

Influence of Repeated Crops, Predecessors and Differentiated Use of Mineral Fertilizers on the Yield of Winter Wheat (In Conditions of Typical Sierozem Soils Committed Irrigation Erosion)

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Abstract: Based on the results of the study, criteria for the selective introduction of suitable secondary crops (beans, mung bean, soybeans) and perennial alfalfa and mineral fertilizers were selected, which reduce the negative effects of irrigation erosion, increase soil fertility, and ensure the production of high-quality grain from winter wheat. The results show that, after repeated crops, the volume mass of the 0-30 cm layer of soil is 0.03-0.05 g / cm³ less than in the case of unwashed soils compared to the initial value, the porosity is 1.9-2.5% higher, in heavily washed soils respectively 0.02-0.04 g / cm³ less and 1.7-2.3% higher, compared to the control of soil water permeability 38.3-51.2 m³ / ha and at the end of the period of application 24.9-42.7 m³. Grain yield in unwashed varieties under the influence of repeated crops and mineral fertilizers (N₁₅₀P₁₀₅K₇₅ kg / ha), providing favorable conditions for full germination, growth and development of winter wheat seeds (92.3-91.5%), providing grain yield in unwashed soil variants (68.8-72.4 c / ha), protein content from 14.8-15.6 and gluten 31.8-32.4%, mineral fertilizers (N₁₈₀P₁₂₆K₉₀ kg / ha) after repeated sowing of the above in areas with strongly washed soils in the applied variants are 69.2-74.5 c / ha, 15.2-15.8 and 32.1-32.8%, respectively, plays an important role in ensuring food security of the population during the current coronavirus pandemic.

Keywords: typical sierozem, irrigation erosion, fertility, winter wheat, grain yield, quality, repeated crop

Introduction

The use of agricultural technologies for the cultivation of secondary, intermediate and green manure crops to prevent and control the degradation of the irrigated soil cover in the Republic of Uzbekistan is the basis for improving the water-physical, agrochemical and microbiological properties and biological activity of the soil [3].

Today, there are 1,094 million people worldwide hectares or 56% of the area is irrigated [14]. In Uzbekistan alone, irrigated arable land is 685.7 thousand hectares, including 121.9 thousand hectares in Samarkand region [1]. Under the influence of irrigation erosion, humus in typical gray soils and some of the nutrients necessary for the growth and development of major agricultural crops: nitrogen, phosphorus, potassium, etc. are washed away by irrigation water and leave the crop fields. As a result, soil fertility, yields of cotton, winter wheat, corn and other crops are reduced by an average of 30-40%, and residues of mineral fertilizers and pesticides in the soil fall into water sources, adversely affecting the environment [7; 8].

In order to ensure food security of the population in Uzbekistan, special attention should be paid to maintaining and increasing the fertility of typical sierozem soils subject to irrigation erosion in order to grow high-quality grain from winter wheat. In the conditions of irrigated agriculture of the Republic, which has the ability to grow 2-3 times a year, one of the most important issues in increasing the fertility of irrigated eroded soils, the selection of optimal secondary and past crops, the development of agro-technologies for their cultivation.

Farms and cluster farms in the country, based on their economic and social interests and goals, use the following crops: legumes (mung bean, soybeans, beans, china, lentil), grain (corn, white corn, sugar corn), oilseeds (flax, sesame, sunflower, safflower) can be planted selectively. However, given the current market economy and declining soil fertility, it is advisable to grow more legumes as a secondary crop in irrigated eroded sierozem soils. This is due to the fact that they serve, firstly, to increase the fertility of gray soils that have lost their fertility due to erosion, and secondly, to provide the population with valuable, protein-rich

foods and adequate feed for livestock. Today, based on the experience of a number of countries around the world (USA, Brazil, India, China, etc.), the task of solving the main problems of crop rotation in farms, clusters and private farms is assigned to legumes [8; 9; 10; 11; 13.]. When these crops are grown as secondary crops, twice the grain yield is obtained in one field, most importantly, conditions are created to maintain and increase the fertility of typical sierozem soils subject to irrigation erosion, creating a favorable and environmentally friendly environment for plants in the soil [12].

Harvesting at least twice a year from agricultural crops grown under typical eroded sierozem soils, to meet the population's demand for food, to maintain and increase soil fertility, to grow legumes as a nitrogen-fixing crop in the soil. One of the most pressing issues is the scientific substantiation of the impact of the selection of effective varieties, their cultivation and differentiated application of mineral fertilizers on the yield and quality of winter wheat.

Research objectives: Determination of the impact on the cultivation of rich, high-quality grain from winter wheat and soil fertility by determining the optimal norms for the selection, cultivation and application of mineral fertilizers stratified by erosion, ensuring the maintenance and increase of fertility of typical sierozem soils of Samarkand region.

Research tasks: to study the technology of growing leguminous crops in the conditions of typical sierozem soils affected by irrigation erosion and to distinguish them from the most suitable type for these conditions; to determine the amount of nutrients and root residues in them, the amount of NPK and nutrients returned to the soil in areas where the soil of the field is not washed and strongly washed; to determine the impact of repeated legume-grain crops on the agrophysical, agrochemical and microbiological properties of eroded soils, winter wheat yield and technological quality of grain, and to assess the economic efficiency of winter wheat cultivation.

Materials and Methods

In order to carry out the above tasks, the objects of our research are: typical sierozem soils prone to irrigation erosion, different rates of mineral fertilizers and the method of using them by differentiation, "Grom" variety of winter wheat, "Tashkent" as a secondary crop, "Ravot, Mahsuldor" as beans, pea "Vostok-55", soybean "Orzu", alfalfa "Dimitra" varieties were grown. Field experiments in 2018-2020 in the typical structure of irrigated eroded gray soils of the farm "Mansurov Muzaffar fayzli zamini" in Jambay district of Samarkand region in the following structure: 1. Autumn wheat - plow (control) + autumn wheat, 2. Beans + autumn wheat; 3. Mung bean + autumn wheat; 4. Soybean + autumn wheat; 5. Pea + autumn wheat; 6. Alfalfa+ autumn wheat was planted. The studies were conducted in 4 repetitions, with a total area of 901.6 m² (length of field 161 m, of which 61 m of soil was unwashed, 72 m of heavily washed and 28 m of washed soil, width 8 rows x 0.7 m = 5.6 m x 161 = 901.6 m²), of which 450.8 m² were taken into account, the options were placed schematically in one tier. In the experimental field, the groundwater is located at a depth of 14-16 meters, so these soils are not salted with harmful salts. Medium and light sand on the mechanical composition of the soil, the slope of the field under study is 0.005 meters. The amount of humus in the plowed (0-30 cm) layer of strongly washed and unwashed parts of the experimental field soils was 0.885-1.152%, total nitrogen 0.73-0.117, phosphorus 0.112-0.194, potassium 1.975-2.216%, respectively, the amount of their mobile forms: nitrate nitrogen (N-NO₃)-11.54-16.11, mobile phosphorus (P₂O₅)-12.66-15.83 and exchangeable potassium (K₂O) - 230-270 mg/kg in soil respectively.

The agrophysical and agrochemical properties of the studied field soils were analyzed in the following ways: - Mechanical composition of typical gray soils subject to irrigation erosion is analyzed by way of pipette, the amount of water-resistant aggregates in the soil according to N.A.Kachinsky, volume mass by the way of cylindrical method – 4 repetitions, comparison mass by pycnometer method 4 repetitions, soil porosity by calculation, soil water permeability (m³/ha) were analyzed by N.A.Kachinsky method [4] in 10 repetitions in unwashed and strongly washed parts of the field soil.

Table 1
Scheme of the experiment

No	Options of the experiment	Soil washout Rate	Rate of application of mineral fertilizers to repeated and	The rate of mineral fertilizers applied to winter wheat after
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opt			previous crops, kg/ha			repeated and previous crops, kg/ha		
			N	P ₂ O ₅	K ₂ O	N	P ₂ O ₅	K ₂ O
1	Autumn wheat (control) + autumn wheat	Unwashed	-	-	-	-	-	
2		washed away	-	-	-	-	-	
3	Autumn wheat + autumn wheat (control)	Unwashed	-	-	-	180	126	90
4			-	-	-	150	105	75
5		washed away	-	-	-	180	126	90
6			-	-	-	150	105	75
7	Beans + autumn wheat	Unwashed	90	63	45	180	126	90
8			60	42	30	150	105	75
9		washed away	90	63	45	180	126	90
10			60	42	30	150	105	75
11	Mung bean + autumn wheat	Unwashed	90	63	45	180	126	90
12			60	42	30	150	105	75
13		washed away	90	63	45	180	126	90
14			60	42	30	150	105	75
15	Soy + autumn wheat	Unwashed	90	63	45	180	126	90
16			60	42	30	150	105	75
17		washed away	90	63	45	180	126	90
18			60	42	30	150	105	75
19	Pea + autumn wheat	Unwashed	90	63	45	180	126	90
20			60	42	30	150	105	75
21		washed away	90	63	45	180	126	90
22			60	42	30	150	105	75
23	Alfalfa (1 year) + autumn wheat*	Unwashed	90	120	90	180	126	90
24			60	90	60	150	105	75
25		washed away	90	120	90	180	126	90
26			60	90	60	150	105	75

Explanation: * Nitrogen fertilizers were applied to alfalfa in the first year

-Humus in the soil by the method of I.V.Tyurin GOST-26213; nitrate nitrogen - by ion-selective method, GOST-13496-10; total nitrogen, phosphorus, potassium were determined in one sample by I.M.Maltseva, L.P.Gritsenko method, mobile phosphorus by B.P.Machigin and exchangeable potassium P.V.Protasov methods, carbonates by Knop method [4].

Norms of nitrogen 60-180, phosphorus 90-126 and potassium 60-90 kg/ha were used in the feeding of autumn wheat in the experimental field. At the same time, 80% of the annual rate of phosphorus fertilizers was applied under plowing, the remaining 20% at the same time as sowing seeds, all annual rates of potassium were given under plowing, and annual rates of nitrogen fertilizers were given at the recommended intervals for crops studied during plant growth.

Ammonia nitrate (NH₄NO₃-N-34,5), ammophos (NH₄ H₂PO₄ -N-10 %, P₂ O₅ - 46 %), potassium chloride (Kl – K₂O – 58-60 %) were used in the experimental field from nitrogen fertilizers.

All phenological observations and biometric measurements carried out at the experimental site were performed on replanted crops (beans, mung bean, soybeans, pea pods) and on autumn wheat modules (0.5 - 1.0 m²) marked in each variant and repetition. In this case, the germination rate of autumn wheat seeds,%; in developmental periods (accumulation, tubing, germination, flowering, milk-wax and full ripening) 25-75%; number of autumn wheat bushes; before winter, in early spring, at the end of the validity period (in pieces per 1 m²); Distribution and mass of plant root system by soil layers, number of spikelets per 1 m², spike

length and number of grains in it, mass of 1000 grains per spike, grain per 1 m² of grain, vitreousness and nature of grain TU Uz-8-115-9,7 according to GOST - 13586, 5-93, the protein content of the grain was determined by the Barnstein method, the yield - moisture content of the grain was adjusted to the standard (14%) [5]. Statistical analysis of the data was performed using B.A.Dospekhov's method [2] using Microsoft Excel program.

Results and Discussion

The results of our research have shown that repeated crops planted after their predecessors (autumn wheat) have improved soil agrophysical, water-physical and reclamation conditions and maintained soil fertility, leaving ditches and root remnants in the soil. The volume mass of the top seedbed (0-30 cm) of typical sierozem soils subject to irrigation erosion is 1.33 - 1.34 g/cm³ in the unwashed part of the field soil, porosity 50.8 -51.6%, and 1.35 in the heavily washed part of the soil. - 1.37 g/c m³ and 48.7 -49.5%, taking into account the fact that these figures varied under the influence of repeated crops at the beginning of the period of application of autumn aestivum wheat. For example, the volume mass of the soil of the control (plowed) variant of the unplanted crop increased by 0.02-0.03 g/cm³ compared to the initial value in the unwashed part of the soil of the experimental area, while the porosity decreased by 1.8-2.3%, it was noted that these values were 0.03-0.05 g/cm³ more and 2.1-3.4% less, respectively, in areas where the soil was heavily washed.

Volume mass of the plowed (0-30 cm) layer of soil after repeated crops (beans, mung bean, soybeans, peas, alfalfa) grown under typical sierozem soils subject to irrigation erosion, 0.03 - 0.05 g/cm³ in the unwashed part of the soil of the experimental area and increased porosity by 1.9-2.5%, while these values were found to be less than 0.02-0.04 g/cm³ and 1.7-2.3% higher, respectively, in strongly washed soils.

It was observed that the repeated crops grown in the strongly washed part of the soil of the experimental area had a significant effect, first of all, on the volume mass of the soil. The results of the study showed that, regardless of the type of repeated crops, as the soil fell into the bottom layers, its volume increased and its porosity decreased to 1.36 -1.39, after sowing and 1.37 -1.41 g/cm³ at the end of the autumn wheat period, and the porosity of the soils in this layer is 47.6-48.5; 49.3 - 50.2 and 48.6 - 49.5% respectively. These data show that repeated crops (beans, mung bean, soybeans, peas, alfalfa) reduce the bulk mass of soils by 0.03 - 0.05 g/cm³, increase the porosity by 2.3 - 2.8%, followed by the growth of sown autumn wheat and it was found that the most favorable conditions for its development were created.

The results obtained in the process of determining the effect of repeated crops on soil water permeability in the cultivation of autumn wheat in the conditions of typical gray soils subject to irrigation erosion show that this property of the soil is inextricably linked with its washing rate, density and porosity. For example, in the uncontrolled part of the experimental field, in the control (plowing) variant of repeated sowing, 138.5 m³/ha in the 1st hour before sowing of autumn wheat seeds or 362.3 m³/ha in the total 3 hours, 4-5-6 215.2 m³/ha or 577.5 m³/ha in 6 hours, at the end of the autumn wheat period it was formed 105.8 or 304.4 m³/ha, 167.5 or 471.9 m³/ha, respectively.

In our study, in order to increase the fertility of typical gray soils subject to irrigation erosion and to protect them from washing, the water permeability of soils in the varieties grown by repeated crops (beans, mung bean, soybeans, peas, alfalfa) in the 1st hour before sowing of autumn wheat seeds 138.6-151, 2 or 356.3-388.5 m³/ha in 3 hours in total, 209.5-230.2 m³/ha in 4-5-6 hours of observations, or 585.8 - 618.7 m³/ha in 6 hours in total. At the end of the period, these indicators were 109.2-118.5 or 275.6 -290.3 and 160.4-182.7 or 486.8-521.6 m³/ha respectively. The data show that the high water permeability of soils in the unwashed and heavily washed areas of the experimental area was observed in all variants, depending on the type of repeated crop, in the first 3 hours of the experiment, and then the water permeability of soils in both parts was equalized in 5-6 hours. Thus, repeated crops grown under typical gray soil conditions under irrigation have a positive effect on soil water permeability, with 38.3-51.2 and less at the end of the control period than in the control (repeated sowing, plowing) period before sowing of autumn wheat seeds in heavily washed soils. It was taken into account that 24.9-42.7 m³/ha provided more water absorption than normal.

After harvesting of replanted crops (beans, mung bean, soybeans, peas, alfalfa) grown to increase the fertility and autumn wheat yields of typical gray soils subject to irrigation erosion, the amount of mobile nitrogen, phosphorus and exchangeable potassium in the soil in the unwashed and heavily washed areas

positively affecting the initial index (N-NO₃ -16,14-11,54; P₂ O₅ – 15,83-12,66; K₂O –270-230 mg/kg) in the top seedbed (0-30 cm) 4.5 - 3.8 according to the above shown; 3.2 -2.7 and 26-20 mg/kg were found to be abundant in the soil, creating the most favorable conditions for full germination, growth and development of autumn wheat seeds and cultivation of high and quality grain crops.

No. opt.	Options of the experiment	soil washout rate	NPK norm kg/ha	Germination of winter wheat seeds		number of plants until winter, m ²	Overwintered plants			winter wheat that was saved at the end of the period of validity	
				units/m ²	%		units/m ²	%	The number of plants that died in winter, %	units/m ²	%
1	winter wheat (control option without fertilizer)	Unwashed	-	426	85,2	415	360,5	86,8	13,2	277,8	75,4
2		washed away	-	413	82,6	399	320,0	80,2	19,8	252,6	72,6
3	winter wheat (control option)	Unwashed	N ₁₈₀ P ₁₂₆ K ₉₀	437	87,4	429	384,8	89,7	10,3	301,3	78,3
4			N ₁₅₀ P ₁₀₅ K ₇₅	432	86,5	424	377,4	89,0	11,0	291,4	77,2
5		washed away	N ₁₈₀ P ₁₂₆ K ₉₀	434	86,8	426	379,9	89,2	10,8	295,5	77,8
6			N ₁₅₀ P ₁₀₅ K ₇₅	427	85,4	418	369,1	88,3	11,7	282,3	76,5
7	Beans+ autumn wheat	Unwashed	N ₁₈₀ P ₁₂₆ K ₉₀	454	90,8	449	412,1	91,8	8,2	334,6	81,2
8			N ₁₅₀ P ₁₀₅ K ₇₅	443	88,6	437	398,8	91,3	8,7	320,4	80,4
9		washed away	N ₁₈₀ P ₁₂₆ K ₉₀	447	89,3	441	404,5	91,6	8,4	326,8	80,8
10			N ₁₅₀ P ₁₀₅ K ₇₅	438	87,5	432	393,8	90,9	9,1	313,5	79,6
11	Mung bean+ autumn wheat	Unwashed	N ₁₈₀ P ₁₂₆ K ₉₀	553	90,6	450	416,7	92,6	7,4	448,0	83,5
12			N ₁₅₀ P ₁₀₅ K ₇₅	447	89,3	443	407,5	92,0	8,0	337,2	82,7
13		washed away	N ₁₈₀ P ₁₂₆ K ₉₀	449	89,8	447	413,4	92,5	7,5	343,5	83,1
14			N ₁₅₀ P ₁₀₅ K ₇₅	443	88,5	439	404,2	91,8	8,2	333,1	82,4
15	Soy +	Unwashed	N ₁₈₀ P ₁₂₆ K ₉₀	457	91,3	454	421,6	92,	7,1	357,5	84,

	autumn wheat	d	0					9			8
16			N ₁₅₀ P ₁₀₅ K ₇₅	453	90,6	449	414,8	92,4	7,6	346,8	83,6
17		washed away	N ₁₈₀ P ₁₂₆ K ₉₀	454	90,8	452	418,5	92,8	7,2	352,4	84,5
18			N ₁₅₀ P ₁₀₅ K ₇₅	447	89,3	444	409,4	92,2	7,8	339,8	83,0
19	Pea + autumn wheat	Unwashed	N ₁₈₀ P ₁₂₆ K ₉₀	452	90,5	447	410,2	91,6	8,4	334,3	81,5
20			N ₁₅₀ P ₁₀₅ K ₇₅	443	88,7	438	399,1	91,1	8,9	321,7	80,6
21		washed away	N ₁₈₀ P ₁₂₆ K ₉₀	446	89,1	442	404,8	91,4	8,6	328,0	81,0
22			N ₁₅₀ P ₁₀₅ K ₇₅	441	88,2	436	396,6	91,0	9,0	316,5	79,8
23	Alfalfa (1 year) + autumn wheat*	Unwashed	N ₉₀ P ₁₂₀ K ₉₀	462	92,4	459	429,8	93,5	6,5	375,1	87,4
24			N ₆₀ P ₉₀ K ₆₀	459	91,8	456	424,5	93,1	6,9	368,5	86,8
25		washed away	N ₉₀ P ₁₂₀ K ₉₀	461	92,2	458	427,8	93,4	6,6	373,0	87,2
26			N ₆₀ P ₉₀ K ₆₀	457	91,3	454	421,7	92,9	7,1	364,8	86,5

In our experiments, the number of winter wheat bushes before wintering in fields with soybeans and mung bean after repeated and previous crops was 454-450 units/m², after wintering was 421.6-416.7 units/m², during wintering 7.1-7.4% of plants died, at the end of the period of operation, compared to the control (without fertilizer), the number of bushes was preserved at 97.7-70.2 units/m², and even in the areas with strong washed soil, these indicators were consistent until the winter: 451-447 units/m², 418, 5-413.4 pieces/m², 7.2-7.5% and 97.8-90.9 pieces/m² were found to be preserved.

The soil of the experimental field grown in the unwashed control variant was 8.2 cm long, the number of grains per grain was 13.4, the number of grains of per grain was 34.5, and the mass of 1000 grains of per grain was 1.29 and 34.8 grams, respectively, these figures were taken into account that in the strongly washed part of the soil of this area, it is 7.9 cm, 12.1 units, 32.7 units 1.27 and 32.6 grams, respectively. Indicators of structural elements of autumn wheat yield under the influence of norms of repeated crops and mineral fertilizers (N₁₅₀ P₁₀₅ K₇₅ and N₁₈₀ P₁₂₆ K₉₀ kg/ha) - length of grain is 1.5 - 0.9 cm if the number increased from 1.4 to 1.1 units, the number of grains in one grain increased from 0.8 to 0.5 units, and the mass of 1000 grains in one grain increased to 1.23-1.15 and 3.5-2.9 grams, respectively, it was noted that these figures were slightly higher in the alfalfa variant.

In our experiments on typical sierozem soils subject to irrigation erosion, it was observed that the stratified application of repeated crop and mineral fertilizer rates had a significant positive effect on the yield and quality of autumn aestivum wheat grains. For example, in the unwashed soil control (non-replanting) variant of the soil of the experimental field, the autumn wheat grain yield was 15.7-16.5 c/ha, and in the heavily washed part of the experimental field, the grain protein content was 14.2-15.4 c/ha in amount, 11.8-12.4%, gluten 27.8-28.2% and 10.6-11.4, 26.7-27.5% respectively;. Under these conditions, the average yield of autumn wheat in the unwashed soil variants planted after repeated crops (beans, mung bean, soybeans, peas, alfalfa) and mineral fertilizers (N₁₅₀ P₁₀₅ K₇₅ kg/ha) was moderate (68.8-70.4 c/ha), grain protein content 14.8-15.6 and gluten 31.8-32.4%, grown after the above repeated crops and applied in the amount of fertilizers (N₁₈₀ P₁₂₆ K₉₀ kg/ha), autumn wheat in areas with strongly washed soils grain yield (69.2-71.5 c/ha) and the protein content of the grain was 15.2-15.8% and gluten 32.1-32.8%.

Conclusion

1. Optimal secondary crop of beans, mung bean, soybeans and perennials, which reduces the negative effects of erosion processes, increases soil fertility, improves its water-physical, agrochemical properties, provides high and high-quality grain harvest from winter wheat in the conditions of typical sierozem soils of Samarkand region optimal norms for the application of stratification of alfalfa and mineral fertilizers, taking into account the degree of soil washing, were selected.

2. It has been identified that after repeated crops (beans, mung bean, soybeans, peas, alfalfa) grown in typical gray soils subject to irrigation erosion, the volume mass of the top seedbed (0-30 cm) in areas where the soil was not washed before sowing autumn wheat seeds 0.03- 0.05 g/cm³ less, porosity 1.9-2.5% higher respectively, and in the heavily washed part of the soil it is 0.02-0.04 g/cm³ less and 1.7-2.3% more soil water permeability - 38.3-51.2 m³/ha compared to the control (non-replanted) and 24.9-42.7 m³/ha at the end of the application period, providing more water absorption, complete winter wheat seeds (92.3-91.5 %) created the most favorable conditions for germination, growth and development.

3. Under the influence of repeated crops and mineral fertilizers (N₁₅₀ P₁₀₅ K₇₅ kg/ha), when the soil of the experimental field was not washed and strongly washed control (not replanted), the yield of autumn wheat was 16.5 and 15.4 c/ha, respectively, grain yield in unwashed soil variants (68.8-70.4 c/ha), grain protein 14.8-15.6 and gluten 31.8-32.4%, mineral fertilizers after repeated crops in areas with washed soil (N₁₈₀ P₁₂₆ K₉₀ kg/ha) in the used variants, the yield (60.2-71.5 c/ha) and the protein content of the grain was 15.2-15.9 and the gluten was 32.1-32.8%, during the current coronavirus pandemic period there is an important role in ensuring food security of the population.

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