АУЫЛ ШАРУАШЫЛЫҒЫ ҒЫЛЫМДАРЫ АГРОНОМИЯ

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STUDYING THE TRANSFORMATION OF THE SOIL COVER IN GRAIN-FALLOW CROP ROTATION

Abstract

The state of the soil cover and the level of soil fertility largely determine the productivity of cultivated crops and the level of development of the agro-industrial complex. Modern soils undergo significant changes in the process of development and usage in agricultural production. Food security of the Republic of Kazakhstan is largely determined by the quality of agricultural lands, which, in turn, depends on the anthropogenic load. Both excessive and insufficient investment of energy subsidies in the agro-ecosystem can lead to negative consequences of the agronomic and environmental plan. In the last decade, significant damage to the soil cover is caused by irrational farming, violations of agricultural technologies associated with the changed economic situation in the country and the deterioration of environmental conditions. This leads to changes in many physical and chemical properties of dark chestnut soils. There is a decrease in the humus content, saturation of the soil absorbing complex with exchange bases, indicators of effective soil fertility. The water balance is disturbed due to the transformation of the physical properties of dark chestnut soils for the worse. Therefore, it is necessary to contribute to the preservation of soil fertility as efficiently as possible. In this regard, the role of monitoring studies that allow timely detection of changes in the level of fertility, if necessary, to develop appropriate corrective measures, as well as to predict the state of the system in the future. Studies have established the transformation of agrochemical and agrophysical indicators of soil cover during long - term use in grain-steam crop rotation.

Keywords*: transformation, dark chestnut soils, agrochemical indicators, humus, grain-fallow rotation.*

The experience of domestic and world agriculture shows that long-term use of agricultural land leads to a decrease in soil fertility. The content of humus decreases, its quality changes, gross forms of nutrients decrease, the reaction of the soil solution and the biological activity of the soils are transformed [1, 2].

It should also be noted that chestnut soils undergo changes in dryland conditions as a result of agricultural development and long-term use. According to the Ershovsky experimental station on chestnut soils, the humus content decreased from 3.26% to 3.22% over the 50-year period [3].

Long-term stationary experiments carried out on dark chestnut soils of the Kustanai region in Kazakhstan showed that changes in stickiness values depend on the value of the specific normal pressure on the soil by the contact surface. In this case, the absolute value of stickiness increases, and the initial and maximum soil adhesion was observed at lower humidity values [4].

According to V.F. Uzuna (1973) the content of humus and nitrogen decreased from the north-west to south-east on the lands under agricultural use throughout the Saratov region. A more gradual decrease in the value of nitrogen than humus was noted when comparing changes in the content of humus and nitrogen along the soil profile. The soils of the Saratov region were characterized by a low mobility of organic nitrogen compounds, as evidenced by the high content of its non-hydrolysable fraction (58.4-70.5% of the total). It was established that the nitrification energy depends on the soil availability of organic matter and nitrogen, as well as on the cultural state of the fields. The nitrification capacity decreased from dark chestnut to chestnut and light chestnut soils. The nitrification capacity of chestnut soils in the Saratov region also decreased as a result of the deterioration of the nitrogen fund and a decrease in the humus content. The value of nitrification capacity strongly depended on the cultural condition of the fields and the applied agrotechnology [5].

According to the data of the Nizhne-Volzhsky Research Institute of Agriculture for the period of study (1987-2003), a tendency of deterioration of physical, water-physical and technological properties was noted in various subzones of chestnut soils of the Volgograd region. These studies showed that the microbiological activity of the soil decreased down the profile regardless of its subtype and tillage system [6].

Studies conducted in the period from 1983 to 1995at the Prikumsky Experimental-Breeding Station of the Stavropol Research Institute of Agriculture showed the decrease in humus content (from 1.58 to 1.41%) in the stationary experiment laid down by the agriculture department in 1969, while observing crop rotation with alternating complete fallow and fall wheat. The introduction of phosphate fertilizers in this rotation did not stabilize humus content in the soil. A decrease in its quantity was observed both on nonfertilized and on fertilized backgrounds. A decrease in the humus content in chestnut soil was also observed in crop rotation, in which there were two fields of complete fallow [7].

Thus, the review of scientific literature gives us the basis to state the deteriorative effect of the agricultural use on properties of chestnut soils.

Due to the presence of various methodological approaches in the assessment of soil fertility, the accumulated material in the scientific literature still does not allow an objective assessment of the transformation of individual indicators of the agrochemical and agrophysical soil properties. It should be borne in mind that the degree of knowledge of this issue varieson different types of soil. It has been established that a decrease in the humus content and an increase in its mobility, a deterioration in the food regime and physical properties of chestnut soils, a decrease in moisture reserves and an increase in soil acidity occur as a result of anthropogenic impact. Most clearly, these processes are expressed on irrigated soils. In dryland conditions their manifestations are smoothed out. However, they occur in almost all zones of chestnut soil distribution. But the scale of their manifestation remains poorly understood, since the transformation of the agrochemical properties of chestnut soils was studied in isolated experiments, which were very few and had a different meteorological basis. Unfortunately, this makes it impossible to draw any general conclusions on this issue. Negative transformation processes of soil cover also occur in the dark chestnut soils of the Akmola region. However, many important aspects, changes in agrochemical properties and the impact on this process of the duration of soil use in agricultural uses still remain poorly understood, and this circumstance served as the basis for choosing the topic of our research.

Research is conducted in the Zhangir Khan WKATU on the topic of PhD doctoral thesis "Transformation of the main fertility indicators of dark chestnut soils with prolonged use in grain-fallow crop rotation".

Field studies are conducted on grain-fallow crop rotations in Arshalinsky district of Akmola region.

In the process of soil research, soil crossovers were laid on the virgin plot (control), as well as grain-fallow crop rotations with a duration of agricultural use of 10, 30 and 40 years.

After appropriate preparation of soil samples, the following indicators were determined:

The humus content - according to the method I.V. Tyurin modified TSINAO after pre-selection of plant residues (GOST 26213-91); the content of mobile compounds P_2O_5 - according to the method of Machigin in the modification TSINAO.

During the research we obtained the following data: humus content and its quality. The soil organic matter has always been the subject of close attention of scientists and practitioners. The formation of soil science, associated in Russia, primarily with the name of V.V. Dokuchaev, significantly deepened and expanded the area of interest on this issue [8].

V.V. Dokuchaev repeatedly pointed out the urgency of studying soil science. Nowadays, its acuteness has become even more tangible, which, in particular, is evidenced by the increased number of alarm messages related to soil dehumification, its negative consequences and ways to overcome them. Until now, among scientists and practitioners there is no single point of view on the role of humus in the fertility of arable soil and the stability of agroecosystems. There are extreme, sometimes opposing, opinions. Apparently, this is partly due to the exceptional diversity of the natural and technological conditions of agricultural production, in which the role of organic matter can indeed be quite different.

The humus state of chestnut soils during their agricultural development varies slightly, although the data on these soils, as noted by A.D. Fokin is clearly not enough [9].

The analysis of research materials showed that the main agrochemical properties of soil have undergone significant changes even for relatively short historical period of land exploitation.

In our studies, there was a marked decrease in the humus content of agricultural land compared to virgin lands. This indicates a high intensity of mineralization processes of humus substances in agricultural plots of the soil.

Dark chestnut soils with medium loamy granulometric composition have significant humus content, which in the virgin areas decreased with depth (from 4.1 to 1.0%) and in a layer of 0-40 cm on average was 3.15%.

As shown by research data, extended agricultural use of dark chestnut soils led to a decrease in humus content. So, when using a grain-fallow crop rotation for 10 years, the humus content decreased by 9.14% in the upper layer 0-20 cm compared to virgin soil and was 3.75%. The loss of humus in absolute terms was –0.40%in a layer of 20–40 cm (table 1).

Table 1- The change in the humus content in the dark-chestnut soils of grain-fallow crop rotations depending on the length of agricultural use

Agricultural land	Soil layer, cm	Humus content,%
Virgin soil	0-20	4,1
	20-40	2,2
	40-60	1,0
Field in grain-fallow crop rotation, with the agricultural land use of 10 years	0-20	3,75
	20-40	1,80
	40-60	1,19
Field in grain-fallow crop rotation, with the agricultural land use of 30 years	0-20	3,01
	20-40	1,25
	40-60	0,98
Field in grain-fallow crop rotation, with the agricultural land use of 40 years	0-20	2,81
	20-40	1,73
	40-60	1,00

According to research data, the humus content decreases in the soil cover with an increase in the usage period of dark chestnut soils in grain-fallow crop rotations.

In studies of dark chestnut soils used in grain-fallow crop rotations for 30 years, the humus content in all soil layers decreased compared to virgin areas. So, the humus content was 3.01%in the horizon of 0-20 cm dark chestnut soil, which is less by 0.99% in absolute values than in the virgin soil. The decrease in the humus content of dark-chestnut soil in a layer of 20-40 cm compared to virgin soil was respectively 0.95%.

Studies have found a slight change in humus content in the lower horizons of 40-60 cm. Here the humus was 0.98%, opposite to 1.00% of the virgin area, the decrease in the humus content was at the level of 0.02%.

The humus content decreased significantly especially in the upper layers when using dark-chestnut soils in grain-fallow crop rotation for 40 years. So, the humus content was 2.81%, which is on 1.29% less in absolute values as compared to the whole areas in the studied No. 4 soil crossover in the soil layer of 0-20 cm. We also found a change in the humus content in the soil layer of 20–40 cm, where the humus content was 1.73% opposite to 2.20%, a decrease at the level of 0.47%.

Dark chestnut soils of the Akmola region are poor in mobile phosphorus. Of the main nutrients, phosphorus is in the first minimum for all crops grown on these soils. Optimization of phosphorus in the mineral nutrition of cultivated plants using phosphorus-containing fertilizers is the main condition for obtaining high yields in this soil-climatic zone.

The phosphate stock of the soil significantly changes due to the accumulation of residual phosphates in it with long-term use of fertilizers. Experiments with long-term use of fertilizers on chestnut soils indicate that applied phosphorus is included in almost all groups of soil mineral phosphates. The largest increase in the content of residual phosphates was observed in the first two groups, both in the case of mineral (2.7-2.9 times) and organic (2.7-5 times) fertilizer application systems. A significant proportion of phosphates of fertilizers remains in the composition of the most mobile groups of mineral phosphates and is well accessible to plants in the future [10].

The relative decrease in the content of organophosphates on rainfed arable land is caused, according to the author, not so much by mineralization processes, since the phosphatase activity of arable chestnut soils is lower than on virgin soil, but mainly by the increase in the share of mineral P_20_5 due to the low utilization rate of phosphate fertilizers [11].

The agricultural use of dark chestnut soils leads to a maximum decrease in the phosphorus content compared to virgin soil. In our studies, significant changes were observed in the phosphate stock of the soil.

In virgin lands, the phosphorus content in layers 0–20, 20–40, and 40–60, respectively, was 12.0; 5.0; 4.0 mg/kg.

The phosphorus content increased in layers to 3.6 (0-20 cm), 6.1 (20-40 cm) and 4.7 mg/kg (40-60 cm), when using dark chestnut soils in grain-fallow crop rotations for 10 years.

The increase in layers is 8.82% (0-20cm), 8.19% (20 + -40cm) and 8.51% (40-60cm).The increase in the phosphorus content is possibly associated with the introduction of phosphate fertilizers, as well as with the processes of the mineralization of phosphorus compounds (table 2).

Table 2 - Changes in the phosphorus content in dark-chestnut soils of grain-fallow crop rotations depending on the duration of agricultural use

Agricultural lands	Soil layer, cm	P_2O_5 content, mg/kg
Virgin soils	0-20	12,0
	20-40	5,0
	40-60	4,0
Field in grain-fallow crop rotation, with the agricultural land use of 10 years	0-20	13,6
	20-40	6,1
	40-60	4,7
Field in grain-fallow crop rotation, with the agricultural land use of 30 years	0-20	10,5
	20-40	7,2
	40-60	3,9
Field in grain-fallow crop rotation, with the agricultural land use of 40 years	0-20	4,5
	20-40	3,2
	40-60	1,5

As shown by research data, the phosphorus content decreases in dark chestnut soils with prolonged cultivation for 30-40 years in grain-fallow crop rotations. So, during 30 years usage of dark chestnut soils under grain-fallow crop rotations, the phosphorus content reduced from 12.0 mg/kg (virgin soils) to 10.5 mg/kg or by 8.75% in the upper soil layer (0-20cm).

The phosphorus content is 6.9 mg/kg in the soil layer of 20-40 cm, i.e. there is a slight increase due to the mineralization of phosphate compounds.

In the lower layers (40-60 cm), the phosphorus content tends to decrease to 2.1 mg/kg or in comparison with virgin areas by 52.5%.

A more intensive process of transformation of phosphorus in dark chestnut soils in both the upper and lower horizons is observed when used in grain-fallow crop rotation for 40 years.

In these soils in the layer of 0-20 cm, the phosphorus content decreased from 12.0 mg/kg (virgin) to 4.5 mg/kg or by 38.0%.

The process of phosphorus transformation continues in the lower layers from 5.0 mg/kg (virgin) to 3.2 mg/kg in a layer of 20-40 cm and from 4.0 mg/kg (virgin) to 1.5 mg/kg in a layer 40-60 cm.

Thus, the prolonged agricultural use in grain-fallow crop rotations results in a process of transformation of indicators of dark chestnut soils. At the same time, there is a more intensive process of transformation of humus and phosphorus when using dark-chestnut soils in grain-fallow crop rotations for 30-40 years. The first 10 years of land reclamation in the grain-fallow crop rotation transformation of soil indicators come at a slower pace. It is associated with the processes of mineralization, as well as with the introduction of maintenance doses of mineral fertilizers.

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ТҮЙІН

Топырақ жамылғысының жай-күйі, топырақ құнарлылығының деңгейі көп жағдайда өңделетін ауыл шаруашылығы дақылдарының өнімділігін, агроөнеркәсіптік кешеннің даму деңгейін анықтайды. Қазіргі заманғы топырақ ауыл шаруашылығы өндірісінде игеру және пайдалану процесінде елеулі өзгерістерге ұшырайды. Қазақстан Республикасының азық-түлік қауіпсіздігі едәуір дәрежеде ауыл шаруашылығы алқаптарының сапалық жай-күйімен айқындалады, ол өз кезегінде антропогендік жүктемеге байланысты болады. Агроэкожүйеге энергетикалық субсидияларды артық және жеткіліксіз салу агрономиялық және экологиялық жоспардың теріс салдарларының туындауына әкелуі мүмкін. Соңғы онжылдықта елдегі экономикалық ахуалдың өзгеруіне және экологиялық жағдайлардың нашарлауына байланысты шаруашылықтарда егіншілік технологияларының тиімсіз жүргізілуі топырақ жамылғысының бұзылуына әкеп соқтыруда. Бұл қара қоңыр топырақтардың көптеген физика-химиялық қасиеттерін өзгертуге әкеледі. Гумус құрамының, топырақ сіңіру кешенінің алмасу негіздемелерімен қанықтығының, топырақтың тиімді құнарлылық көрсеткіштерінің төмендеуі байқалады. Қара қоңыр топырақтың физикалық қасиеттерінің нашар жағына өзгеруіне байланысты су балансы бұзылады. Сондықтан топырақ құнарлылығын сақтауға барынша

тиімді ықпал ету қажет. Осыған байланысты құнарлылық деңгейінің өзгеруін уақтылы анықтауға, қажет болған жағдайда тиісті түзету іс -шараларын әзірлеуге, сондай-ақ болашақта жүйенің жай-күйін болжауға мүмкіндік беретін мониторингтік зерттеулердің рөлі артады. Зерттеулер астық-пар ауыспалы егісінде ұзақ уақыт пайдаланылуына байланысты топырақ жамылғысының агрохимиялық және агрофизиялық көрсеткіштерінің өзгеретінін анықтады.

РЕЗЮМЕ

Состояние почвенного покрова, уровень плодородия почв во многом определяют продуктивность возделываемых сельскохозяйственных культур, уровень развития агропромышленного комплекса. Современные почвы претерпевают значительные изменения в процессе освоения и использования в сельскохозяйственном производстве. Продовольственная безопасность Республики Казахстан в значительной степени определяется качественным состоянием сельскохозяйственных угодий, которое, в свою очередь, зависит от антропогенной нагрузки. Как избыточное, так и недостаточное вложение энергетических субсидий в агроэкосистему может привести к возникновению негативных последствий агрономического и экологического плана. В последние десятилетие значительный ущерб почвенному покрову наносится следствие нерационального ведения хозяйства, нарушения земледельческих технологий, связанных с изменившейся экономической ситуацией в стране и ухудшением экологических условий. Это приводит к изменению многих физико-химических свойств темно-каштановых почв. Отмечается снижение содержания гумуса, насыщенности почвенного поглощающего комплекса обменными основаниями, показателей эффективного плодородия почв. Нарушается водный баланс, в связи с трансформацией физических свойств темно-каштановых почв в худшую сторону. Поэтому необходимо как можно более эффективно по способствовать сохранению почвенного плодородия. В связи с этим повышается роль мониторинговых исследований, которые позволяют своевременно выявить изменения уровня плодородия, при необходимости разработать соответствующие корректирующие мероприятия, а также спрогнозировать состояние системы в перспективе. Исследованиями установлено трансформация агрохимических и агрофизических показателей почвенного покрова при длительных использованиях в зерно-паровом севообороте.

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STUDYING THE IMPACT OF CLEANING TERM ON THE PRODUCTIVITY AND FEEDING VALUE OF *S. SUDANENSE (RIPER) STAPF.*

Abstract

The most important link in the creation of a sustainable forage base in the rainfed lands of the Ural region is the obligatory cultivation of drought-resistant sorghum crops. Among this group of crops *S. Sudanense (Riper) Stapf.,* is considered promising. According to the features of the photosynthetic cycle, Sudanese belongs to the type of C4, which determines its high productivity. In dry weather conditions, it provides stable yields compared to traditional fodder crops, is able to grow quickly after mowing, and can be used for silage, haylage, grass meal and green mass. However, despite all the advantages noted, the areas under crops of Sudanese grass are by now insignificant and its productivity in the West Kazakhstan region remains very low. The main reason is the lack of adaptive technologies for its cultivation. In this regard, the study of elements of the cultivation technology of Sudanese grass, which is the basis, the timing of harvesting the harvesting period: before cutting out, at the beginning of sprouting, flowering for the production of green fodder, haylage