ISSN 1068-3674, Russian Agricultural Sciences, 2009, Vol. 35, No. 2, pp. 110–111. © Allerton Press, Inc., 2009.
Original Russian Text © L.Yu. Goncharova, E.I. Simonovich, A.A. Kazadaev, L.S. Vezdeneeva, 2009, published in Doklady Rossiiskoi Akademii Sel'skokhozyaistvennykh Nauk, 2009, No. 2, pp. 35–36.

PEDOLOGY

Change in Biological Activity of Ordinary Chernozem and Productivity of Forage Meadow Agrocenose under the Effect of Biofertilizers

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Received January 17, 2008

Abstract—The positive effect of using biofertilizers Vesna and Belogor on the biological activity of ordinary chernozem in a perennial forage grass agrocenose is revealed.

Key words: meadow agrocenose, biofertilizers, chernozem.

DOI: 10.3103/S106836740902013X

It is known that the yield of crops and intensity of microbiological processes in soil are in direct dependence, and therefore methods of activating them, for example, applying biofertilizers, which are becoming widespread in agriculture, are acquiring great importance [1]. Microbiological preparations increase the stability of agricultural production, provide against the background of producing ecologically clean products an increase of soil fertility and decrease of the level of anthropogenic loads on agrophytocenoses, and also have a positive effect of profitability of agriculture as a whole [2].

The purpose of the present investigations was to reveal the efficacy of the effect of biofertilizers Vesna and Belogor on productivity of a forage agrocenose and biological activity of ordinary chernozem.

METHODS

The investigations were conducted on the grounds of the Botanical Garden of the Southern Federal University in 2005–2007 from May through August under conditions of a perennial meadow agrocenose created by the mosaic planting method in 1987 on ordinary chernozem (content of humus in 0–20 cm soil layer 3.5%, total nitrogen 0.23%. $N–NO_3$ 0.95 mg/100 g soil, P_2O_5 3.6 mg/100 g soil). The composition of the six-species agrocenose contained alfalfa (*Medicago sativa*), birdsfoot trefoil (*Lotus corniculatus*), red clover (*Trifolium pratense*), meadow fescue (*Festuca pratensis*), smooth bromegrass (*Bromopsis inermis*), and orchardgrass (*Dactylis glomerata*). The conventional agrotechnical measures were used for planting it. Fertilizers had not been applied since 1987.

We studied two types of biofertilizers, Vesna and Belogor, produced by OOO Scientific and Technical Center of Biological Technologies in Agriculture (Shebekino city, Belgorod oblast). The basis of the biofertilizer Vesna is a lysine concentrate solution containing amino acids, B vitamins, trace elements, mineral and organic substances, and the complex mineral fertilizer nitroammofoska (azofoska) with a content of nitrogen, phosphorus, and potassium of 16% each at a rate of 100 kg/1000 l of liquid lysine concentrate. The biofertilizer Belogor of series KM-104 contains a set of lactic acid and propionic acid bacteria, yeasts, and phytopathogenic cultures of microorganisms of the genera *Bacillus* and *Pseudomonas*, as well as bacterial metabolic products, macro- and microelements necessary for vital functions of microorganisms and beneficial for plant development.

The efficacy of the biofertilizers was studied according to the following scheme, including variants: (1) control, (2) biofertilizer Vesna, (3) biofertilizer Belogor. Replication of the variants was threefold. The biofertilizers were applied twice, in May 2005 and 2006, with a 2-week interval. Watering was done on top of the plants with a biofertilizer solution (100 ml/10 l water) at a rate of 400 l/ha (this concentration was recommended by the fertilizer producer as the most optimal for forage

Table 1. Productivity of aboveground phytomass (air-dry, g/m^2), on average for 2005–2007

Crop	Control	Vesna	Belogor	LSD_{05}
Smooth bromegrass	183.3	190.3	192.8	5.5
Meadow fescue	52.7	127.0	129.9	10.2
Orchardgrass	143.6	168.4	178.8	8.4
Alfalfa	144.1	256.0	262.4	6.7
Red clover	32.7	58.3	56.3	10.5
Birdsfoot trefoil	65.1	60.7	57.8	6.8
Total	621.5 ± 2.22	860.7 ± 2.62	878.0 ± 2.65	205.1

Table 2. Change in numbers of microorganisms in ordinary chernozem under perennial grasses with application of biofertilizers, on average for 2005–2007

Variant	Bacteria, million/g		*Azotobacter*, % overgrowth on soil lumps	Actinomycetes, million/g	Microscopic fungi, thousand/g	
	WPA	SAA			W–A	Czapek medium
Control	12.4	17.5	100.0	3.2	140.0	187.0
Vesna	16.1	31.8	104.7	4.0	181.0	142.0
Belogor	17.8	29.2	101.2	3.5	161.0	157.0
LSD_{095}	3.1	2.4	4.5	1.2	8.3	10.6

Note: WPA (wort–peptone agar), SAA (starch–ammonium agar), bacteria utilizing respectively organic and mineral nitrogen; W–A (wort–agar), Czapek medium, fungi utilizing respectively organic and mineral nitrogen.

grasses). Plants of the control plot were watered with the same amount of water.

For microbiological analyses, we took soil samples a month after applying the biofertilizers and determined in them the content of bacteria, fungi, *Azotobacter*, and actinomycetes by the conventional methods. Catalase, urease, and invertase activity was studied in soil samples taken before applying fertilizers and 1 and 3 months after their application by conventional methods [3].

RESULTS AND DISCUSSION

The use of biofertilizers had a positive effect on the productivity of aboveground phytomass of the meadow agrocenose, which on average was 1.4 times higher than in the control variant. With respect to productivity, the most responsive crop to the application of biofertilizers, especially Belogor, was alfalfa and the least responsive was birdsfoot trefoil (Table 1).

Not all investigated physiological groups of soil microorganisms reacted positively to biofertilizers; bacteria utilizing organic and mineral nitrogen and microscopic fungi utilizing organic nitrogen reacted to a greater degree. Their numbers in these variants were on average 15–81.7% higher than in the control (Table 2). The content of actinomycetes and *Azotobacter* hardly changed, and microscopic fungi (Czapek medium) experienced suppression: their numbers in variants with biofertilizers were 1.2–1.3 times less than in the control, which serves as a indirect indicator of a reduction of soil toxicity [4].

A study of enzyme activity of ordinary chernozem showed that the activity of the investigated enzymes was at the same level in all variants prior to applying biofertilizers (Table 3). After applying them, they increased on average by 1.14–2.20 times; the effect of Vesna was stronger. An increase of enzyme activity was due to the composition of the biofertilizers—lysine enriched with various mineral and organic substances (Vesna) and a set of microorganisms of various physiological groups with the addition of macro- and microelements (Belogor).

Thus, mineralization of organic compounds, being constituents of humic substances and their change into plant-available mineral forms intensify in variants with biofertilizers. The content of nutrient elements in soil increases and accordingly root nutrition of plants improves and crop yield increases. The productivity of the forage perennial grass agrocenose with application of biofertilizers increased by 1.4 times compared with the control, which attests to the prospects of using biofertilizers for increasing the yield of forage crops.

Table 3. Enzyme activity of soil of perennial grass agrocenose, on average for 2005–2007

Variant	May	June	August
Catalase (ml O_2/min/g soil)			
Control	12.3	13.6	13.1
Vesna	11.9	12.5	16.1
Belogor	12.5	15.2	17.2
LSD_{095}	1.3	1.1	1.8
Urease (mg NH_4/10 g soil)			
Control	19.6	23.1	24.2
Vesna	18.9	26.4	36.6
Belogor	18.7	25.1	30.5
LSD_{095}	1.2	1.9	4.5
Invertase (mg glucose/g soil)			
Control	32.7	39.8	25.0
Vesna	31.5	56.0	54.8
Belogor	32.7	49.7	28.7
LSD_{095}	1.5	3.6	5.7

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