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PEDOLOGY

Alteration of Agrochemical Indicators of Ordinary Chernozem and Yield of Coneflower Purple Plants under the Influence of Fertilizers

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Abstract—The positive effect of the application of different fertilizers on agrochemical indicators, enzyme activity of ordinary chernozem, and yield of coneflower purple plants was revealed.

Keywords: fertilizers, ordinary chernozem, agrochemical indicators, coneflower purple, enzyme activity, productivity

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The dehumification as a result of replacement of natural biocenosises by agrocoenosises, for which reduction of biological activity of the soil is characteristic, is allocated among the reasons for decrease in fertility of the soils of agrocoenosises. The coneflower purple plant (*Eshipasea purpurea* Moensh.) is a valuable herb. This genus includes five species of grassy plants, which grow as a native plant in Atlantic areas of North America and Mexico. Both the aboveground and underground parts of the plant are the basic material for the industrial production of immunomodulatory medications. The preparations produced are extracted from all parts, both fresh and dried up, of the plant [1, 2]. Taking into account the prospects of the use of coneflower purple in applied medicine, we performed experiments on the cultivation of this plant in the environment of the Rostov oblast in ordinary chernozem in the Botanical Garden of Southern Federal University.

The purpose of this work was to reveal the influence of various fertilizers on the agrochemical indicators of ordinary chernozem and productivity of coneflower purple plants. In this connection, we compare the influence of organic fertilizers (microbiological and humic) with that of mineral fertilizer on the content of humus and NPK, as well on the activity of catalase enzyme in the soil and productivity of the coneflower purple plants.

METHODS

The study was performed from May to September 2009–2011 under the herb coneflower purple growing on ordinary chernozem carbonate. Fertilizers of three types—microbiological Belogor fertilizer, which is a concentrate of microorganisms manufactured in the Scientific Technological Center of Biological Technologies in Agriculture (Shebekino, Belgorod oblast), the Lignogumat K, BM brand fertilizer manufactured in the Realization of Ecological Technologies Research Manufacturing Association (St. Petersburg), and the liquid mineral Pokon fertilizer containing trace elements (the Netherlands)—were studied. The Belogor KM-104 series fertilizer contains a complex of lactic bacteria with propionate bacteria, yeast and phytopathogenic cultures of microorganisms of the *Bacillus* and *Pseudomonas* genera, and also bacterial products of metabolism, macroelements, and trace elements that are necessary for vital functioning of microorganisms and useful to development of plants. This fertilizer contains 1.4% nitrogen, 0.9% phosphorus, 1.5% potassium, 55 mg/kg zinc, 31 mg/kg manganese, 9.6 mg/kg magnesium, 5.7 mg/kg iron, 7.1 mg/kg copper, 1 mg/kg selenium, 6.0 mg/kg boron, and 2.7 mg/kg molybdenum. The Lignogumat K, BM brand fertilizer contains 18% salts of humic substances, whose pH value is 8.5–10.0. The mass fractions of solids of this fertilizer are as follows: 9% potassium, 3% sulphur, 0.2% iron, 0.12% manganese, 0.12% copper, 0.12% zinc, 0.015% molybdenum, 0.15% boron, and 0.12% cobalt, calcium, silicon, and magnesium are also present in this fertilizer. The Pokon fertilizer contains 7% nitrogen (2.9% nitrate nitrogen, 1.8% ammonia nitrogen, and 2.3% in the form of urea), 3% water-soluble P_2O_5, 7% water-soluble K_2P, 0.02% boron, 0.004% copper, 0.04% iron, 0.02% manganese, 0.002% molybdenum, and 0.004% zinc.

The efficiency of the fertilizers was studied according the following scheme: (1) control (without fertiliz-

ers), (2) Belogor fertilizer containing the concentrate of microorganisms, (3) Lignogumat K fertilizer, and (4) Pokon fertilizer with trace elements. Each variant was replicated three times. The fertilizers were applied two times in May 2009 and 2010 by means of watering with fertilizer solution over plants (100 mL of fertilizer per 10 L of water) in an amount of 400 L/ha (this concentration is recommended by manufacturers of fertilizers). The plants of a control plot were watered with the same quantity of water. One and three months after the application of fertilizers, the samples of the soil were selected according to variants of the experiment. Humus was determined according to the Tyurin method (modified by Simakov), nitrate nitrogen content was measured by ionometry, content of ammonia nitrogen was measured by photocolorimetry with Nessler reagent, mobile phosphorus and potassium were determined according to Machigin's method, and catalase activity was determined according to Haziev's method [3, 4].

RESULTS AND DISCUSSION

One month after application of the fertilizers, the humus content increased in the soil of plots treated with Belogor and Lignogumat K; 3 months later, the content decreased by 1.1 times because of mineralization of organic substance (Table 1). The Pokon fertilizer did not affect the value of this indicator 1 month after the application; 3 months after application, the humus content increased a little both in control and in a variant with fertilizer, which may be explained by the intake of organic substance from the underground phytomass that died off at the end of vegetation of coneflower purple plants. By autumn, the humus content in the soil of all variants, except that treated with Lignogumat K, was almost the same. Furthermore, the dynamics of the humic soil status by variants was not changed. The reliability of distinctions between variants was not established, except for the variant with Lignogumat K.

Thus, all fertilizers, except for Lignogumat K, do not influence the humus content both immediately after application, and in aftereffect. The Lignogumat K fertilizer accelerates the mineralization of the organic substance of ordinary chernozem, which reduces the humus content. One month after application, all fertilizers positively influenced the content of nitrate nitrogen, ammonia nitrogen, and mobile phosphorus (Table 1). Belogor and Lignogumat K were the most effective. The content of exchangeable potassium decreased as compared to the control, because of especially active absorption of potassium by plants during the stages of budding and flowering. Towards the end of vegetation, the content of nitrate nitrogen decreased in the soil of all variants, which may be explained by intensive uptake of nitrate nitrogen by plants of coneflower purple, which use this nutrient to form more phytomass than in the control (Table 1).

Table 1. Content of humus (%) and NPK (mg/kg of soil) in ordinary chernozem (0–25 cm) under the coneflower purple plants for 2009–2011 on average

Variant	Humus	$N\text{-}NH_4$	$N\text{-}NO_3$	P_2O_5	K_2O
July					
Control	3.85	0.25	12.00	2.7	12.71
Belogor	4.28	0.30	15.50	3.5	11.86
Lignogumat K	3.97	0.28	12.80	3.6	11.07
Pokon	3.60	0.25	12.34	3.6	11.07
September					
Control	4.28	0.25	10.52	3.6	12.42
Belogor	4.03	0.25	10.24	3.6	11.14
Lignogumat K	3.66	0.28	9.80	3.6	11.33
Pokon	4.09	0.30	7.78	3.6	11.07

Table 2. Productivity of the coneflower purple plants (dry weight, centner per hectare)

Variant	2009	2010
Control	3.60	41.03
Belogor	4.51	46.26
Lignogumat K	4.15	45.24
Pokon	3.65	42.93

During 3 months after application, the fertilizers also activated the enzyme activity of the soil. Thus, activity of catalase (mL O_2/min/g of soil) 1.8–2.9 times increased in the soil of all variants with fertilizer in comparison with the control. In the soil of control plate, the activity was 2.5; in the soil of variant with Belogor, the activity was 5.9; in the soil of variant with Lignogumat K, the activity was 7.2; and the activity was 4.6 with Pokon.

The application of fertilizers positively affected the development of plants. Especially effective were Belogor and Lignogumat K [5], which is explained by activation of humus mineralization. The quantity of nutrition elements in the soil increases, the root nutrition of plants improves respectively, and productivity of agricultural crops increases [6].

The calculation of the yield of dry weight of plants was performed according to the variants in g/m^2 with subsequent recalculation to centner per hectare. The data about the productivity in the year of the application of fertilizers and in the year after the application are presented in Table 2. The application of microbiological and humic fertilizers increased the value of this indicator by 1.1–1.2 times in comparison with control, which testifies to the prospects of the use of the Belogor fertilizer, which contains a concentrate of microorganisms. The Pokon mineral fertilizer did not have a positive action on productivity of the culture;

reliability of difference with control was not established.

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