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COMPARATIVE AMELIORATIVE EFFICIENCY OF PHOSPHOGYPSUM AND SULFUR IN SEMI-TERRESTRIAL MODERATELY ALKALINE SULPHATE SALINE SOLONETS OF THE LIGHT GRAY EARTH SUBZONE

Abstract. The article presents the data from field tests for determining the relative ameliorative efficiency of equivalent dosages of phosphogypsum and elemental sulfur on the alkaline saline semi-terrestrial solonetz. Based on the analyses of soils water extract, higher ameliorative efficiency of elemental sulfur and fast amelioration of alkali-saline soils with the use of sulfur have been detected. Ten-month incubation of phosphogypsum and elemental sulfur in the semi-terrestrial alkali-sulfate moderately saline high-sodium medium solonetz from the area of light gray earth had significant influence on the content and composition of salts, by altering their ionic composition, increasing the amount of salts and reducing pH. Flushing initial primary and the newly formed secondary salts from the root zone of the soil had little effect on salt removal (only 0.032%) in the variant with phosphogypsum from 0.527% to 0.543%, while in the variant with elemental sulfur, considerable desalination with salt content decreasing from 0.527% to 0.354% was observed. Moreover, after flushing salts in the variants with phosphogypsum became more toxic due to the "peak" of alkalinity.

Keywords: alkali-saline soil, fertility, amelioration, sulfur, phosphogypsum.

Introduction. Soda-saline (alkaline) soils have been widely distributed in the two regions of the Republic of Kazakhstan: in the grain belt of chernozems and chestnut soils in the form of solonets and solonchak-solonetsous soils (more than 25 million hectares) and in the southern part, among the most fertile soils of the foothill plain of the Northern Tien Shan meadow-chestnut and meadow-gray soils (7.09 million hectares) [1]. The main method of melioration is the introduction of gypsum and phosphogypsum. However, recent studies have found low profitability of traditional meliorants of gypsum and phosphogypsum on soda-saline soils due to a rapid decrease in their initial efficiency, due to the coating of the crystal surface with an insoluble calcium carbonate layer, which isolates them from the environment [2, 3].

Among the meliorants, sulfur is the most effective. Therefore, it was practically not applied and the problem of increasing its reclamation efficiency was almost not dealt with. However, the recent rapid growth in the volume of oil and gas production in the republic led to a sharp increase in the volume of their processing and accumulation, its byproduct - elemental sulfur, it's volume in the republic exceeded more than 8 million tons. The country became the largest in the world (second place after Iran) by the sulfur storage [4], in connection with which the problems of its utilization increased. Our research resulted in 2009-2012. It is established that in the first year only 25% of the added sulfur passes into its oxide forms, samples of sulfuric acid. Hence, it takes four years to obtain a full meliorative effect [5].

Thus, the above-mentioned circumstances prevailing in the republic, i.e. the presence of a large area of alkaline saline soils in areas of intensive farming, the low economic efficiency of the currently used ameliorant of phosphogypsum and the huge amount of accumulated sulfur requires the development of technologies for reclamation of alkaline saline soils using sulfur. In our opinion, the solution of this problem can be achieved by accelerating the oxidation of elemental sulfur, which is possible with high dispersity of its particles.

Program and methodology. The studies were conducted in 2015 and 2016 on the territories of LLP "Amiran" of Talgar district of Almaty region.

To establish the comparative meliorative efficiency of phosphogypsum and elemental sulfur on soda-saline soils, we selected a site of 0.5 ha. Soil soil is a soda-sulfate-solonchak semihydromorphic salt. The field experiment was carried out by applying calculated equivalent doses of ameliorants. The doses of meliorants were calculated to a depth of 0.5 m according to the formula of B.M. Agaeva Phosphogypsum of the Zhambyl plant of phosphorus fertilizers and micronized sulfur of the Atrau refinery were used as ameliorants (1966). [6]. The scheme of the field experiment is as follows:

#	Variant of experience	Doses of meliorants, t/ha
1	Control	–
2	Phosphogypsum	15
3	Elemental sulfur	5

The plot area is (3×5) 15 m^2, replication of the experiment is 3-fold. Samples of soils were selected in the spring before the introduction of meliorants (26.06.2015), in the autumn after 4.5 month incubation of ameliorants (07.11.2015), next year in spring and summer before (26.03.2016) after (28.04.2016) washing. Correction of ameliorants into the soil was carried out by plowing to a depth of 29 cm, followed by disking. The depth of sampling of samples is 0-20, 20-40 and 40-60 cm. In them, the composition of the ions of the water extract of Arinushkin was determined [7]. The field experiment was conducted according to the generally accepted method [8, 9].

The removal of the tertiary salts formed as a result of the interaction of phosphogypsum and sulfur in 2016 led to soil washing. The calculated norm of washing water per plot was submitted in 2 stages (6.04 and 14.04.2016) in the volume of 6900 liters or 4600 m3 / ha. During the entire meliorative period, optimum soil moisture was maintained.

Results and discussion. The analysis of the water extract on the initial salt composition of the trial options shows the average degree of salinity (the amount of salts is 0.5-0.7%). Salts are represented by soda-sulphate chemistry (table 1).

Table 1 – Initial composition of aqueous extract
of medium-sulphatesolonchak high-sodium hemihydromorphicsolonetz subzone of light gray soils, (mg-eqv) / %

Variant	Depth, cm	HCO^-_3	CO^{2-}	Cl^-	SO_4^{2-}	Ca^{2+}	Mg^{2+}	$Na^+ + K$	Total salts, %	pH
1. Control	0-20	1,44 0,087	Нет Нет	0,65 0,022	8,25 0,39	4,37 0,087	2,50 0,03	3,34 0,076	0,692	8,0
	20-40	1,62 0,098	Нет Нет	0,55 0,019	8,38 0,40	4,75 0,095	2,75 0,03	3,05 0,070	0,715	8,2
	40-60	1,70 0,103	0,37 0,011	0,60 0,021	8,88 0,42	5,00 0,1	2,88 0,034	3,70 0,085	0,774	8,2
2. Phospho-gypsum	0-20	1,12 0,068	Нет Нет	0,75 0,026	8,63 0,41	4,25 0,085	2,88 0,034	3,37 0,077	0,777	8,1
	20-40	1,56 0,095	Нет Нет	0,70 0,024	4,25 0,20	1,75 0,035	1,38 0,016	3,69 0,084	0,454	8,2
	40-60	1,64 0,100	0,48 0,014	0,60 0,021	4,13 0,19	2,25 0,045	1,50 0,018	3,10 0,071	0,459	8,3
3. Sulfur	0-20	1,48 0,090	Нет Нет	0,65 0,022	7,75 0,37	4,00 0,08	2,88 0,034	2,75 0,063	0,659	8,1
	20-40	1,92 0,117	Нет Нет	0,75 0,026	5,38 0,25	2,5 0,05	1,75 0,021	2,29 0,052	0,516	8,2
	40-60	2,32 0,141	0,60 0,018	0,75 0,026	4,38 0,21	2,00 0,04	1,25 0,015	4,80 0,110	0,560	8,5