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Influence of High-Siliceous Rocks on Agrochemical Properties of Soddy and Podzolic Soil and Yielding Capacity of Winter Wheat.

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ABSTRACT

The researches established a considerable improvement of agrochemical indicators of the soddy and podzolic sandy loam soil when using high-siliceous rocks (diatomite, zeolite and bentonite clay) as a fertilizer. In cultivating winter wheat the application of diatomite in a dose of 6 t/hectare into the soil is the most effective way that made it possible to increase the grain yield by 0,59 t/hectare (in control - 2,5 t/hectare).

Keywords: silicon, high-siliceous rocks, agrochemical properties of the soil, winter wheat.

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INTRODUCTION

Results of numerous studies of domestic and foreign authors testify to a positive role of silicon in the life of plants [1-5]. At the same time it was shown that in connection with an irretrievable loss of silicon the deficit of available silicon (monosilicon acid) is possible in the process of growing crops (from 30 to 700 kg/hectare a year) [4] on any soils.

Lack of available silicon can be compensated by siliceous fertilizers which are now applied only abroad (the USA, Japan, Brazil, Mexico, China, India, etc.) [6]. In our country they were not manufactured and in the nearest future they are unlikely to be produced. At the same time Russia possesses tremendous stocks of high-siliceous rocks with a high content of amorphous (available) silicon which has a marked positive effect comparable in some cases to efficiency of mineral fertilizers [7, 8].

The positive effect from their use in agriculture is conditioned by two unique features: adsorptive and structural characteristics and high content of amorphous silicon. However, efficiency of high-siliceous rocks in the system of fertilization of crops is determined by many factors and, first of all, their influence on a condition of the soil- plant system in specific soil and climatic conditions. Besides, the use of high-siliceous rocks in agricultural industry and in particular, for ecological purposes, is restrained by lack of technologies of applying these materials. The last factor determines the importance of conducted researches.

Objects, conditions and methods of study. Objects of study were:

– high-siliceous rocks - diatomite, zeolite and bentonite clay and their generalized chemical characteristics is given below;

Rock	Element in oxide form (% for absolute dry matter)					
	SiO_2	SiO_2 in amorphous form	K_2O	P_2O_5	CaO	MgO
Diatomite	83,1	42,1	1,25	0,05	0,52	0,48
Zeolite	56,6	26,7	1,25	0,23	13,3	1,90
Bentonite	52,3	33,4	0,92	0,12	5,49	3,03

– the soddy and podzolic sandy loam soil with the humus content of 1,2%, with the soil solution reaction of average acidity (4,8 units of pH_{KCl}) and average supply with mobile compounds of phosphorus (86 mg/kg) and potassium (110 mg/kg according to Kirsanov);

– the winter wheat variety - Moskovskaya 39.

Small plot experiments (the area of an accounting plot of 1 sq.m), included the following variants: control (K) without application of high-siliceous rocks, variants with three doses of diatomite (D1 = 3 t/hectare, D2 = 6 t/hectare, D3 = 12 t/hectare), zeolite (Z1, Z2, Z3 – doses are similar to diatomite) and bentonite clay (B1, B2, B3 the doses are also similar). A layout of plots was randomized, replication – quadruple, analytical replication - triple.

Agrotechnology of crop cultivation – commonly accepted for small plot experiments, all works were carried out manually. Wheat was harvested in the phase of complete grain ripeness (2015). All analyses of soil and plant samples were carried out according to corresponding state standard specifications.

RESEARCH RESULTS

The data on the content of mobile compounds of phosphorus, potassium and silicon as well as values of soil solution reaction and their fluctuation when high-siliceous rocks were applied in the soil are given in the table below.

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Agrochemical values of the soddy-podzolic soil after application of high-siliceous rocks

№	Variant	pH_{KCl}, units pH	Content of mobile compounds of nutrients in the soil, mg/kg				
			P_2O_5	K_2O	SiO_2		
					current	potential	active
1	Control	4,81	90	107	16	213	370
2	Diatomite 3 t/ha	4,92	110	127	29	317	602
3	Diatomite 6 t/ha	5,06	122	140	36	523	880
4	Diatomite 12 t/ha	5,13	126	134	34	506	848
5	Zeolite 3 t/ha	5,04	99	118	22	281	499
6	Zeolite 6 t/ha	5,21	117	132	24	330	565
7	Zeolite 12 t/ha	5,16	112	130	29	409	701
8	Bentonite 3 t/ha	4,94	103	111	24	308	548
9	Bentonite 6 t/ha	5,14	121	124	33	476	808
10	Bentonite 12 t/ha	5,10	119	127	32	462	782
	LSD_{05}	0,22	11	15	4	51	65

First of all, general regularity attracts attention in their analysis: average doses of high-siliceous rocks are more effective whereas in case of their further increase (to 12 t/hectare) a decline in values was observed or they remained at the same level. Agafonov E. V. and Khovansky M.B. [9] consider that, apparently, there is a suppression of microbiological activity processes due to this. We are inclined to adhere to this point of view as in our experiments a three-fold increase of a dose of high-siliceous rocks did not lead to reliable strengthening of biological activity of the soddy and podzolic soil. It remained at the same level, or in some indicators there was a tendency to its decrease.

When applying high-siliceous rocks in the soil there was an improvement of all of its considered agrochemical indicators. At the same time the greatest shift of pH_{KCl} towards acidity reduction of soil solution was observed in the variant with application of zeolite of 6 t/hectare (by 0,4 units pH) and bentonite (by 0,33 units pH) that is quite explainable by rather a high content of calcium oxide in them (13,3 and 5,49% respectively). Besides, a rise in content of mobile compounds of phosphorus and potassium in an arable layer of the soil was observed in the experiments.

The application of high-siliceous rocks was followed by a considerable improvement of silicon nutrition of winter wheat plants. So, in case of diatomite application the content of current silicon (monosilicon acid) on average increased by 13-20 mg/kg. The latter, undoubtedly, is caused by a high content of amorphous silicon dioxide in the rock (42,1%). From the tested rocks zeolite of the Khotynetsky deposit (26,7% of SiO2) differed in the smallest amount of amorphous silicon that did not make it possible to eliminate significantly a deficit of silicon in soil solution. It should be noted that in the soddy and podzolic soil there is a major deficit of available compounds of silicon [10]. Apparently, the latter became one of the causes of forming lesser yielding capacity of experimental crops in the variant with the use of zeolite in comparison with other high-siliceous rocks (diatomite and bentonite).

A change of the winter wheat grain yield depending on application of high-siliceous rocks as a fertilizer is provided in the figure.

A balanced mineral nutrition of plants in any soil and climatic conditions is the basis of a full manifestation of potential yielding capacity of crops. Application of diatomite formed the most suitable nutrition regime for winter wheat on the soddy-podzolic soil in our experiments that provided a yield gain from 0,29 (доза 3 t/ha) to 0,59 t/ha (a dose of 6 t/ha) (in control the grain yield - 2,51 t/ha), or it rose by 11-24 %.

Yielding capacity increase when zeolite was used as a fertilizer was lower in comparison with variants of diatomite application practically in 3 times. A rise of cropping power from the use of bentonite clay reached 0,19 and 0,42 t/ha (8 и 17 %) respectively with application of a single or double dose (3-6 t/ha). In view of

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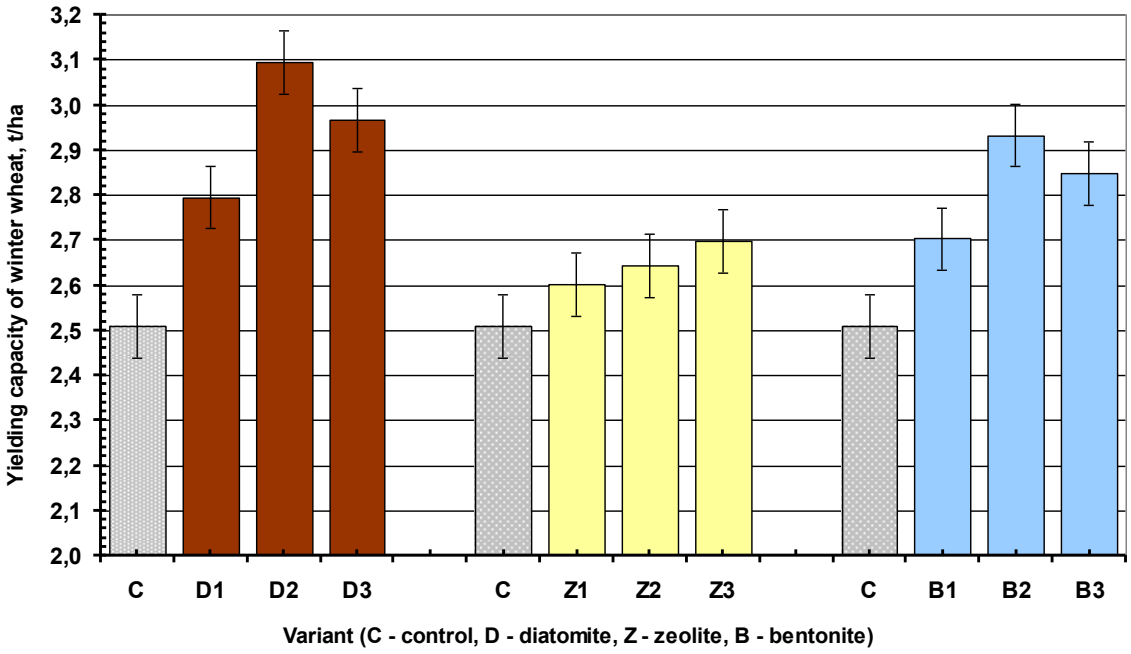
conducted experiments and data obtained it is possible to state that the factor limiting winter wheat yielding capacity in our experiments is a deficit of the silicon content available to plants in the soddy-podzolic soil.



Influence of high-siliceous rocks on winter wheat yielding capacity

CONCLUSION

High-siliceous rocks contribute to a considerable improvement of agrochemical indicators of the soddy-podzolic sandy loam soil, and also deficit elimination of available silicon in it. From the tested rocks in winter wheat cultivation the application of diatomite in a dose of 6t/ha was the most efficient and this enables to create the most suitable nutrient status in the arable layer including in the content of available silicon in it.

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