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The effect of phosphogypsum and organic fertilizers on the soil structure and cotton yield

[1] Aliev Jurakul Kholikulovich, [2] Shodmanov Makhkam

[1]Independent Researcher, Department of Farming and Land Reclamation,
[2]Candidate of Agricultural Sciences, Associate Professor, Department of Farming and Land Reclamation,
Tashkent State Agrarian University, 100140, University streeet-2, Tashkent, Uzbekistan

Abstract: *This article provides information that application of 10 t/ha of manure and 15-20 t/ha of phosphogypsum to the soil once every three years simultaneously with autumn plowing improves the structure and the agrochemical properties of the soil, which helps create optimal conditions for growth and cotton development, as well as increasing its yield. In variants with soil application of 10 t/ha of manure + 15 t/ha of phosphogypsum and 10 t/ha of manure + 20 t/ha of phosphogypsum relatively to the control variant without adding manure and phosphogypsum, respectively, more cotton yields were obtained by 5.3 and 6, 8 c/ha.*

Key Words: *Phosphogypsum, cattle manure, cotton variety S-6524, organic fertilizers, agrophysical properties of the soil, soil structure, soil fertility, cotton yield, size of bolls.*

1. INTRODUCTION:

In the literature there is information that when applying phosphogypsum and composts, manure and other organic waste containing phosphogypsum in different ratios, soil fertility increases and the activity of beneficial microorganisms improves [2].

The effect of manure on phosphate fertilizers is of particular importance. First, the microorganisms digesting phosphorus from the fertilizer content protects it from the action of salts and prevents its transition to an arduous form. Secondly, organic fertilizers and humus absorb phosphorus and thus, to a certain extent, prevent its transition to a hard-to-reach form for plants. Third, under the action of soil enzymes and CO2, released in the process of respiration of microorganisms, as well as organic acids formed in the process of splitting organic fertilizers, the solubility of phosphate fertilizers increases and they become easily accessible for plants [4].

B.S.Musayev [4], in his many years of research, determined that cheap organic fertilizer, fuel can be obtained from organic waste and, based on the obtained outcomes, wrote that "Organic waste is an environmentally friendly fertilizer, cheap fuel and a source of additional income."

The creation of optimal water, air, heat and nutrient regimes of the soil and their regulation depends largely on its agrophysical properties, in particular, on its structure. Solid soil structure provides favorable agrophysical properties and leads to increased fertility [3].

For example, the soil structure to a certain extent improves with the introduction of phosphogypsum and organic fertilizers.

Specific research in this field can improve the agrophysical properties, in particular the structure, as well as soil fertility and increase the yield of cotton. It is what has determined the choice of topics for research.

2. MATERIALS AND METHODS:

Aims and objectives of the research. The aim of the research was to study the effect of the phosphogypsum and organic fertilizers use on the agrophysical, agrochemical properties of the soil, development and yield of cotton.

The research task was to: study the effect of phosphogypsum and organic fertilizers on the agrophysical, water-physical and agrochemical properties of the soil; determination of the effect of phosphogypsum and organic fertilizers on the growth, development and yield of cotton.

For the first time in the conditions of meadow soils on cotton crops, the effect of phosphogypsum and organic fertilizers on the agrophysical, water-physical, agrochemical properties of the soil, on the growth, development and yield of cotton has been studied.

Field experiments were carried out in conditions of meadow soils of the Tashkent region in 8 variants of 4 times recurrence (Table 1).

While the experiment, observations, calculations and analyzes, we used the methodology of the field experiment of B.A.Dospekhov [1985] and the Field Experience Methodology developed at UzSRCI [5].

Layout of plants 90×10×1. Cotton variety C-6524 was cultivated. Organic fertilizers, phosphogypsum was applied under the plowing soil in 2009, and in 2010-2012 studied their aftereffect.

Table 1: The experiment scheme

Variants	Background			Manure, t/ha	Phosphogypsum, t/ha	Bird dung, t/ha
	N	*P*	*K*			
1.	200	140	100	-	-	-
2.	200	140	100	10		
3.	200	140	100	20		
4.	200	140	100	10	5	
5.	200	140	100	10	10	
6.	200	140	100	10	15	
7.	200	140	100	10	20	
8	200	140	100	10	5	5

3. RESULTS AND DISCUSSION:

In 2009, phosphogypsum and organic fertilizers in various ratios and norms were introduced into the soil before autumn plowing in 2010-2012 their effect on agrophysical, in particular on soil structure, growth, development and yield of cotton was studied.

In our experiments, the effect of using phosphogypsum and organic fertilizers in various ratios on changes in the soil structure was revealed. The results are shown in table 2.

The analyzes of the structural condition show that in the variant where manure was applied at a rate of 10 t/ha, after dry sifting, the number of fractions with a size of 10-0.25 mm was 80.4%, and in the variant where 20 t/ha of manure were applied it was 81,8%, i.e., 2.0-3.4% more in comparison with the control variant. In the variant where 10 t/ha of manure + 5 t/ha Phosphogypsum was introduced, the number of these aggregates was 80.3%, in the variant where manure was introduced at a rate of 10 t/ha + Phosphogypsum 15 t/ha – it was 82.8%, in the variant where manure 10 t/ha + Phosphogypsum 20 t/ha – it was 84.2%. In the variant where manure was introduced at a rate of 10 t/ha + bird dung 5 t/ha + Phosphogypsum 5 t/ha, the number of fractions 0.25-10 mm in size was 80,4 %.

Table 2: The effect of different norms of phosphogypsum and organic fertilizers on the soil structure, (Number of aggregates in% to dry weight. Dry sifting/wet sieving, 2010-2012).

№	Variants	Layer, cm	Size of fractions, mm							
			>10	10-7	7-5	5-3	3-2	2-1	1-0,25	<0,25
	1	2	3	4	5	6	7	8	9	10
The number of aggregates, %										
1.	Monitoring (background)	0-30	12,1 -	13,4 -	11,3 -	11,5 5,30	12,1 12,1	15,5 16,2	14,6 17,4	9,5 49,0
2.	Background+ 10 t/ha of manure	0-30	11,2 -	11,0 -	11,1 -	12,3 5,3	11,5 11,9	19,5 16,9	15,0 18,3	8,40 47,6
3.	Background + 20 t/ha of manure	0-30	10,4 -	11,6 -	10,8 -	12,1 5,4	12,0 12,3	20,2 17,7	15,1 18,8	7,80 46,8
4.	Background + 10 t/ha of manure+5 t/ha of PHG	0-30	11,6	11,9 -	11,2 -	11,8 4,8	12,9 13,2	21,7 18,8	10,8 17,7	8,10 45,5
5.	Background + 10 t/ha of manure+10 t/ha of PHG	0-30	10,1 1	11,1 -	10,5 -	11,3 9,3	19,2 13,3	21,2 15,1	8,90 15,2	7,70 47,0
6.	Background + 10 t/ha of manure+15t/ha of PHG	0-30	10,7 -	11,7 -	10,1 -	12,0 8,6	18,5 13,9	22,0 15,7	8,5 15,8	6,50 46,0
7.	Background + 10 t/ha of manure+20 t/ha PHG	0-30	9,50 -	9,80 -	9,70 -	11,9 9,2	16,7 13,8	25,8 15,7	10,3 16,3	6,30 45,0
8.	Background + 10 t/ha of manure + 5 t/ha of bird dung + 5 t/ha of PHG	0-30	12,8 -	11,8 -	10,8 -	13,8 10,1	14,0 11,2	20,5 14,8	9,50 17,5	6,80 46,4

**PHG - Phosphogypsum*

The process of structure formation is relatively slow. The most intensive structure formation is observed on soils of heavy texture, rich in organic matter and mineral colloids, when exposed to plants with a strong root system and fertilizer application, especially manure.

One can see not only a large positive effect of plants on the soil structure, but also the positive role of manure and mineral fertilizers in structuring. The largest number of structural aggregates larger than 0.25 mm is formed under perennial grasses, or when organic fertilizers are applied.

The amount of water resistance of the structural elements of the soil also depends on the content of divalent cations in the soil. The more two-year cations, the more water-resistant aggregates in the soil.

In the variants where manure was introduced intro in the norm of 10 and 20 tons, the number of water-resistant units increases significantly as compared with the control variant.

Calcium contained in the phosphogypsum composition is important in restoring and strengthening the soil structure. The results show that with the introduction of phosphogypsum at a rate of 15 ton/ha with manure (10 t/ha) and phosphogypsum at a rate of 20 t/ha with manure (10 t/ha), the soil structure improves markedly. As a result, the agrophysical properties of the soil are improved , the number of water-intensive units increases.

Therefore, the introduction of phosphogypsum and organic fertilizers improves the structure and strength of the aggregates to the water, this provides an increase in the effective fertility of the soil.

In field experiments, we revealed the effect of the use of manure and phosphogypsum in various ratios and norms on the yield of cotton in the background of mineral fertilizers (Table 3).

Table 3: The effect of phosphogypsum and organic fertilizers on cotton yields, kg/ha

№	Variants	Years			Yield on average for 3 years	Yield increase
		2010	2011	2012		
1	$N_{200}+P_{140}+K_{100}$	33,7	33,9	32,6	33,4	+0
2	*NPK*+ 10 t/ha of manure	35,8	36,3	34,7	35,6	+2,2
3	*NPK* +20 t/ha of manure	37,2	38,8	36,9	37,6	+4,2
4	*NPK* + 10t/ha of manure +5 t/ha of PHG	36,4	37,7	35,7	36,6	+3,2
5	*NPK* + 10 t/ha of manure +10 t/ha of PHG	37,2	38,6	35,9	37,2	+3,80
6	*NPK* +10 t/ha of manure +15 t/ha of PHG	38,6	39,8	37,7	38,7	+5,30
7	*NPK* + of manure +20 t/ha of PHG	40,0	41,3	39,3	40,2	+6,80
8	*NPK* + 10 t/ha of manure + 5 t/ha of bird dung + 5 t/ha of PHG	37,9	39,5	37,2	38,2	4,80
	LSD_{05}, c/ha	1,60	1,40	1,25		
	LSD_{05}, %	4,32	3,66	3,46		

From the data presented it can be seen that in the control variant using only mineral fertilizers (*NPK*), the yield of cotton, respectively, was 33.7; 33.9 and 32.6 centners per hectare, and on average for 3 years - 33.4 centners per hectare.

It was observed that in this variant, the cotton harvest in 2012 compared to 2010 decreased by 1.1 centners per hectare. This decrease can be related to a decrease in soil fertility. In two or three options with the introduction of 10 and 20 tons of manure on the background of mineral fertilizers relative to the control variant over three years, on average, respectively, there was more cotton harvest by 2.2 and 4.2 c/ha.

In the variants where 10 t/ha of manure with 15 t / ha of phosphogypsum and 10 t/ha of manure with 20 t/ha of phosphogypsum were applied, the three-year average yield of cotton was 38.7-40.2 c/ha, and relative to the control variant more yield was obtained by 5.30-6.80 c/ha. In these two variants, when compared with the variant where mineral fertilizers were applied and 20 t/ha of manure, 2.60 c/ha of additional yield was obtained.

And when using 10 t/ha of cattle manure + 5 t/ha of bird dung + FG 5 t/ha in the background of mineral fertilizers, the cotton crop averaged 38.2 centners/ha over the three years and more related to the control was obtained 4.8 centners per hectare, and in relation to manure application rates - 0.6–2.6 centners/hectare.

4. CONCLUSION:

To conclude, in the conditions of meadow soils in the Tashkent region, the use of 10 t/ha of manure and phosphogypsum at rates of 15 and 20 t/ha in the background of mineral fertilizers relatively to the control variant improves the soil structure and ensures a greater yield of cotton by 5.30 and 6,8 c/ha.

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