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Influence of Resource-Saving Technologies Applied in the Conditions of Rapid Typical Gray Soils on Soil Properties

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Abstract It is known that the introduction of scientifically based resource-saving technologies into the soil is considered important for improving the quality of agricultural products and reducing production costs. The implementation of resource-saving technologies allows not only to significantly reduce production costs, but also to prevent soil degradation as a result of reducing the intensity of erosion processes and humus mineralization. In the soil and climatic conditions of our republic, the application of non-till technology for the soils of the rainfed zone is considered important. The research results show that the amount and reserves of underground biomass of barley grown using the NO-Till method in typical sierozem soils are 1,0-1,2 times higher than in soils cultivated using the traditional method. A high biomass content in the soil treated using the non-Till method ensured a constant enrichment of the soil with humus, which led to an improvement in the water-physical, physical, agrophysical, and chemical properties of the soil, as well as an improvement in the soil structure as a result of year-round coverage of the soil surface with crop residues.

Keywords No-Till, Plant residues, Humus, Density, Aggregate structure, Winter wheat, Barley

1. Introduction

It is advisable to use land without tillage or minimal tillage in arid and degraded lands. The deposition of plant residues in the upper soil layer plays an important role in moisture retention in the soil, and also protects the soil from water and wind erosion. Minimal tillage is economically efficient, in particular, it reduces labor, machinery, fuel consumption, pollution from machinery, as well as soil hardening and compaction [1,2,5].

Due to the fact that plant residues remain in the upper soil layer and the soil is not turned over when sowing without plowing, soil moisture evaporates less, and living microorganisms are preserved in its composition. The preservation of plant residues, in turn, contributes significantly to good plant development and reduces water and wind erosion. Soil compaction and hardening sharply decrease. Various raw materials can be used as plant residues, such as plant stems, straw, wood shavings (apilka), ash, peat, leaves, oil waste, coal powder, which were tested in field experiments, and the first work in this direction was started by American farmers in the second half of the 19th century [9,10,11].

Burnet and Fisher emphasize that soil moisture is particularly important for yields in the 0-30 layer [13,14]. Winger and Parker concluded that wheat straw as a vegetation cover retains four times more moisture than cotton residues [15]. Candoval and Bens showed that the use of wheat straw as vegetation cover was more effective on heavily saline soils than on less saline soils [16]. Also, a number of researchers have found that leaving vegetation cover in the surface layer of the soil leads to the preservation of moisture in the soil, i.e., non-evaporation and a decrease in salt accumulation [12,4].

Minimal tillage is understood as the efficiency of energy, economic, and labor costs due to a reduction in the number, depth, and area of tillage. This method was developed by I. E. Ovsinskiy in the 19th century [6]. Minimal tillage is considered an important requirement in the ecologization of land use. Particular attention is paid to plant remains [7]. From world experience, it is known that the most effective methods of resource-saving technologies for soil protection are minimal and zero tillage. From an economic point of view, winter wheat was the most effective of these methods.

2. Object and Methods of Research

The research was conducted on eroded rainfed typical sierozem soils of the farm “Jovli bobo o‘g‘li Baxtiyor” of the Savson massif, Kamashi district, Kashkadarya region. The content of above-ground and underground plant residues in the soil was studied by N.A. Kachinsky [3], N.I. Savvinov and N.A. Pankova [8].

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3. Obtained Results and Their Analysis

The amount of biomass residue in the 0-30 cm layer of typical sierozem soils of the "Jovli bobo o'g'li Baxtiyor" farm of the Savson massif, where No-Till technology was implemented and soil cultivation was carried out according to the traditional method, was studied. According to the data obtained, on non-eroded rainfed typical sierozem soils obtained from the barley field of section 1, the amount of aboveground biomass (stub) of barley grown using the NO-Till method is 191,9 g/m^2 and the amount of underground biomass (root) is 289,5 g/m^2 (Table 1).

The amount of aboveground biomass (stub) in moderately eroded soils of the southeastern exposition of section 2, obtained from the field of barley sown on the No-Till technology of the farm "Jovli bobo o'g'li Baxtiyor" of the Savson massif, was 170,1 g/m^2, the amount of underground biomass (roots) was 217,1 g/m^2, in moderately eroded soils of the northwestern exposition of section 6, the amount of aboveground biomass (stub) was 241,3 g/m^2, the amount of underground biomass (roots) was 323,6 g/m^2.

The amount of aboveground biomass (stub) of wheat cultivated in the traditional method on typical sierozem soils of the 4th section of the Savson farm of the "Jovli bobo o'g'li" farm is 181,3 g/m^2 and the amount of underground biomass (roots) is 263,4 g/m^2.

In the moderately eroded soils of the southeastern exposition of section 5, obtained from the traditional wheat field, the amount of aboveground biomass (stub) residue was 170,1 g/m^2, the amount of underground biomass (roots) residue was 217,1 g/m^2, in the moderately eroded soils of the northwestern exposition of section 3, the amount of aboveground biomass (stub) residue was 241,3 g/m^2, the amount of underground biomass (roots) residue was 323,6 g/m^2.

According to the data obtained, the underground biomass of barley grown using the NO-Till method in typical sierozem soils was 71,3-96,2 g/m^2 in the decomposed part, and 98,8-145,1 g/m^2 in the undecomposed part, with undecomposed roots prevailing over decomposed roots. The ratio of underground biomass to surface biomass is significantly higher than one and is 1,28-1,51. The total biomass reserves were 3,872-5,649 t/ha.

The underground biomass of wheat cultivated by the traditional method in the studied rainfed typical sierozem soils was 68,2-82,3 g/m^2 in the decomposed part, and 91,1-142,7 g/m^2 in the undecomposed root part, where undecomposed roots prevailed over decomposed roots. The ratio of underground biomass to surface biomass is significantly higher than one and equals 1,27-1,45. The total biomass reserves were 3,824-5,418.

When cultivating typical sierozem soils with traditional and No-till methods, the residues of biomass were determined, and the amount of nutrients (N, P, P) in the residues of biomass left in the soil was determined. The total amount of nitrogen in the biomass of winter wheat grown on non-eroded soil using the non-till method was 21,1 kg/ha, phosphorus – 9,9 kg/ha, and potassium – 12,7 kg/ha. The amount of nitrogen in the total biomass of winter wheat 3,82 t/ha in moderately eroded soils of the southeastern exposition was 19,8 kg/ha, the amount of phosphorus 9,3 kg/ha, and the amount of potassium 12 kg/ha, the amount of nitrogen in the total biomass of winter wheat 5,65 t/ha in moderately eroded soils of the northwestern exposition was 19,8 kg/ha, the amount of phosphorus 9,3 kg/ha, and the amount of potassium 12 kg/ha (Table 2).

The total amount of nitrogen in the biomass of barley grown on non-eroded soils with traditional sowing was 22,8 kg/ha, phosphorus – 10,1 kg/ha, and potassium – 13,0 kg/ha. The amount of nitrogen in the total biomass of winter wheat 3,82 t/ha in moderately eroded soils of the southeastern exposition was 19,7 kg/ha, the amount of phosphorus 9,1 kg/ha, and the amount of potassium 11,3 kg/ha, the amount of nitrogen in the total biomass of winter wheat 5,42 t/ha in moderately eroded soils of the northwestern exposition was 21,9 kg/ha, the amount of phosphorus 9,8 kg/ha, and the amount of potassium 12,4 kg/ha.

Table 1. Amount of biomass left by agricultural crops in typical sierozem soils

Layer depth, cm	Surface biomass g/m^2		Underground biomass g/m^2		Underground /aboveground	Total reserve	
	decayed	undecayed	decayed	not rotten		g/m^2	t/ha
Barley sown using the NO-Till method in the Savson massif, Kamashi district, Kashkadarya region, is not eroded.							
0-30	78,2	113,7	119,4	170,1	1,51	481,1	4,814
Kashkadarya region, Kamashi district, Savson massif, barley sown by the NO-Till method is moderately eroded, southeastern exposure							
0-30	71,3	98,8	96,7	120,4	1,28	387,2	3,872
Kashkadarya region, Kamashi district, Savson massif, barley sown by the NO-Till method is moderately eroded, northwestern exposure							
0-30	96,2	145,1	115,4	208,2	1,34	564,9	5,629
Kashkadarya region, Kamashi district, Savson massif Traditionally sown wheat crops are not eroded.							
0-30	71,2	110,1	113,4	150,1	1,45	444,7	4,447
Kashkadarya region, Kamashi district, Savson massif. Traditionally sown wheat is moderately eroded, southeastern exposure.							
0-30	68,2	91,1	93,4	120,7	1,27	382,4	3,824
Kashkadarya region, Kamashi district, Savson massif. Traditionally sown wheat is moderately eroded, northwestern exposure.							
0-30	82,3	142,7	119,2	197,6	1,41	541,8	5,418

Table 2. Amount of nutrients in the biomass left by agricultural crops in the soil

Depth of the formation 0-30 cm	Water separator				Southeast Exposition				Northwest exposure			
	Total biomass t/ha	N	P	P	Total biomass t/ha	N	P	P	Total biomass t/ha	N	P	P
NO-Till	4,81	23,1	10,9	13,7	3,87	20,8	9,7	12,6	5,65	22,5	10,1	12,9
Traditional	4,44	22,8	10,1	13,0	3,82	19,7	9,1	11,3	5,42	21,9	9,8	12,4

4. Conclusions

Humus is not only formed in the soil, but also decomposes. The process of humus decomposition, i.e., mineralization, proceeds at different rates depending on the soil reaction, humidity level, temperature, and aeration conditions. In neutral and near-reactive soils, the mineralization of humus occurs much faster. In soils with average temperature and humidity levels, the process of humus mineralization and carbon dioxide formation occurs faster than in highly humid or dry soils. The importance of studying root and stubble residues in rainfed soils also lies in the fact that the biomass remaining from them serves as the main source for the formation of soil humus. A high content of biomass in the soil ensures the continuous enrichment of the soil with humus, improves the water-physical, physical, agrophysical, and chemical properties of soils, and also improves the soil structure as a result of the year-round coverage of the soil surface with crop residues, reduces the negative impact of erosion processes, and, as a result, creates favorable conditions for the next year's crops. Also, in the soil cover with well-developed vegetation, the humus layer thickens, which leads to an increase in the fertility of these soils.

According to studies conducted in the rainfed typical sierozem soils of the Kamashi district of the Kashkadarya region, as a result of the implementation of resource-saving technologies, the amount of humus accumulated in the upper layers of soils plowed by the traditional method in fields sown on the basis of No-Till. The main reason for this can be explained by the large accumulation of plant residues in the soil in these areas.

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