Efficient activity of soil depending on of precursors and major treatment of soil when cultivating winter wheat

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Abstract. The article presents data on the change in the enzymatic activity of the soil in winter wheat crops under the influence of the methods and techniques of tillage and the previous crop in the Central Ciscaucasus zone. The studies were carried out in the zone of the Central Ciscaucasia on the basis of the experimental station of Stavropol State Agrarian University. The determination of the activity of invertase shows that its maximum values are in the variants of the combined treatment, which is associated with more favorable hydrothermal conditions of the arable layer of the soil. Thus, according to its predecessor, pea + oats for green fodder, invertase activity is 27.9 mg of glucose per 1 g of soil for 40 hours, which is almost twice as high in comparison with surface treatment and three times with plowing. The decrease in the activity of invertase during dump processing indicates a rapid rate of mineralization of organic matter. Catalase activity on the studied precursors: on peas with oats for green fodder 1.6 and 1.3; 1.5 and 1.8 peas; for corn silage 1.5 and 1.4 ml 0.1 n. KMnO4 per 1 g of soil for 20 minutes. Revealed a decrease in activity under the influence of plowing, as urease enters the soil with plant debris. When dumping treatment due to movement of plant residues in the underlying layers, the activity of this enzyme decreases to 0.8–0.9 mg of N-NH4 per 10 g of soil for 4 hours, whereas with surface treatment, depending on its predecessor, it is 0.8— 1.3 mg of N-NH4 / 10 g of soil for 4 hours, with a combination of 1.0–1.1, and for shallow soil, 1.1–1.2 mg of N-NH4 / 10 g of soil in 4 hours.

1 Overview

Currently, the Stavropol Territory is one of the largest producers and processors of agricultural products, and agricultural land occupies 87% of the total area of the region. And at the same time, anthropogenic load is high on agricultural lands of the region, the types, volumes and periods of which, from modern ecological positions, have led to the degradation of agricultural land [1].

Every year in the North Caucasus region, as a result of erosion, annually irrevocably carried away from fields of 0.57 t / ha of humus. The reasons for soil dehumification are the increased mineralization of soil organic matter, the lag of humus neoplasm processes from

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mineralization due to insufficient organic fertilizers entering the soil and a decrease in soil enzymatic activity [2,3].

Biochemical transformations of soil organic matter occur as a result of microbiological activity under the influence of enzymes [4,5,6].

Soil enzymes are involved in the decay of plant, animal and microbial residues, as well as the synthesis of humus.

As a result, nutrients from poorly digestible compounds are transferred to easily accessible forms for plants and microorganisms [7]. Enzymes are distinguished by high activity, strict specificity of action, and great dependence on various environmental conditions. Due to the catalytic function, they provide a rapid flow of chemical reactions in the body or outside of it [8,9].

Together with other criteria, soil enzymatic activity can serve as a reliable diagnostic indicator to determine the degree of soil cultivation [10,11].

As a result of research conducted by many scientists, a relationship has been established between the activity of microbiological and enzymatic processes and the implementation of measures that increase soil fertility [12,13,14]. Soil tillage, fertilization significantly change the ecological environment of the development of microorganisms [15].

Central to the collection of biological techniques that ensure the preservation of soil fertility belongs to catalysts for biochemical reactions - enzymes, as they regulate soil metabolism, ensuring the integrity of the soil as a system [16,17,18].

Enzymes produced by microorganisms react clearly to changes in environmental factors and the use of various agrotechnical techniques, while reliably reflecting the intensity of biological processes [19].

Studying the role of individual crops and their alternation in crop rotation, as well as the methods and techniques used for tillage used in the formation of the enzymatic potential, will allow us to regulate soil processes in the direction of increasing soil fertility.

The enzymes studied in the experiment belong to the group of hydrolytic, which play an essential role in the most important biochemical processes: invertase and phosphatase - in the hydrolytic decomposition of organic matter, catalase - in redox reactions, urease is involved in the hydrolysis of urea. Invertase is carbohydrase, it acts on fructofuranosidase bond in sucrose, raffinosis, gentianosis, etc. This enzyme most actively hydrolyzes sucrose.

2 The purpose of research

The purpose of research to identify the features of enzyme activity in the soil under winter wheat, depending on the previous culture and the main tillage.

3 The technique

Studies were conducted in 2010–2016. in the stationary experience of the Department of Agricultural Chemistry and Agriculture of the Experimental Station of the Stavropol State Agrarian University,

The experimental station of the SSAU is located on the Stavropol Upland, according to the agro-climatic zoning scheme, in the zone of unstable humidification of the Stavropol Territory, in the III agroclimatic region. Climatic conditions are caused by the influence of vertical zonality (height above sea level of 500–550 m) and the sharply continental climate of the adjacent areas.

A characteristic feature of the zone is the uneven precipitation during the year. The average long-term amount of precipitation is 623 mm; during the growing season, 350–370 mm; the average annual air temperature is 9.2 ° C. Hydrothermal coefficient 1.1–1.3. The sum of positive air temperatures above 10 ° is 2800–3200 ° C.

The soils of the experimental plot are leached chernozem, which is currently characterized by an average content of humus (5.5%), nitrification capacity (16–30 mg / kg), mobile phosphorus (18–28 mg / kg, according to Machigin) and increased - exchange potassium (240–290 mg / kg). The reaction of the soil solution in the upper soil horizons is neutral, the pH is in the range of 6.2–6.7. The content of total nitrogen - 0.25%, total phosphorus - 0.13–0.15%, total potassium - 2.3%.

Enzymatic activity was determined: catalases by Johnson and Temple, urease invertase - according to the method, phosphatases - according to the method. The activity of the ureae was studied by a colorimetric method with Nessler's reagent on a KFK-2-UHL4.2 photoelectric colorimeter with a violet light filter, and phosphotases by a colorimetric method on an FEC instrument with a blue light filter [20].

Statistical processing of the research results was performed by the correlation-regression method using the Poly Factor computer program.

4 Results

The determination of the activity of invertase shows that its maximum values are in the variants of the combined treatment, which is associated with more favorable hydrothermal conditions of the arable layer of the soil. Thus, according to its predecessor, pea + oats for green fodder, invertase activity is 27.9 mg of glucose per 1 g of soil for 40 hours, which is almost twice as high in comparison with surface treatment and three times with plowing. The decrease in the activity of invertase during dump processing indicates a rapid mineralization of organic matter (Figure 1).

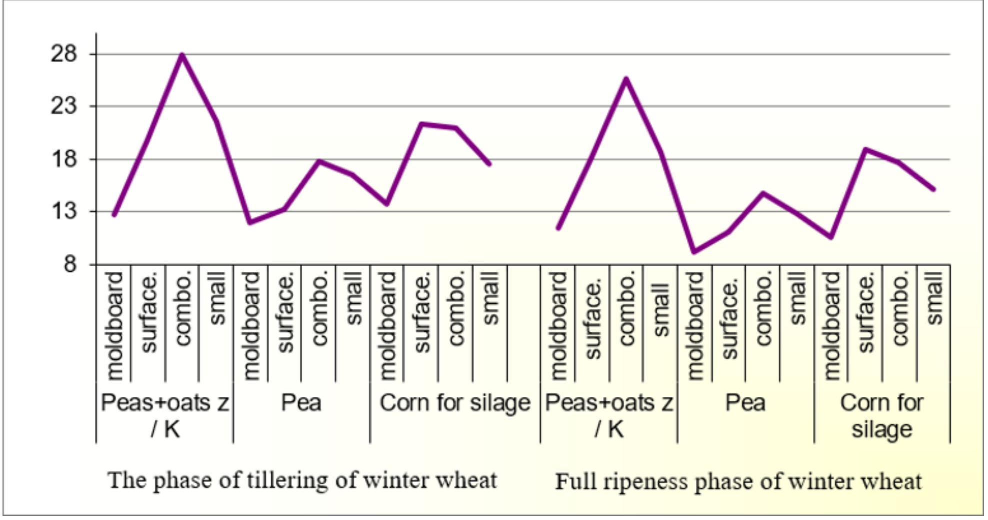

Fig. 1. Invertase activity, mg of glucose per 1 g of soil for 40 h.

According to the studied precursors, the invertase activity of the soil increases in the series maize for silage pea + oat for green fodder pea. With regard to seasonal dynamics, it tends to decrease from spring tillering to full ripeness, data on the effect of crops on soil invertase activity are given in.

Catalase is synthesized by almost all microorganisms, therefore, the activity of this enzyme is quite high in all variants of experience, which is evidence of the intensity of energy processes in the soil. Significant differences in the activity of the enzyme catalase predecessors is not observed. Between the tillage options, there is a tendency to a decrease in catalase activity during surface and minor treatments, which indicates an increase in negative trends associated with the accumulation of hydrogen peroxide, due to inhibition of the development of vital activity of rhizosphere microorganisms (3). Catalase activity on the studied precursors: on peas with oats for green fodder 1.6 and 1.3; 1.5 and 1.8 peas; for corn silage 1.5 and 1.4 ml 0.1 n. KMnO4 per 1 g of soil for 20 minutes. (Figure 2).

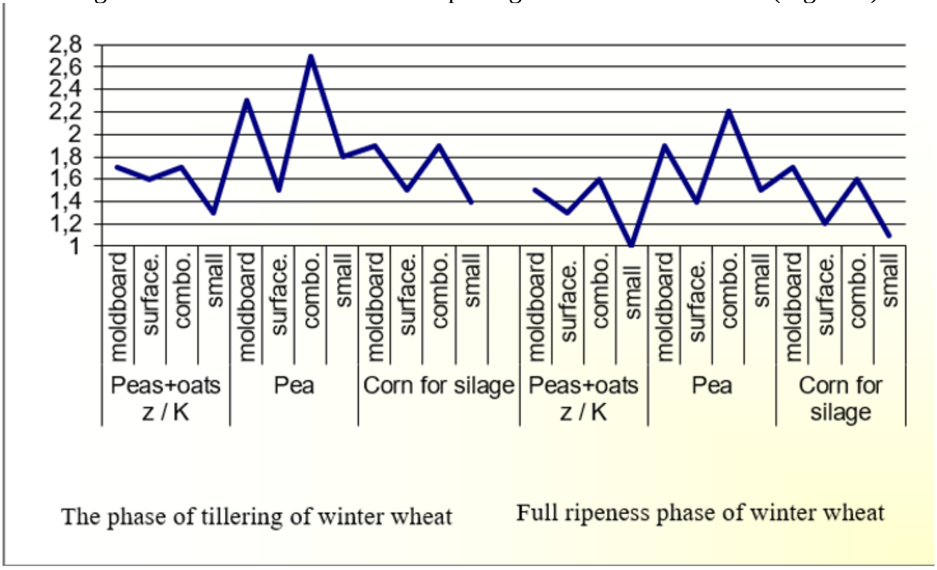

Fig. 2. Catalase activity of the soil, ml 0.1 n. KMnO4 per 1 g of soil for 20 minutes.

On the contrary, an increase in its activity in case of dumps and dump-free treatments is associated with the optimization of hydrothermal conditions for the activation of the enzyme and the destruction of toxic hydrogen peroxide for organisms. An increase in the activity of the enzyme in the soil under the pea was also noted, which confirms the data on the advantage of continuous sowing crops in the activity of this enzyme in comparison with row crops.

The enzymes involved in the conversion of protein substances include the enzyme urease, which carries out the hydrolysis of urea.

As a result of studies on the influence of various variants of the main tillage on the activity of the soil enzyme urease, a decrease in activity under the influence of plowing was revealed, since the urease enters the soil with plant residues. When dumping treatment due to movement of plant residues in the underlying layers, the activity of this enzyme decreases to 0.8–0.9 mg of N-NH4 per 10 g of soil for 4 hours, whereas with surface treatment, depending on its predecessor, it is 0.8– 1.3 mg of N-NH4 / 10 g of soil for 4 hours, with a combination of 1.0–1.1, and for shallow soil, 1.1–1.2 mg of N-NH4 / 10 g of soil in 4 hours (figure 3).

In general, the activity of urease is relatively small and manifests itself mainly in the spring, then by the end of the growing season it is significantly reduced, which is indirect evidence of its bacterial origin.

Phosphatases (phosphohydrolases of monoethers of orthophosphoric acid) belong to the group of phosphohydrolases that catalyze the hydrolysis of organophosphorous substances, which cannot be used by plants without prior cleavage and mineralization. The activity of these enzymes is an indicator of the intensity of the biochemical processes of mobilization of soil organophosphates.

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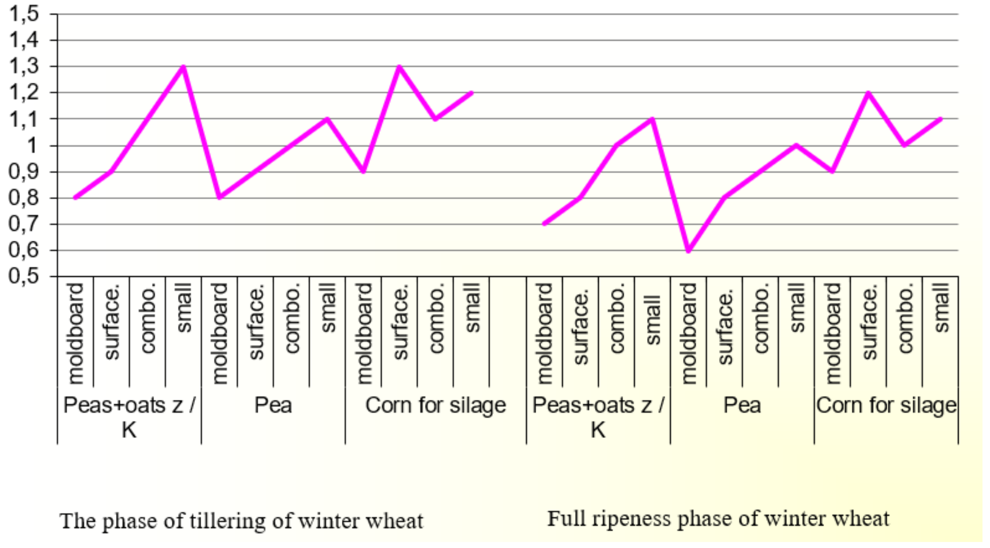

Fig. 3. Urease activity of the soil, mg N-NH4 / 1 g of soil for 4 h.

The highest phosphatase activity is observed in the rhizosphere of plants. Consequently, with regard to the method of tillage, we can state the following: the average phosphatase activity of the soil in all variants without a turn of the reservoir is higher compared to ploughing. Thus, according to the predecessor, pea + oats for green fodder, phosphatase activity by waste processing was 4.0, combined - 8.4, surface - 5.6 and shallow - 10.0 mg P2O5 / 10 g soil for 1 h. Similar patterns can be traced on peas and corn for silage (Figure 4).

The research results show that both in the heading phase and in the wax ripeness phase of winter wheat, there is a tendency for an increase in the phosphatase activity of the soil after maize for silage.

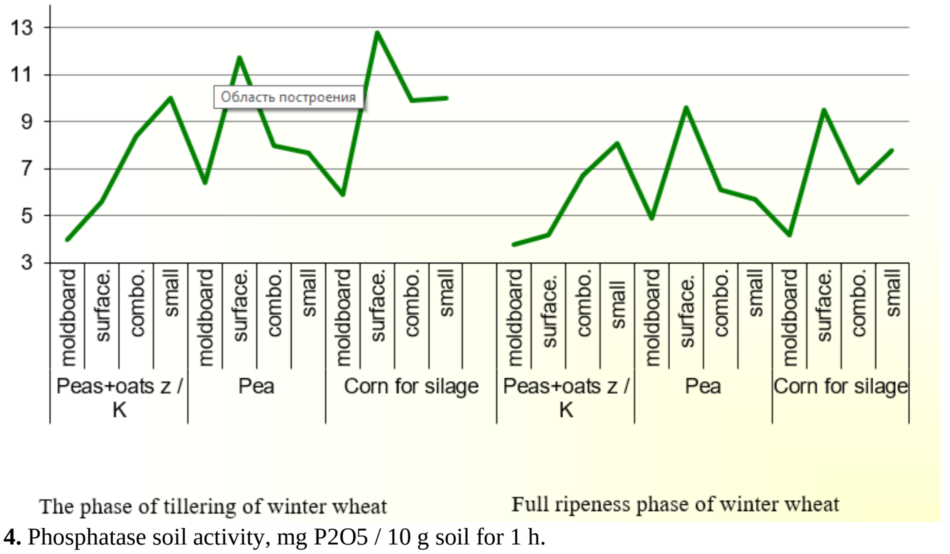

Fig. 4. Phosphatase soil activity, mg P2O5 / 10 g soil for 1 h.

From the earing phase to the ripening period of winter wheat, the activity of the enzyme phosphatase decreases, but nevertheless, the soils are classified as rich in the content of this enzyme in the phase of tillering and medium enriched in the phase of full ripeness. As for the other enzymes, the degree of soil enrichment with invertase is characterized as medium enriched with catalase and urease - poor.

Analysis of the effect of enzymatic activity on the formation of winter wheat yields shows the presence of a connection between them, which is expressed by the model: = –45.938 + 0.8372x4 - for busy couple, = –14.618 + 0.4105x4 - corn for silage and = –13.133 + 0.336x4 for peas. In these models, the regression coefficients b are positive. This fact confirms that the increase in yield is influenced by the enzymatic activity of the soil. The correlation coefficients have the values: r1 = 0.9388, r2 = 0.24025, r3 = 0.3449. They are positive, indicate a strong and average relationship, and confirm the presence of a tendency to increase the yield of wheat from the magnitude of the enzymatic activity.

The results showed that the crop, methods and techniques of the main tillage affect its enzymatic activity.

The highest enzyme activity, with the exception of phosphatase, was observed in variants with the use of tailless and combined treatments, using leguminous cultures and cereal-legume mixtures as precursors. The dynamics of the seasonal activity of enzymes from sowing to harvesting was also identified, which is associated with a decrease in the amount of organic matter and a weakening of the activity of microorganisms.

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