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Soil Fertility Problems in Central Ciscaucasia.

Valerii Sergeevich Tshovrebov*, Vera Ivanovna Faizova, Anastasia Mikhailovna Nikiforova, Andrei Anatolyevich Novikov, and Alexander Nikolaevich Marin.

Stavropol State Agrarian University, Zootekhnicheskiy lane 12, Stavropol 355017, Russia.

ABSTRACT

The main problems of soil fertility in the Stavropol Territory are considered: drainage, flooding, secondary salinization, deterioration of composition, properties, depletion of soils with organic matter and accessible forms of nutrients, and the development of water and wind erosion. It is established that in the plowland in 70-100 years of agricultural use, there was a significant decrease in the organic matter content by an average of 1.5-2%. The soil is being merged, which is caused by the joint action of the newly formed swelling minerals of the montmorillonite group and the cementing action of mobile colloidal silicon compounds. The massive construction of modern irrigation systems, without proper waterproofing and improper, unreasonable irrigation has led to the fact that more than 2 million hectares in the province are considered as flooded. The processes of wind erosion are most developed in the regions of the east of the region and in the zone of the Armavir wind corridor. Water erosion has developed in areas located on the Stavropol Upland and its spurs. For the last 50-60 years on the plowed land, soils have been depleted in accessible forms of macro- and microelements in contrast to virgin lands.

Keywords: soils, fertility, organic matter, liquefaction, flooding, salinization, erosion.

Corresponding author

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INTRODUCTION

The territory of the Stavropol Territory can be divided into two almost equal soil zones: western - chernozem, occupying 3136 thousand hectares (47.4%) and eastern - chestnut, occupying 3480 thousand hectares (52.6%). Soils are formed mainly on related parent rocks. In the chestnut zone loesses and loesslike loams predominate, and loess-like loams and partially loesslike clays are predominant in the chernozem zone. Intrazonal chestnut solonetzes and solonetzic complexes are formed on saline loesslike rocks, and chernozem solonetzes and solonetsous soils - on rocks of marine genesis - tertiary deposits of Maikop and Quaternary sediments of the Sarmat of different ages. According to climatic parameters, chestnut soils are in the arid and very arid zone, and chernozems in the zone of insufficient and moderate moistening.

In the structure of agricultural lands, arable land occupies 3929.7 thousand hectares (69.4%). The main subtypes of chernozem soils are ordinary calcareous chernozems, distributed on an area of 1,254,000 ha (19.8%) and southern, covering 658,000 ha (10.4%). Among the chernozems common, the genus of solonetsous ones associated with solonetzes occupies the Yankul, Sengileevskaya depressions, the valleys of the rivers Surkul and Barsukov, and also a considerable part of the Mineralovodsky hilly plain on the total area of 405,000 hectares (6.4%). The share of chernozem leached is only 55.5 thousand hectares, or 0.84%.

Dark chestnut carbonate soils occupy 1112 thousand hectares (17.7%). In combination with them, there are dark chestnut solonetsous soils on an area of 154,000 hectares (2.3%). Chestnut carbonate soils occupy only 316 thousand hectares, and their solonetsous analogues have a high prevalence on the area of 734 thousand hectares (11.6%). Light chestnut carbonate soils total 246 thousand hectares (3.9%), and light chestnut solonetsous and saline soils 162 thousand hectares (2.6%).

Natural virgin ecosystems differ from agrocenoses in that all biological products remain in place, mineralized, and mineralization products are involved in a new nutrient cycle of plants. The biological circulation of substances goes along a closed type [1].

The most acute environmental problems for the soils of the zone are considered to be the drainage, flooding, secondary salinization, deterioration in composition, properties, depletion of soils with organic matter and accessible forms of nutrients, and the development of water and wind erosion [2].

Agricultural production changes the mechanism of functioning of natural ecosystems. Biological products are alienated with the crop. This leads to an open cycle of chemical elements and a change in energy balance in the ecosystem. There is a gradual depletion of arable land stocks of organic matter and elements of mineral nutrition [3-5].

MATERIAL AND METHODS

The object of the study was the soils of Central Ciscaucasia. To explain the processes of slip on the conjugate areas of virgin land and arable land of common and leached chernozems, the composition of clay minerals and the content of silicic acids was studied. The quantitative composition of clay minerals was carried out according to the method of N.I. Gorbunov. The content of organic matter was determined by the method of Tyurin in the modification of CINAO.

RESULTS AND DISCUSSION

Generalization of long-term studies of the Department of Soil Science of the Stavropol Agrouniversity has shown that in the plowland of chernozems for 70-100 years of agricultural use there was a significant decrease in the organic matter content by an average of 1.5-2% (Table 1). The most exploited chernozem has lost most of all humus (up to 2.2%).

The content of organic matter underwent certain changes in solonetzic soils during the period of their exploitation, although to a lesser extent than in chernozem soils (Table 2). In chestnut solonetzes and solonetsous soils, the decrease in humus was about 0.5%. In solonetz chernozem, this value fell by 0.7%, in solonetsous-fused chernozems - by 0.59%. Most of all, humus was lost by chernozem solonetsous (0.93%). In its distribution zone, it is the most fertile type of soil and has been plowed most often.

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Table 1: The content of organic matter in the chernozems of the Central Ciscaucasia

The ordinary black soil (n=12)			Southern black soil (n=18)			Leached black soil (n=17)		
Genetic horizont	Virgin soil	Arable land	Genetic horizont	Virgin soil	Arable land	Genetic horizont	Virgin soil	Arable land
A_d, $A_{ar.}$	5,58	3,38	A_d, $A_{ar.}$	4,36	2,83	A_d, $A_{ar.}$	6,86	5,71
A	4,20	3,46	A	3,15	3,01	A	6,07	5,74
AB	3,50	3,10	B_1	2,48	2,15	AB	5,28	5,06
B	2,27	2,48	B_2	1,28	1,46	B	3,71	3,11
BC	1,11	1,45	BC	0,78	1,0	BC	2,46	2,21
C	0,51	0,63	C	0,40	0,42	C	0,74	0,83
HCP_{05}	0,27	0,21		0,19	0,18		0,24	0,22

Changes in the content of organic matter concern not only the upper arable horizon, but also the sub-plow layers. Down the profile, the amount of humus is stabilized and becomes the same both on the virgin soil and on the plowland in the transition horizon and in the rock.

The main reason for the decrease in the content of organic matter is its active mineralization with prolonged and intensive agricultural exploitation of soils [6]. This is also facilitated by the inadequate or absence of manure application on the fields from the beginning of the 1990s to the present, as well as increased activity of erosion and deflation processes. Not only the upper arable layer but also the entire soil profile is subject to active dehumification.

To eliminate the existing problem, it is necessary to biologize agriculture, based on the introduction of perennial grasses into the crop rotation, the abandonment and embedding of plant residues, the use of manure as the main means of maintaining a positive balance of the supply of organic material to the soil. But for this it is necessary to develop the livestock sector in the province, which is still in a deplorable state in comparison with the pre-perestroika period.

Sluitization is manifested everywhere, but mainly on the chernozems of the region and is expressed by the appearance of wide and deep vertical cracks, compactness and structurelessness of the upper horizons. The development of this negative process is observed only in plowed fields. On virgin soils, it is absent.

Slitogenesis is inextricably linked with the formation of clay minerals of the montmorillonite group. If the content of smectites from the total amount of clay minerals reaches 20% and more of the soil begin to acquire all the features of the fusion.

For example, we took a change in the composition of clay minerals of chernozem ordinary carbonate. Our studies have revealed a significant difference in the composition of clay minerals of virgin and arable land. It has been established that montmorillonite is absent on the virgin land in virgin land (Table 3). Montmorillonite appears in horizon A (8%) and increases the content to 26% in the rock.

In the profile of the chernozem plowing area there is a transformation of illite with a new formation of montmorillonite. So in the arable horizon its number increases to 24%, i.e. in the zone of intensive root activity of plants. It was also established that in the $A_{ar.}$ horizon, the content of this mineral is higher than that of the subsoil horizon.

Such changes are related to the features of the weathering zone and the functioning of agroecosystems. The bulk of the root system of cultivated plants is concentrated in the upper arable horizon. This causes the constant removal of potassium and its weathering from the crystalline structure of illites. In this situation, there is a reorganization in the system of clay minerals, the ilites become montmorillonites. Below the subsoil horizon, the regularity in the distribution of minerals is similar to the virgin land. Consequently, the transformation of the mineral basis of the soil occurs only in the arable agrogenic horizon.

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Table 2: The content of organic matter in solonets and solonetsous soils

Chestnut solonetz (n=22)			Chestnut solonetsous (n=23)			Solonets black soil (n=17)			The black soil is solonetsous-fused (n=24)			Black soil solonetsous (n=27)		
Genetic horizont	Virgin soil	Arable land	Genetic horizont	Virgin soil	Arable land	Genetic horizont	Virgin soil	Arable land	Genetic horizont	Virgin soil	Arable land	Genetic horizont	Virgin soil	Arable land
A_d, $A_{ar.}$	1,93	1,48	A_d, $A_{ar.}$	2,46	1,98	A_d, $A_{ar.}$	5,60	4,90	A_d, $A_{ar.}$	5,42	4,83	A_d, $A_{ar.}$	6,63	5,7
B_1	1,44	1,23	B_1	1,72	1,34	AB	4,18	3,63	B_1	4,16	3,38	A	5,42	5,41
B_2	0,90	0,92	B_2	1,11	0,92	B	2,50	2,25	B_2	2,61	2,34	B_1	4,51	4,50
BC	0,44	0,45	BC	0,50	0,45	BC	1,00	1,03	BC	0,87	0,91	B_2	3,04	2,56
C	0,14	0,12	C	0,18	0,21	C	0,50	0,59	C	0,50	0,48	BC	1,33	1,22
												C	0,10	0,10
HCP_{05}	0,11	0,12		0,14	0,14		0,19	0,18		0,21	0,20		0,24	0,22

Table 3: Composition of clay minerals black soil of ordinary carbonate virgin soil and arable land (n=9)

Genetic horizont	Composition of clay minerals, %					
	montmorillonite		hydromica		coalitol + chlorite	
	virgin soil	arable land	virgin soil	arable land	virgin soil	arable land
$A_{ar.}$	-	24	69	45	32	31
A	8	15	61	58	31	27
AB	9	8	57	62	34	30
B	9	9	54	59	37	32
BC	22	19	50	52	28	29
C	26	27	45	45	29	28
HCP_{05}	1,2	1,4	1,8	1,6	1,6	1,5

Eliminate, at least in part, this problem can be the introduction of potassium in the soil. It is most expedient to introduce it together with organic fertilizers. As a rule, the soil after application of manure loses its features of fusion and acquires more favorable physical properties. It is also necessary to make potassium along with mineral fertilizers, but this element is applied only to sugar beet and sunflower on the soils of the region, which makes up 5-7% of agricultural land.

A certain role in the formation of fused soils is played by mobile silicon compounds. Illuvial fusions and solonets horizons and those in low-sodium solonetzes can be formed as a result of accumulation of hydrophilic compounds, among which silicon plays a primary role. Polysilicic acids affect the physical properties of the soil, have a cementing effect, are able to bind the soil particles between themselves, firmly sorbing on them, forming silicone bridges and causing soil cohesion.

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In our investigations, the content of monosilicic acids and mobile silicon in seasonal dynamics was studied in black and white chernozems of ordinary and leached types: in spring, in summer and in autumn. The two upper horizons were studied: A_d and A on the virgin land, $A_{ar.}$ and A on arable land (Table 4). On chernozem carbonate in the turfy virgin soil, the content of monosilicic acids varies slightly during the season and is in the range 6.5-8.2 mg / 100 g. This can also be attributed to the humus-accumulative horizon, with the only difference being that in the turfy horizon in the summer period the values are minimal, and in the horizon A are maximal. In the content of mobile silicon there is a constant increase from the spring (86 mg / 100 g) to autumn (102 mg / 100 g) in the A_d horizon. In horizon A, its content is lower in comparison with A_d. The difference in the indicators increases by 2 times in autumn.

In plowland, in comparison with the virgin land, there is a sharp decrease in the content of monosilicic acids and an increase in mobile silica. Monosilicic acids are the least in the plow horizon in summer (1.8 mg / 100 g) and the difference with the virgin soil is almost 5 times. In the subsoil horizon at this time the amount of this substance is higher by the same amount.

Table 4: The content of monosilicic acids and mobile silicon in the subtypes of chernozems (mg / 100 g)

Name of soil	Type of land	Genetic horizon, cm	Spring		Summer		Autumn	
			Monosilica	Mobile	Monosilica	Mobile	Monosilica	Mobile
Black soil carbonate (n=7)	virgin soil	A_d A	8,2 6,8	86 51	6,5 9,4	96 72	7,0 5,2	102 46
	arable land	$A_{ar.}$ A	4,0 6,0	250 66	1,8 6,1	210 59	3,2 4,6	272 70
Leached black soil (n=11)	virgin soil	A_d A	5,8 4,1	142 125	3,2 1,8	165 140	7,4 5,1	180 160
	arable land	$A_{ar.}$ A	4,0 3,8	440 328	5,0 2,4	382 344	13,0 7,6	420 370

The content of mobile silicon in the arable horizon increases 2-3 times in comparison with the virgin soil. Characteristically, its lowest values are in the summer, i.e. in the period of not only the maximum weathering of minerals, but also intensive absorption of silicon. This agrees with the data on the composition of clay minerals.

When studying the leached chernozem, a similar analogy with chernozem carbonate is found. It can only be noted that the content of mobile silicon here is 2-3 times higher than in chernozems of ordinary.

Thus, the involvement of chernozems in agricultural production leads to an increase in the content of those siliceous compounds that perform a cementing role and lead to the development of processes of soil co-fusion. Hence, it is possible to explain the significant changes in the physical parameters of the soils of agrocenoses. The effect of the merger is most likely caused by the joint action of the swelling minerals of the montmorillonite group and the cementing action of mobile colloidal silicon compounds.

Flooding is another problem of modern farming. The development of this process in the territory of the Central Ciscaucasia is purely anthropogenic. Recently, the entire territory of the Northern Caucasus has been the scene of irrigation and watering of vast territories. Mass construction of modern irrigation systems, without proper waterproofing and improper, excessive irrigation led to a loss of water for filtration, and its flow into the groundwater flow was significant.

Another factor contributing to the rise of groundwater is that over the past 50 years more than 80 large irrigation systems and a number of huge reservoirs have been built on the territory of the Rostov Region, Stavropol and Krasnodar territory. In addition, thousands of ponds and reservoirs of daily water accumulation have been created on steppe rivers. Prior to the irrigation and irrigation of the lands in the region, ground waters in the plain in the beams and floodplains of rivers lay at depths of 7 to 15 m, and in watershed areas - up to 50-70 m. At present, the groundwater almost completely filled the aeration zone and in some places reached a mark above 3 m from the soil surface. More than 2 million hectares in the province are considered as flooded. Out of wetlands, 17.5 thousand hectares are swamped. To solve the existing problem, it is necessary: first - to revise existing irrigation norms and the second - to ensure the effective drainage of irrigated land. The total irrigation rate is 3-3.5 thousand m3. It does not cause doubts, but it should not be given out for 3-4 vegetative and one rechargeable watering, but for 10-12 vegetation irrigation, as is customary in countries with traditional irrigation. Effective drainage, according to some sources, has only a third of irrigated farmland.

Soil salinity: the scale of this problem is not catastrophic, but still present. The most widespread saline soils were obtained on the territory of farmland in Levokumsk, Neftekumsk, Andropov and Apanasenkovsky districts, where their specific gravity from the total area of soils in the province is 12.9, respectively; 12.8; 11.4 and 10.4%. Salinization in the Apanasenkovskoye, Levokumsky and Neftekumsky areas is caused by salinity of the original parent rock and the rise of the saline cushion as the groundwater level rises on irrigation. In Andropov region salinization is of a natural nature. The soils of the region are formed mainly on the initially saline rocks of the marine genesis of the Maikop layer. The least widespread saline soils were obtained in Novoaleksadrovsky (0.1%), Novoselitskiy (0.5%), Blagodarnoy (0.6%) and Kursk (0.9%). All the hayfields of Apanasenkovsky and Levokumsky districts are located on saline lands, 94.6% in Petrovsky, 51.5% in Kochubeyevsky, 43.2% in Neftekumsky, and 19.2% in Andropov districts.

Recently, erosion processes are actively developing. The loss of soil within the boundaries of the Stavropol Territory from dust storms is 60-265 million tons. In places, the whole arable horizon is blown out. The system of farming and land management of farms is often carried out without taking into account the soil and geomorphological conditions. New virgin lands are plowed in difficult terrain with slopes up to 6 ° or more. This leads to the washing away of the soil and the exposure of the illuvial horizon, and in some places also the soil-forming rock. Especially active processes of water erosion occur in areas of complex terrain with a slope of more than 2 degrees. As it turned out, the territory of the Stavropol Upland and its spurs are prone to erosion processes. More than 1 million hectares or 27% of the total area are located on gradients from 2 to 5 degrees. 162558 hectares or 4.5% are located in especially dangerous areas with a slope from 5 to 10%.

Deflation and erosion are among the main factors of soil dehumification. In various zones of the region, catastrophic rates of loss of organic matter and destruction of the entire humus layer are observed.

Currently, the area of eroded lands is 1671 thousand hectares or 31.7% of the area of agricultural land. The largest area in the eroded lands is occupied by soils that are prone to water erosion - 914 thousand hectares or 16.2% of the area of farmland. Deflated soils - 13.3%, which is 754 thousand hectares. The joint manifestation of the processes of water and wind erosion is revealed on the area of 123 thousand hectares, that is, by 2.2% of the area of farmland. The processes of wind erosion are most developed in the regions of the east of the region and in the zone of the Armavir wind corridor. Water erosion has developed in areas located on the Stavropol Upland and its spurs.

With the existing system of farming: the rectangular organization of the territory of working areas with forest strips of width 350-700 m and length 700-3000 m along the slope, the introduction of pure steam without preserving plant residues on its surface, the constant application of the dump processing, leaving only the stubble-root residues, the lack of sowing of perennial grasses will continue the destruction of the natural

fertile layer of soils. But the fight against this negative process must begin with the modernization of the land management system. In the province there are a lot of areas of arable land located in an erosion hazard zone. It is necessary to remove them from the system of farming for haymaking pastures.

The content of available forms of food on the plowland is changed as follows: the content of mobile phosphorus is increased due to the application of fertilizers; according to the exchange potassium of the soil, can be considered secured (the average magnitude at the edge is 371 mg / kg), but in comparison with the first rounds of surveys conducted in the early 1960s, this indicator decreased by 15-18%. The content of mobile sulfur is disturbing. According to this element of the soil nutrition can be considered as low-income (about 90% of the territory of agricultural land contains less than 6 mg / kg). But even 30 years ago, the content of sulfur in soils was 1.5-2.5 times higher and they were classified as medium- and high-income. This sharp change in this indicator is due to the constant removal of the element from the soil and alienation along with the harvest. The resulting impoverishment contributes to a decrease in the quality of the products received, sulfur determines the amount of protein formed in plants.

Another factor that is responsible for the quality of the products is the content of microelements. Only according to the content of mobile boron our soils can be considered highly provided. The content of mobile manganese is basically low except for Aleksandrovsky, Novoselitsky, Georgievsky, Kirovsky and Predgorny districts. For copper, zinc and cobalt, 97% of the areas are of low security (50-60 years ago, the soils also had a low supply of these elements, but during this period there was a decrease in 2-3 times and only on arable land). No such phenomenon was found on virgin lands.

CONCLUSION

Microelements play an important role in the formation of quantity and especially the quality of the crop. We forgot when we received a strong and valuable grain. Back in the late 70's and early 80's, most of the production of winter wheat was first and second class. The content of gluten in the grain was more than 30% and often rose to 40%. The third class was not enough. Now we get, basically, the fourth class and forage. This situation needs to be corrected by applying fertilizers. At the end of the 1980s, the amount of applied fertilizers in the province reached 112 kg / ha in the active substance. Last year, a record amount of fertilizers was introduced - 62 kg / ha in the active substance. This is almost 2 times lower compared to the previous period. Basically it is nitrogen and phosphorus fertilizers. The amount of fertilizers containing potassium, sulfur and trace elements is 7-8%. In addition to the introduction of mineral fertilizers in the biologization of farming systems, it is necessary to increase the application of organic fertilizers. In the absence of, or insignificant quantities of manure, they may be plant residues of previous crops. Thus, the most acute problems of soil fertility in the Stavropol Territory are considered to be liquefaction, flooding, secondary salinization, which cause deterioration in the composition and properties of arable land.

REFERENCES

[1] Changes in the Content of Organic Matter in Black soils of Central Ciscaucasia Caused by Their Agricultural Use / V. S. Tshovrebov, V. I. Faizova, D. V. Kalugin, A. M. Nikiforova, V. Y. Lysenko // Biosciences Biotechnology Research Asia. 2016. Vol. 13(1). P. 231–236.

[2] Kovda, V.A. Soil cover, its improvement, use and protection. -M .: Nauka, 1981.-182 p.

[3] Emelyanov S.A., Mandra Y.A., Gudiev O.Y., Maznitsyna L.V., Korostylev S.A. Effects of Anthropogenic Environmental and Food Safety // Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2016. Volume 7. Issue 3. P. 2562 - 2569.

[4] Grechishkina Yu.I. Influence of joint application of macro- and microfertilizers on the nitrogen regime of chernozem soils of Central Ciscaucasia / Yu.I. Grechishkina, L.S. Gorbatko, O.Yu. Lobankova, A.A. Belovolova // Harvard Journal of Fundamental and Applied Studies. - 2015. -№ 1 (7). - P. 2007-2014.

[5] Agrochemical Principles of Targetting Winter Wheat Yield on Leached Chernozem of the Stavropol Elevation / A. N. Esaulko, M.S. Sigida, E.A. Salenko, S.A. Korostylev, E.V. Golosnoy // Biosciences Biotechnology Research Asia, April, 2015, Vol.12 (1), P. 301-309.

[6] Shipulya A.N., Volosova E.V., Pashkova E.V., Glazunova N.N., BezginaJu.A. Synthesis and Study of Composite Organic Silica Sorption Materials // Oriental journal of chemistry. 2016, vol. 32, №. (1): pp. 227-234.