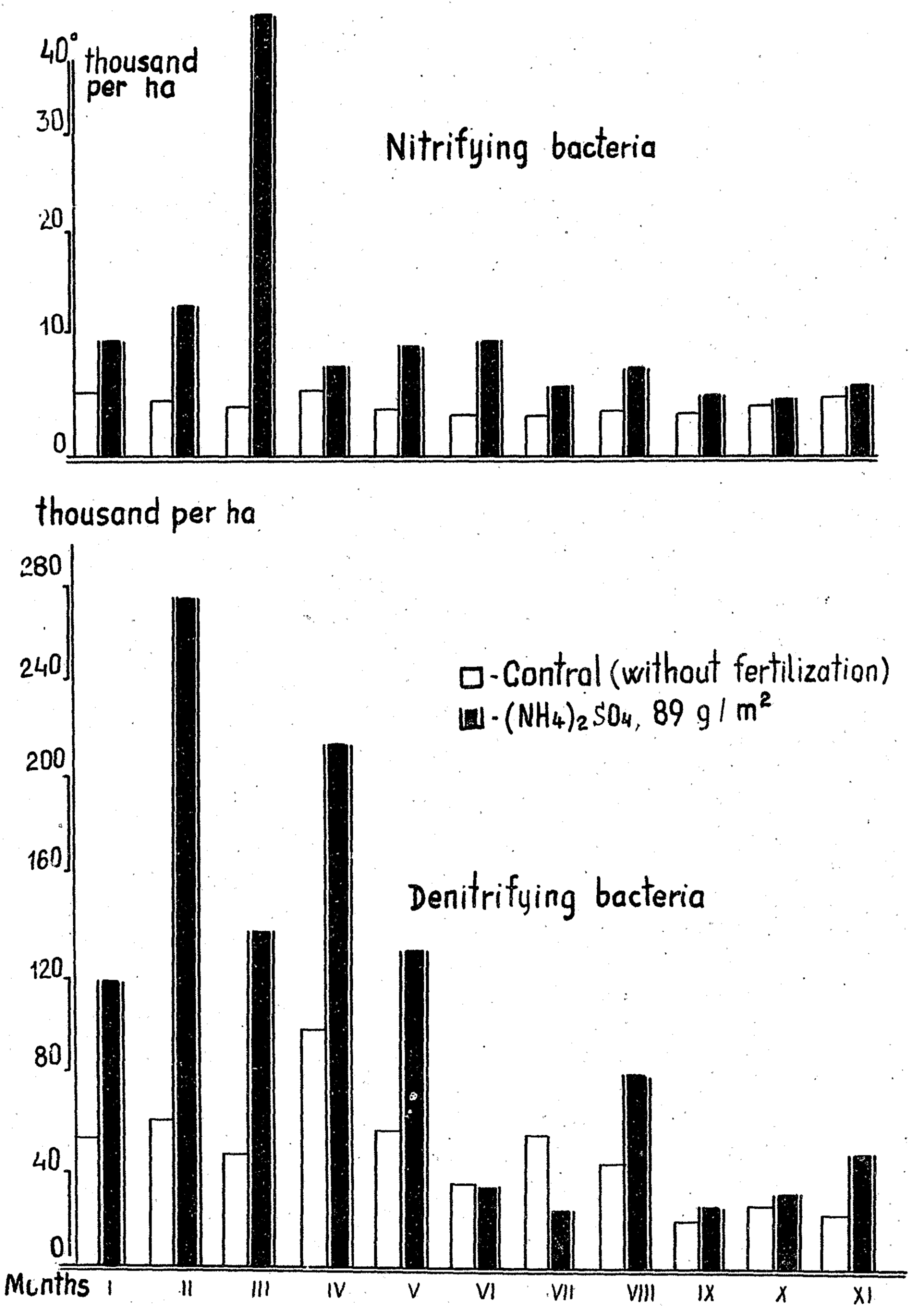

Fig. 1. Effect of $(NH_4)_2SO_4$ on dynamics of nitrifying and denitrifying bacteria under biometer conditions (1972-1975)

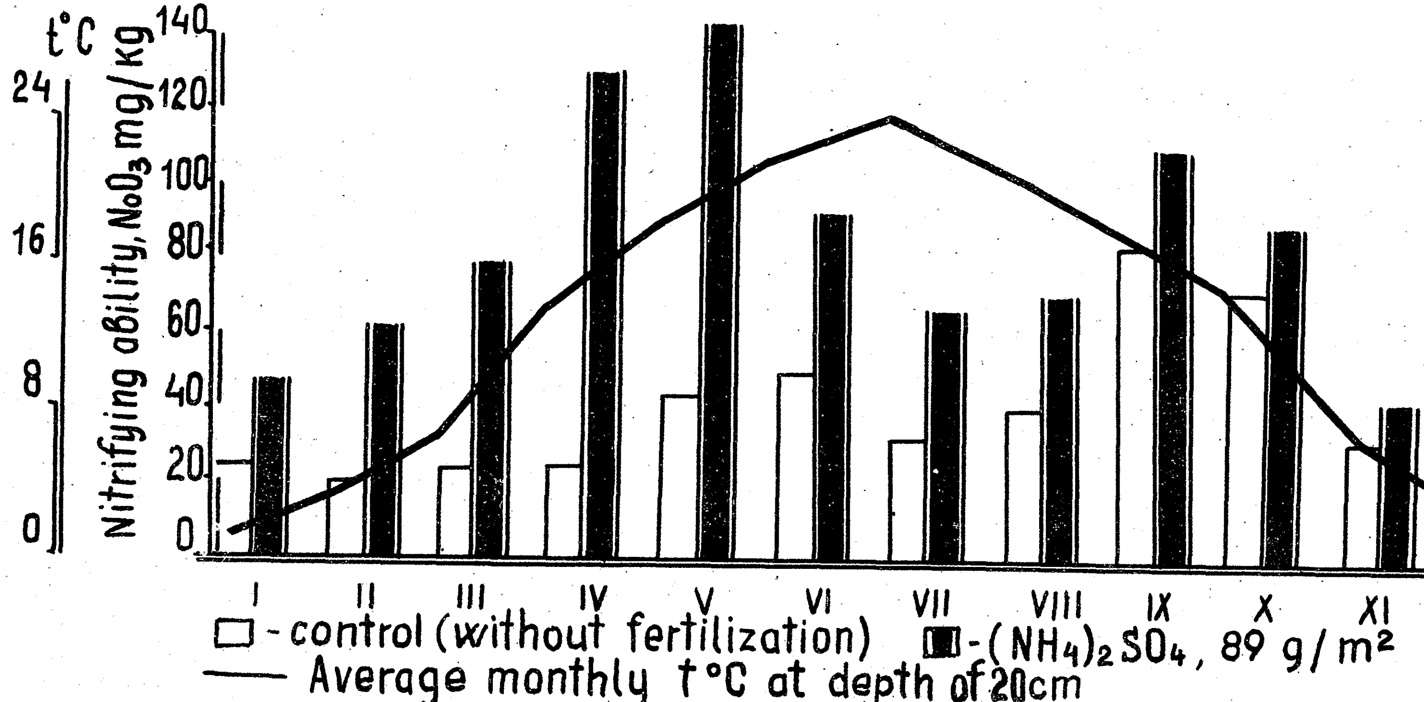

Fig. 2. Effect of $(NH_4)_2SO_4$ on dynamics of soil nitrifying ability under biometer conditions

by different microorganisms during 6-7 months. This is accompanied by inevitable losses due to the nitrification. Besides, a considerable portion of ammoniae nitrogen in fertilizers changes into the nitrate form and as our experiments showed, is gradually being washed out from the root-layer to the depth lower than 5 metres.

The data obtained underlie experiments currently conducted to establish the optimal time of applying different forms of nitrogen fertilizer.