Study on technological properties of winter wheat soils

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Abstract. The aim of the study is to study and analyze the physical, mechanical and technological properties of soils from under winter grain crops in the hot climate of Uzbekistan. The results of determining the moisture content, density, hardness and resistance to various deformations of soils after harvesting winter wheat are presented. The basic principles and methods of classical mechanics, mathematical analysis and statistics were used in this study. Studies have found that, in the layer 0-30, the soil moisture for ten days after harvesting winter cereals decreases by 12.1-16.3%, and the soil hardness increases by 10.7-16.4% and are 3.22-5.14 MPa. At the same time, at an average humidity of 12-14%, the resistance of the soil to breakage and torsion, respectively, is 1.3-1.8 and 1.0-1.1 times higher than the resistance of the soil to shear. The resistance of the soil to shear is 87.9 kPa, and to breakage and torsion-69.7 and 78.6 kPa, respectively.

1 Introduction

In the zone of Uzbekistan, tillage from under grain crops is carried out in July-August. During this period, the topsoil compacted by tractors and harvesters is severely dried up. The moisture content of the top layer is reduced to 5%, and the hardness is reduced to 11.8 MPa [1]. Therefore, when processing soils that are prone to clumping, plowing turns out to be coarse-grained. The precipitation that fell in the winter and early spring periods on such soil quickly evaporates. K. M. Mansurov [1], M. Muradov [2], O. R. Kenzhaev [3], V. I. Kravchenko [4], F. M. Mamatov [5, 6, 7], and I. T. Ergashev studied the physical and mechanical properties during the main tillage at various times [5, 6, 8, 9], B. S. Mirzaev [6, 7, 10-24], D. Chuyanov [11, 25], H. Ravshanov [10-12, 23, 26, 27, 28], H. Fayzullaev [11, 26, 28, 29, 30] and others. The most interesting are the studies of the physical and mechanical properties of soils conducted by K. M. Mansurov [1]. He studied the moisture content, density, hardness of the arable layer, tear resistance, compression and friction of the upper horizon of takyr soils and light gray soils. It is established that the value of the soil hardness depends on the agrotechnical background, humidity and depth of immersion

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of the plunger. The lowest soil hardness was observed in the horizon of 0-5 cm of the arable layer, and the highest hardness at a depth of 10-20 cm. M. M. Muradov [2] as a result of studies, they conclude that the soil in the sub-arable horizon (at a depth of 50-60 cm), compared with the arable one, has lower humidity, greater hardness and high coefficients of soil friction against metal. The analysis of the conducted studies shows that the physical, mechanical and technological properties of soils from under winter grain crops in a hot climate are not sufficiently studied.

The aim of the study is to study and analyze the physical, mechanical and technological properties of soils from under winter grain crops in the hot climate of Uzbekistan.

2 Methods

The basic principles and methods of classical mechanics, mathematical analysis and statistics were used in this study.

Studies of the physical, mechanical and technological properties of soils from winter grain crops were conducted in the Kashkadarya region of Uzbekistan. The density and humidity of the soil were determined by sampling with the Litvinov device. The resistance of the soil to various deformations was determined using a reconstructed device by the authors (Fig. 1). When determining the resistance of the soil to tear and tear, a bottomless box 4 with a size of 100x100x50 mm is pressed into the soil. The soil around the box 4 is carefully removed to prevent friction. When the handle 2 rotates, the cord 5, winding on the pulley 3, through the pulley 6 drags the rod 8 along with it, compressing the spring 9. The nature of the change in the separation force is recorded with a pencil 7 on a paper tape wound on the drum 10.

a)

b)   *c)*
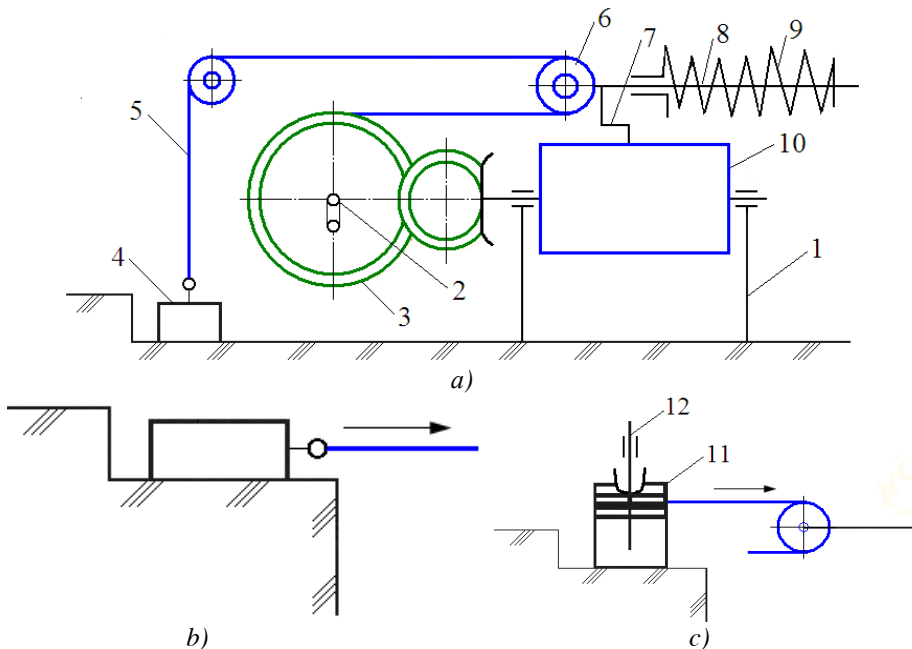
Fig.1. Scheme for determining the resistance of the soil to rupture (*a*), shear (*b*) and torsion (*c*)

The tensile strength of the soil was determined by the following formula

$$K_r = \frac{P_{st} - G}{F},$$

(1)

where P_{st} – the force of separation of the soil from the base; G – the weight of the soil in the box; F – the area of the torn part of the sample.

The shear resistance (ultimate strength) of the soil was determined by the following formula

$$K_{cd} = \frac{P_{cd}}{F},$$

(2)

where P_{cd} – is the shear force of the soil from the base.

To determine the torsion resistance of the soil, a special cylinder 11 with an internal diameter of 100 mm was made. When determining the torsion resistance of the soil, the cylinder 11 with the cord 5 wound on it is pressed into the soil. Then the soil around cylinder 5 is removed. When the handle 2 rotates, the cord 5 is wound on the pulley 3, and overcoming the force of the spring 9, it moves the rod. In this case, the torsion force of the cylinder with the soil is fixed on the tape of the device.

The torsional resistance (ultimate strength) of the soil is determined by the following formula

$$K_{kr} = \frac{P_{kr} - P_s}{F},$$

where P_{kr} – is the force of rolling the cylinder with soil; P_s – is the force of rolling the cylinder without soil.

3 Results

After the fall grain harvest, soil moisture and density were studied for several days in a row before the repeated crops were prepared for planting. Soil moisture, density, and hardness values were determined at a depth of 0-50 cm in every 10 cm of soil layer (Table 1).

Table 1. Soil moisture values for 10 days after winter grain harvesting, %

Soil layer. cm	Soil moisture after winter grain harvesting					
	1-day	2-day	3- day	5- day	7- day	10- day
0-10	9.8	9.3	8.8	8.5	8.4	8.2
10-20	11.6	10.8	10.6	10.5	10.3	10.2
20-30	12.8	12.7	12.4	12.3	12.1	12.1
30-40	12.6	12.4	12.2	11.9	11.9	11.9
40-50	11.9	11.8	11.8	11.6	11.7	11.5

According to Table 1, in areas free of autumn cereals, soil moisture changes rapidly over days. For example, in the 0-10 cm layer, the humidity decreased from 9.8% to 8.2% in 10 days, which is 16.3% less than in the first day. In the 10-20 cm layer of soil, the decrease was 12.1%, in the 20-30 cm, 30-40 cm layers 5.5%, and in the 40-50 cm layer 3.3%. This means that under the influence of hot weather, moisture is lost quickly in the upper layers of the soil, and in the lower layers, the decrease in moisture is slower due to the upper layer. Soil moisture decreases rapidly within 3 days after harvest of autumn cereals. This decrease was 10.2% relative to the moisture content of the first day in the 0–10 cm soil layer, 8.6% in the 10–20 cm layer, 3.1% in the 20–30 cm, 30–40 cm layer, and 40–50 cm layer. while 0.84%. Over the next 7 days, the decrease in soil moisture in these layers was 6.8%, respectively; 3.8%; 2.4% and 2.5%, respectively.

Table 2 shows the dynamics of changes in soil density in the first ten days after the autumn grain harvest. The soil type is light gray. According to Table 2, the density of irrigated soils does not change significantly in any layer over days. Differences in density values are not

larger than experimental errors. However, the density varies depending on the depth of the soil layers. Fig.2 shows the changes in moisture and density at different depths of the soil.

Table 2. Soil density values within 10 days after winter grain harvesting, g/cm^3

Soil layer, cm	Average humidity value, %	Soil hardness after winter grain harvesting					
		1-day	2-day	3-day	5-day	7-day	10-day
0-10	8.8	1.23	1.22	1.23	1.23	1.22	1.23
10-20	10.5	1.32	1.32	1.33	1.32	1.31	1.33
20-30	12.2	1.44	1.42	1.41	1.46	1.43	1.42
30-40	12.0	1.50	1.52	1.51	1.50	1.49	1.51
40-50	11.5	1.39	1.37	1.37	1.39	1.40	1.38

According to Fig.2, soil moisture has the highest value (12.2%) at a depth of 20-30 cm. Its value is 27.8% more than 0-10 cm, 13.9% more than 10-20 cm, 1.64% more than 30-40 cm and 5.7% more than 40-50 cm. ldi. The density of the soil is the highest in the 30-40 cm layer (1.51 g / cm^3). The density of the 30-40 cm layer of soil is 19.2% relative to the 0-10 cm layer, 12.6% relative to the 10-20 cm layer, 5.3% relative to the 20-30 cm layer, and 8 relative to the 40-50 cm layer; More than 6%.
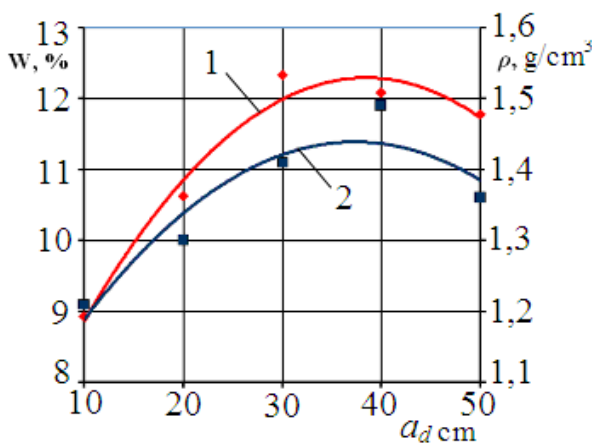
Fig.2. Graphs of the dependence of humidity (*W*) and density (ρ) of light gray earths depending on the depth of horizons (a_d): 1 – humidity; 2 – density

Soil hardness is an important indicator that depends on its mechanical composition and moisture, the amount of organic matter in it, the type of crop grown, the depth of pre-tillage, the drag resistance of working tools during tillage and the degree of soil erosion. is calculated.

The dynamics of changes in soil hardness in the first ten days after the autumn grain harvest were studied. Studies have shown that soil hardness values fluctuate and increase with time (Table 3).

According to Table 3, the soil hardness in 10 days in the 0-10 cm layer is 16.4% compared to the hardness in the first day, 10.7% in the soil layer at a depth of 10-20 cm, and 7.9% in the soil layer at a depth of 20-30 cm. ha, by 6.2% in the soil layer at a depth of 30-40 cm, and by 3.1% in the soil layer at a depth of 40-50 cm. In this case, the hardness in the upper

layers of the soil increases rapidly, and in the lower layers of the soil changes slowly accordingly.

Table 3. Values of soil hardness within 10 days after harvesting of winter grain, Mpa

Soil layer. cm	Soil hardness after winter grain harvesting					
	1-day	2-day	3-day	5-day	7-day	10-day
0-10	2.69	2.72	2.76	2.90	3.06	3.22
10-20	3.73	3.76	3.83	3.92	4.03	4.18
20-30	4.64	4.70	4.76	4.85	4.94	5.04
30-40	5.53	5.60	5.65	5.76	5.83	5.90
40-50	4.98	4.50	5.04	5.07	5.09	5.14

The hardness of the soil reached its maximum value (5.70 MPa) at a depth of 30-40 cm. In this case, it is 49.2% of the soil layer at a depth of 0-10 cm, 31.7% of the soil layer at a depth of 10-20 cm, 15.6% of the soil layer at a depth of 20-30 cm and 40-50 cm of soil. had a stiffness of 12.9% more than the stratum.

Soil hardness decreases after a depth of 30–40 cm. This is because the aggregates have little effect on the compaction of the underlying soil layers.

We have determined the resistance of the soil to rupture, shear and torsion (Table 4). The data show that the resistance of the soil to various deformations has the highest values in the soil layer at a depth of 15-20 cm. This is because when the humidity is low (8-10%), the hardness of the soil increases and its resistance to breakage and displacement increases.

In soils with sufficient moisture, there are water shells around its molecules. They reduce the torsional and shear resistance of the soil. However, an increase in moisture leads to an increase in the torsional resistance of the soil.

According to Table 4, in the 0-30 cm deep layer of soil, its shear resistance is 1.3-1.8 and 1.0-1.1 times higher than the shear and torsional resistance, respectively. In fields devoid of autumn cereals, the average soil moisture is 12-14%, its shear strength is 87.9 kPa, and shear and torsional strength is 69.7 and 78.6 kPa. As the moisture content decreases, the resistance of the soil to breakage and shear increases rapidly. The torsional strength of the soil changes gradually.

Table 4. Resistance of the soil of light gray soils from under winter cereals to various deformations

Soil layer, cm	Humidity, %	Gap, kPa	Shift, kPa	Torsion, kPa
0-5	8.9	39.4	71.5	63.6
5-10		62.5	79.6	73.0
10-15	10.6	75.6	93.3	80.0
15-20		78.5	96.6	81.4
20-25	12.4	78.1	91.7	82.7
25-30		70.3	89.3	84.0
30-35	12.2	73.5	87.5	81.4
35-40		80.0	94.4	82.9

Thus, the physico-mechanical and technological properties of soils in irrigated areas freed from fall grain crops for replanting show that when moisture content is low, the soil has high strength and a large amount of energy in their cultivation.

4 Conclusions

1. Studies have found that, in the layer 0-30, the soil moisture for ten days after harvesting winter cereals decreases by 12.1-16.3%, and the soil hardness increases by 10.7-16.4% and is 3.22-5.14 MPa.

2. At an average humidity of 12-14%, the resistance of the soil to breakage and torsion, respectively, is 1.3-1.8 and 1.0-1.1 times higher than the resistance of the soil to shear. The resistance of the soil to shear is 87.9 kPa, and to breakage and torsion-69.7 and 78.6 kPa, respectively.

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