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CHANGE OF GRAY-BROWN SOILS WATER-PHYSICAL PROPERTIES UNDER THE WINTER WHEAT

*©**Osmanova S.,** Ph.D., Institute of Soil Science and Agrochemistry Azerbaijan NAS, Baku, Azerbaijan, osmanova-sona@mail.ru*

ИЗМЕНЕНИЕ ВОДНО-ФИЗИЧЕСКИХ СВОЙСТВ СЕРО-КОРИЧНЕВЫХ ПОЧВ ПОД ОЗИМОЙ ПШЕНИЦЕЙ

*©**Османова С. А.,** канд. с.-х. наук. Институт почвоведения и агрохимии НАН Азербайджана, г. Баку, Азербайджан, osmanova-sona@mail.ru*

Abstract. Research is conducted at the Terter Regional Experimental Station of the Research Institute for Agriculture. In order to improve soil fertility and obtain high and high-quality crop yields, we studied the water-physical properties of the soils of the experimental plot. Soil and fertilizer treatment in the 0–30 cm layer reduced the density of the soil but increased the natural moisture and total porosity compared with the control variant. As a result, soil fertility increased, which in turn significantly affected the grain yield of winter wheat.

Аннотация. Исследования проведены на Тертерской региональной опытной станции научно-исследовательского института земледелия. С целью улучшения плодородия почв и получения высоких и качественных урожаев сельскохозяйственных культур были изучены водно-физические свойства почв опытного участка. Методы исследования стандартные — это определение физико–химических свойств почвы в различных вариантах опытов. При обработке почв и удобрении в слое 0–30 см уменьшили плотность почвы, а естественную влажность и общую пористость по сравнению с контрольным вариантом увеличили. В процессе проведенных работ было установлено, что увеличилось плодородие почвы, что в свою очередь значительно повлияло на урожай зерна озимой пшеницы.

Keywords: fertility, humidity, density, porosity, minimal processing, traditional processing.

Ключевые слова: плодородие, влажность, плотность, пористость, минимальная обработка, традиционная обработка.

Introduction

At the present stage of civilization, the most global problem facing humanity is the effective use of nature and its resources. Since soil cover is very valuable, preserving it for future generations is a major concern. Passing this wealth to future generations, when using the soil, it is necessary not only to preserve, but also to improve soil fertility [1].

The main functions of soil treatment are optimal conditions for improving soil density and structure, air and water regimes, preventing deflation and erosion, controlling organic matter and phytosanitary conditions, eliminating pests and weeds, and sowing seeds.

Modern science and practice have come to the conclusion that the ways to solve the problem of tillage are deep and shallow plowing, turning or not turning the layer, minimizing tillage, zero processing (no-till).

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The traditional processing system, deeply turning the soil, destroys its structure. Cleaning, burning and turning plant residues deep into the soil leads to a decrease in soil fertility. Also leads to the destruction of microorganisms, macro and mesofauna of the soil, which are agronomical important. Intensive soil cultivation has a negative impact on its quality, humidity, air, climate and landscape [2].

As is well known, in the traditional farming system heavy machinery is used. As a result, the soil is compacted, moisture infiltration decreases, the top layer is washed out.

Scientific research and practical experiments led to the discovery of resource-saving technologies and the emergence of a new soil-protective farming system. Soil protection systems include minimal and zero tillage [3].

In order to study the above issues, through the application of traditional and minimal technologies of cultivation under crops in the Tartar region, real scientific achievements are expected in improving the fertility and improving the ecological environment of the soil.

Research methodology

The object of our research is the Terter Regional Experimental Station of the Research Institute of Agriculture. Were laid two-factor field experiments. 1. tillage — traditional and minimal. 2. — norms of fertilizers — 1. control (without fertilizer); 2. 10 tons of manure+$N_{60}P_{60}K_{30}$; 3. 10 tons of manure+$N_{90}P_{90}K_{60}$; 4. 10 tons of manure+$N_{120}P_{120}K_{90}$. Mineral fertilizers were used at the test site: nitrogen — in the form of ammonium nitrate 34.7%; phosphorus — in the form of simple superphosphate — 18.7% and potassium — in the form of potassium sulphate — 46%, and manure in the half-pith state (nitrogen — 0.5%, phosphorus — 0.25%, potassium — 0.6%) used on experimental plots.

Results and discussion

The lack of the right amount of moisture in the soil affects the physicochemical and biological processes, soil fertility, plant growth and development, yield, nutrient absorption by the plant, etc. Therefore, the creation of a favorable water regime in the soil is one of the most important tasks in agronomy.

To obtain high yields of agricultural crops, it is necessary that the total field moisture capacity of the soil is 60–70%, since it takes up to one liter of water to produce one gram of dry matter. Different soils have different attitudes towards moisture: some of them have good water permeability and water-holding capacity, while other types of soils cannot hold water. And the third type of soil — badly pass and quickly lose water. Therefore, water, in different parts of the soil behaves differently, its quantity and value is different [4].

Soil moisture is a major factor in crop production. It is known that plowing the soil without turning promotes the freezing of deeper soil layers and in early spring during the melting of these ices, absorption of moisture by the soil, a decrease in surface runoff and an increase in moisture in the soil compared to classical plowing 1.5–2 times. Experiments show that plowing without turning retains moisture 10% more [5].

Moisture — one of the main indicators for the growth and development of plants. Almost the main source of moisture for plants is soil. The water regime of the soil depends on the income from different sources and the movement of this moisture, while the moisture reserves depend on the process of soil formation, plant residues, topography, weather conditions and processing methods. Processing factors affecting soil moisture, physical and agrochemical processes are still very relevant today. And this in turn depends on the technological means of their modernization, technology and soil and climatic conditions [6].

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The soil is constantly evolving. In it continuously go complex physic–chemical and biological processes. Therefore, in this or in any other soil, the physicochemical properties do not remain stable. The natural conditions are changing, and the influence of agro technical measures is constantly changing. The physical properties of the soil directly affect the growth and development of plants. By physical properties of the soil, we mean its basic physical and physic-mechanical properties. The main physical properties of the soil are its bulk density, density and porosity. The depth and main methods of tillage significantly affect the water, nutrient and nitrogen regime of the soil and the productivity of agricultural crops [7].

The maximum productivity of agricultural crops is formed with optimal indicators of water-physical properties of the soil. One question constantly provokes debate among scientists: a decrease in the density and intensity of the soil as a result of deep plowing. Many scientists have noted an increase in soil density above the optimum in the topsoil with systematic zero and minimum treatments [8].

The technology of minimal tillage reduces the cost of growing crops. With minimal tillage, the reserves of useful moisture in the meter layer was 107–114 mm, which is 13–16% less than with plow plowing with soil turning. Reducing moisture with minimal processing reduces water–holding capacity, accelerates evaporation of precipitation in the second half of the growing season [9].

In our republic, in the research of I. Djumshudov it is noted that depending on the technology of soil treatment and the phases of the development of winter wheat, the density of the soil also changes. So, for example, in the variant of the main tillage at 20–22 cm in the tillering phase of winter wheat, the soil density was 1.17 g/cm^3, in the sibling phase — 1.23 g/cm^3, and during the full ripeness period it was 1.32 g/cm^3. That is, depending on the phase of development of wheat plants from the tillering stage and up to the full ripeness phase, the density of the soil in all variants of growing grows. With minimal tillage, these figures were respectively 1.19; 1.25; 1.28 g/cm^3. With zero tillage, in the spring tillering stage compared with other options, the soil density of 0.03 g/cm^3 was higher. The increase in this variant in comparison with other variants is explained by the fact that it was sown without any tillage. Although this pattern is observed in the stage of booting, in the phase of full ripeness the lowest density was observed in the variant of zero tillage — 1.26 g/cm^3. In the variant of traditional tillage in the phase of complete ripeness, the density of the soil was the highest, which is estimated as an unfavorable factor for the development of plants [10].

We have studied the effect of tillage and doses of fertilizers for winter wheat on the density and total porosity of the soil. The research results are presented in Tables 1 and 2. Soil samples were taken from 0–10 soil layers; 10–20 and 20–30 cm successively in the tillering phases of winter wheat, booting and full ripeness. Depending on the processing of the soil and the rates of fertilizers, regular changes were observed in the indices of natural moisture, soil density and total porosity in the studied soil layers.

At the end of the growing season, an increase in soil density, moisture, and a decrease in porosity was observed in all variants and in phases of development. According to the soil layers, it should be noted that in the 0–10 cm layer the soil moisture and density were low, as they moved down the profile, they increased. And the total porosity — on the contrary, in the upper 0–10 cm layer — is high, and down the profile — decreased.

As can be seen from the table on the basis of traditional soil treatment in the control variant (without fertilizers), in the tillering stage of winter wheat the humidity in the soil layers is 0–10; 10–20 and 20–30 cm was 17.1; 19.5 and 20.8%, respectively, the density (bulk weight) of the soil — 1.10; 1.14 and 1.24 g/cm^3, total porosity 58.80; 57.30 and 53.90%. In the phase of full ripeness, these figures were respectively equal to humidity — 12.5; 13.4 and 15.2%; soil density (bulk density) — 1.19; 1.24 and 1.34 g/cm^3; total porosity — 55.43; 53.56 and 50.18%.

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On the basis of traditional soil tillage, the use of organic and mineral fertilizers has contributed to a significant increase in porosity and moisture in the development phases and soil layers, and the density of the soil has decreased. So, for example, in the variant manure 10t/ha+$N_{60}P_{60}K_{30}$, in the tillering stage the humidity in the layers 0–10, 10–20 and 20–30 cm was 17.5; 18.2 and 20.3%, respectively, the density was 1.03; 1.08 and 1.20 g/cm^3, total porosity — 61.42; 59.55 and 55.39%. In the phase of full ripeness, respectively, humidity — 13.0; 14.2 and 16.5%; soil density — 1.17; 1.21 and 1.33 g/cm^3; total porosity — 56.18; 54.68 and 50.56%.

In the embodiment, the manure 10 t/ha+$N_{90}P_{90}K_{60}$ in the spring in the tillering stage, the humidity in the layers 0–10, 10–20 and 20–30 cm was 19.5; 21.5 and 22.6%, respectively, the density — 0.98; 1.03 and 1.19 g/cm^3, total porosity — 63.30; 61.42 and 55.59%. In the phase of full ripeness, respectively, humidity — 14.2; 15.8 and 17.2%; soil density — 1.08; 1.15 and 1.29 g/cm^3; total porosity — 59.55; 56.93 and 52.04%. In the embodiment, the manure 10t/ha+$N_{120}P_{120}K_{90}$, in the tillering stage, the moisture content in the layers of 0–10, 10–20 and 20–30 cm was 19.0; 21.1 and 21.8%, soil density, respectively, 1.01; 1.05 and 1.21 g/cm^3, total porosity — 62.17; 60.67 and 55.02%. In the phase of complete ripeness, humidity, respectively, 13.7; 14.6 and 17.1%; density — 1.13; 1.19 and 1.31 g/cm^3; total porosity — 57.68; 55.43 and 51.30%.

From the Table 1 it can be seen that with the minimum tillage in each of the variants, the soil layers and vegetation phases showed that moisture and porosity in the 0–10 cm layer were higher than traditional treatment and density was lower. In the lower 10–20 and 20–30 cm layers, on the contrary, the density is higher, and the porosity is less. This is explained by the fact that in the 0–10 cm layer the root mass and fertilizers accumulate more, and less goes to the lower layers. So, for example, in the control (without fertilizer) version in the spring in the tillering stage, the moisture content in the layers of 0–10, 10–20 and 20–30 cm was 17.1; 19.2 and 22.8%, respectively, the density of the soil — 1.08; 1.20 and 1.33 g/cm^3, total porosity 59.55; 55.06 and 50.56%. In the phase of full ripeness, the humidity was 12.2; 13.4 and 15.7%; soil density of 1.17; 1.29 and 1.37 g/cm^3; total porosity of 56.18; 51.68 and 49.07%.

Table 1.

IMPACT OF TRADITIONAL SOIL AND FERTILIZER TREATMENT
ON WATER–PHYSICAL PROPERTIES

№	*Experience options*	*Depth, cm*	*Tillering*			*Bobbing*			*Full ripeness*		
			Humidity, %	*Soil density, g/cm^3*	*Total porosity, %*	*Humidity, %*	*Soil density, g/cm^3*	*Total porosity, %*	*Humidity, %*	*Soil density, g/cm^3*	*Total porosity, %*
1	Control (without fertilizer)	0–10	17.1	1.10	58.80	18.2	1.17	56.18	12.5	1.19	55.43
		10–20	19.5	1.14	57.30	20.6	1.22	54.31	13.4	1.24	53.56
		20–30	20.8	1.24	53.90	21.7	1.33	50.56	15.2	1.34	50.18
2	Manure 10 t/ha+$N_{60}P_{60}K_{30}$	0–10	17.5	1.03	61.42	18.7	1.15	56.93	13.0	1.17	56.18
		10–20	18.2	1.08	59.55	19.6	1.19	55.43	14.2	1.21	54.68
		20–30	20.3	1.20	55.39	21.5	1.31	51.30	16.5	1.33	50.56
3	Manure 10 t/ha+$N_{90}P_{90}K_{60}$	0–10	19.5	0.98	63.30	20.7	1.07	59.92	14.2	1.08	59.55
		10–20	21.5	1.03	61.42	22.8	1.13	57.68	15.8	1.15	56.93
		20–30	22.6	1.19	55.59	23.8	1.27	52.79	17.2	1.29	52.04
4	Manure 10 t/ha+$N_{120}P_{120}K_{90}$	0–10	19.0	1.01	62.17	20.1	1.11	58.43	13.7	1.13	57.68
		10–20	21.1	1.05	60.67	22.0	1.17	56.18	14.6	1.19	55.43
		20–30	21.8	1.21	55.02	23.2	1.29	52.04	17.1	1.31	51.30

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With minimal tillage in soil layers and development phases, as well as in traditional tillage, the amount of moisture and porosity increased, and the density decreased. So, for example, in the variant manure 10 t/ha+$N_{60}P_{60}K_{30}$, in the tillering stage the moisture content in the layers 0–10, 10–20 and 20–30 cm was 18.5; 20.3 and 23.1%, respectively, the density of the soil — 1.05; 1.13 and 1.27 g/cm^3, total porosity — 60.67; 57.68 and 52.79%. In the phase of full ripeness, respectively, the humidity was 13.1; 14.6 and 16.3%; density — 1.16; 1.25 and 1.34 g/cm^3; total porosity — 56.55; 53.18 and 50.18%.

Table 2.

IMPACT OF MINIMIZING THE TREATMENT OF SOIL AND FERTILIZER
ON WATER–PHYSICAL PROPERTIES

№	Experience options	Depth, cm	*Tillering*			*Bobbing*			*Full ripeness*	
			Humidity, %	*Soil density, g/cm^3*	*Total porosity, %*		*Humidity, %*	*Soil density, g/cm^3*	*Total porosity, %*		*Humidity, %*
1	Control (without fertilizer)	0–10	17.1	1.08	59.55	17.3	1.15	56.93	12.2	1.17	56.18
		10–20	19.2	1.20	55.06	18.8	1.26	52.81	13.4	1.29	51.68
		20–30	22.8	1.33	50.56	21.3	1.37	49.07	15.7	1.37	49.07
2	Manure 10 t/ha+$N_{60}P_{60}K_{30}$	0–10	18.5	1.05	60.67	17.8	1.13	57.68	13.1	1.16	56.55
		10–20	20.3	1.13	57.68	19.2	1.24	53.56	14.6	1.25	53.18
		20–30	23.1	1.27	52.79	22.1	1.35	49.81	16.3	1.34	50.18
3	Manure 10 t/ha+$N_{90}P_{90}K_{60}$	0–10	19.2	0.96	64.04	19.7	1.09	59.18	14.5	1.11	58.43
		10–20	21.3	1.11	58.43	21.3	1.17	56.18	15.6	1.19	55.43
		20–30	23.5	1.23	54.27	22.1	1.32	50.93	17.2	1.33	50.56
4	Manure 10 t/ha+$N_{120}P_{120}K_{90}$	0–10	18.8	1.02	61.80	18.2	1.13	57.68	13.7	1.15	56.93
		10–20	20.8	1.15	56.93	20.3	1.20	55.06	15,.2	1.21	54.68
		20–30	23.5	1.25	53.53	22.5	1.33	50.56	16.8	1.35	49.81

In the embodiment, manure 10 t/ha+$N_{90}P_{90}K_{60}$, in the tillering stage, the moisture content of 0–10, 10–20 and 20–30 cm to the layers was 19.2; 21.3 and 23.5%, respectively, the density of the soil — 0.96; 1.11 and 1.23 g/cm^3, total porosity — 64.04; 58.43 and 54.27%. In the phase of full ripeness, respectively, the humidity was 14.5; 15.6 and 17,2%; soil density — 1.11; 1.19 and 1.33 g/cm^3; total porosity — 58.43; 55.43 and 50.56%. In the embodiment, manure 10t/ha+$N_{120}P_{120}K_{90}$, in the branching phase, the moisture content in the layers of 0–10, 10–20 and 20–30 cm was 18.8; 20.8 and 23.5%, soil density, respectively, 1.02; 1.15 and 1.25 g/cm^3, the total porosity was 61.80; 56.93 and 53.53%. In the phase of full bloom, respectively, humidity — 13.7; 15.2 and 16.8%; density — 1.15; 1.21 and 1.35 g/cm^3; total porosity — 56.93; 54.68 and 49.81% (Table 2).

Conclusion

Thus, soil tillage and fertilizer in a layer of 0–30 cm reduced the density of the soil but increased the natural moisture and total porosity compared with the control (without fertilizer) option. As a result, soil fertility increased, which in turn significantly affected the grain yield of winter wheat.

In each of the two soil treatments, the best indicators were observed in the manure variant 10t/ha+$N_{90}P_{90}K_{60}$. When comparing the control options due to the minimum soil treatment in a layer of 0–10 cm, the density decreased by 0.01–0.02 g/cm^3 compared to traditional treatment, the natural humidity increased by 0.8–1.8%, and the total porosity by 0.38–0.75%.

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