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Changes in the granulometric composition of Zarafshan river soils under irrigation and comparative analysis

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Abstract. According to the granulometric composition of all soil types (typical, light gray, gray-meadow and meadow-alluvial) located on terraces I - II - III of the Zarafshan oasis, it is mainly medium and heavy sand, physical clay (<0.01 mm) and large dust (0.05 – 0.01 mm), medium dust (0.01 – 0.005 mm), fine dust (0.005 – 0.001 mm) and silt particles due to irrigation for many years reduced sand particles and increased the amount of dust and silt particles in all layers of the soil . It is explained by the erosion of feldspar, mica-like substances in the sand particles, the increase of dust and silt particles in the upper layers of the soil as a result of irrigation, and the fact that certain parts are washed to the lower layers of the soil.

1. Introduction

Widespread in the long-established farming regions of Uzbekistan thick agro-irrigated soils are, and these soils are distinguished as an independent type of oasis soils.

The soils of the middle reaches of the Zarafshan River are scattered in ancient agricultural oases. They were formed from natural gray soils during irrigation. However, as a result of human activities, the morphogenetic characteristics of the soil profile characteristic of natural gray soils have changed radically.

The process of soil formation under the influence of irrigation led to changes in the microclimate, moisture biota, distribution of salts and flora of these lands. Due to irrigation, the non-washable water regime of gray soils is replaced by the irrigation water regime. Periodic irrigation moistened the soil layer several times and led to the acceleration of the eluvial process.

During 1920-1932 under the leadership of N.A. Dimo, M.A. Orlov, N..B. Bogdanov, M.A. Pankov, D.M. Klavdienko and others compiled soil maps of irrigated lands in Central Asia, including Uzbekistan and soil types are described.

Orlov [1] defined it as "Culturally irrigated" soils. Currently, Uzbek soil scientists have developed a classification of gray soil region and oasis soils of the desert zone. The classification of irrigated soils of Uzbekistan created by B.V. Gorbunov and N.V. Kimberg (1962, 1975) was divided into soil types and information was given on gray oasis soils.

According to Kimberg [2], in such soils, the layer consisting of irrigation supplies reaches from 0.5 to 2-3 m. Depending on the thickness of the agro-irrigation horizon, it is divided into thin (up to 0.5 m), medium thick (up to 0.5 - 1.0 m) and thick (above 1.0 m) types.

Kimberg's article "Zarafshan Valley" contains information on soils and conditions of soil formation [2]. The Base points were taken from the parts of Zarafshan river divided into Aqdarya and Karadarya, on the left and right banks of the Aqdarya, with flat relief and long cultivated lands.

Geomorphological and hydrogeological conditions of soils according to Kovda [3], it consists of complex alluvial deposits. Beneath these alluvial deposits are layers of gravel, sand, and silt.

According to Molodsov [4], 10.8-17.9 tons of mud flows with water per hectare of irrigated land in the Zarafshan river basin every year, as a result of which it was determined that the thickness of the irrigation deposits increases by 0.8-1.3 mm per year.

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The soil cover in the middle reaches of the Zarafshan River is typical and light gray soils, which are composed of automorphic and hydromorphic soils and are very complex, which is also related to the geomorphological structure of the region and the nature of the soil. It is explained by the soil-forming rocks, hydrogeological conditions, and differences in the development distance and processing of individual plots [5-10].
According to the conditions of soil development, main characteristics and the influence of irrigation, studies were carried out on 4 types of gray oasis soils (old-irrigated typical gray, pale gray, gray-meadow and meadow-alluvial) distributed in the studied area of the middle course of the Zarafshan River.
The soils distributed in these areas were developed in the upper terraces I, II and III of Zarafshan [6].

2. Methods

Field-soil studies and camera-analytical works "Metody agrokhimicheskikh, agrofizicheskikh i microbiologicheskikh issledovaniy v polivnykh pochvax khlopkovyx rayonakh" developed at UzPITI and "Rukovodstva k proveteniyu khimicheskikh i agroflzicheskix analizov pochv pri monitoringa zemel" developed at TAITI and R. Ko'ziev and others were carried out on the basis of methodological manuals entitled "Instructions for conducting soil surveys and drawing up soil maps for the maintenance of the state land cadastre".
At each physical point of observation, soil sections were lowered to a depth of 1.5-2.0 m to seepage waters, soil samples were taken for analysis of granulometric composition in laboratory conditions, and the granulometric composition of the obtained soil samples was determined by the pipette method of Kachinsky [8].

3. Results and Discussions

3.1. Irrigated typical gray soils

"Tilovqabilov Mahmudjan" farm, "Tilovqabilov Mahmudjon" farm, Kattakurgan district, Samarkand region, the soil cover of contour №125 is typical gray soils with old irrigation. It developed on the terrace of Zarafshan III.
Comparative analysis of the changes of typical old irrigated gray soils distributed in the middle reaches of the Zarafshan River under the influence of irrigation and treatments. Typical irrigated gray soils morphologically retain some of the characteristics of dry gray soils, especially significant changes in the topsoil. Although a new driving layer is formed here, the mechanical and material structure remains the same. The reason for this is that the upper and lower layers are mixed in the same way during soil cultivation every year.

Table 1. Variation of the granulometric composition of typical gray soils, %

Soil section	Layer. cm	Fractional amount [%] and particle size [mm]							physical mud. < 0,01	Names of soils according to their granulometric composition
		sand			dust			il		
		>0,25	0,25-0,1	0,1-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001		
Typical gray soil (1963 y)										
50	0-20	2,07	9,29	15,82	36,08	9,6	15,82	11,32	36,74	Medium sand
	20-34	1,6	8,39	13,69	38	11,26	14,72	12,34	38,32	Medium sand
	34-68	1,02	11,03	6,29	41,96	8,78	18,64	12,28	39,7	Medium sand
	68-82	1,02	11,03	6,29	41,96	8,78	18,64	12,28	39,7	Medium sand
	82-109	1,49	13,59	18,56	32,94	10,18	14,52	8,72	33,42	Medium sand
Typical gray soils (2020 y)										
5	0 – 23	1,9	7,11	14,02	36	12,09	15,01	13,87	40,97	Medium sand
	23 – 47	1,19	6,09	12,09	39,01	12,11	16,43	13,08	41,62	Medium sand
	47 – 71	1,02	9,04	5,99	39,42	10,39	19,03	15,11	43,53	Medium sand
	71 – 83	1,02	10,03	5,89	40,02	10,59	19,33	13,12	42,04	Medium sand
	83 – 109	1,49	11,31	16,69	33,29	12,69	15,31	9,22	37,22	Medium sand

A carbonate eluvial layer is formed in the lower part of the profile, and new creates (white pores, eselvak, etc.) are found. The agronomic importance of these soils is related to the degree of leaching. An increase in the level of leaching leads to the leaching of humus and other nutrients, and at the same time, their agrophysical properties deteriorate. The granulometric composition of typical gray soils has not changed much.
But a small agro-irrigation layer was formed in the upper layer of the soil. The reason for this is the distribution of typical gray soils in high and low terrain. For example: in the table, due to the increase in the amount of fine dust,

the amount of particles has increased. In some parts, it is noticeable that the upper part of the soil profile has changed. This can be explained by the fact that the relief is located in a somewhat flat part.
According to the granulometric composition of these old irrigated typical gray soils, it is mainly medium sandy, and the amount of physical clay particles (<0.01 mm) fluctuates between 40.97 - 41.62% in the arable layer and 43.53 - 37.22% in the lower layers. stood, large dust particles (0.05 - 0.01 mm) made up 36.0 - 39.01% in the arable layer of the soil and 39.42 - 33.29% in the lower layers, the average dust (0.01 - 0.005 mm) particles oscillated in a wide range and accounted for 11.09 - 12.69% in the cross-section of layers, while fine dust particles (0.005 - 0.001 mm) accounted for 15.01 - 16.43% in the arable layer and 19.03 - 15.03% in the lower layers. , 31% were observed, and il particles were 13.87 - 13.8% and 15.0 - 9.22% in the above layers, respectively (Table 1).
According to Kh.M.Abdukadirov, this type of soil belongs to the type of typical gray soil, and comparing the results of the 2020 study with the mechanical composition data of 1963, it was observed that the amount of sand particles, the amount of dust and silt particles increased in all layers of the soil. The main reason for this is explained by the erosion of feldspar and mica-like substances in the sand particles over many years, the increase of dust and silt particles in the upper layers of the soil as a result of irrigation, and the fact that certain parts are washed to the lower layers of the soil (Table 1).

3.2. Irrigated light gray soils

The soil cover of plot № 45 in "Ismat Sarkarda" farm, Zarafshan massif, Narpay district, Samarkand region is pale gray soils that have been irrigated for a long time. It developed on the third terrace of Zarafshan.
Comparative analysis of the changes of the old irrigated pale gray soils distributed in the middle reaches of the Zarafshan River under the influence of irrigation and tillage. According to the granulometric composition of these pale gray soils, it is mainly heavy sand, the amount of physical clay particles (<0.01 mm) in the driving layer is 47.04 - 47.64%, large dust particles (0.05 - 0.01 mm) 33.55-34.09%, and average dust particles (0.01-0.005 mm) are 12.21-18.99%.

Table 2. Changes in the mechanical composition of light gray soils, %

Soil section	Layer. cm	Fractional amount [%] and particle size [mm]							physical mud. < 0,01 il	Names of soils according to their granulometric composition
		sand			dust			il		
		>0,25	0,25-0,1	0,1-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001		
Light gray soils (1963 y)										
238	0 – 20	2	7,3	16,7	39,6	9,7	13,1	11,6	34,4	Medium sand
	20 – 28	1,3	2,6	12,1	43,4	12,2	15,8	12,6	40,6	Medium sand
	28 – 52	1,7	4,2	14,9	45,3	10,8	12,4	10,7	33,9	Medium sand
	52 – 69	0,6	6	29,8	42,4	6,6	7,7	6,9	21,1	Light sand
	69 – 110	1,6	6	29,8	42,4	6,6	7,7	7,9	21,1	Medium sand
Light gray soils (2020 y)										
7	0 – 24	1,13	3,09	15,19	33,55	12,21	19,69	15,14	47,04	heavy sand
	24 – 32	0,89	2,19	15,19	34,09	13,29	18,99	15,36	47,64	heavy sand
	32 – 55	1,29	2,39	15,39	35,27	12,49	18,59	14,58	45,66	Medium sand
	55 – 71	1,54	4,58	14,25	35,69	13,49	18,55	11,90	43,94	Medium sand
	71 – 110	1,62	6,59	26,09	38,49	7,23	11,89	8,09	27,21	Light sand

Fine dust particles (0.005 - 0.001 mm) make up 19.69 - 118.99%, and dust particles make up 15.14 - 15.36%, and it was observed that their amounts decrease as they go to the lower layers (Table 2). On the contrary, in physical sand, their amount increased in the lower layers compared to the driving layers. We believe that this is definitely related to its granulometric composition.
According to H.M. Abdukadirov (1963), light-colored gray soils in the arable layer have a medium-sandy mechanical composition, and the main part of the mechanical elements consists of small sand and large dust particles. By 2020, the impact of irrigation has changed from medium sand to heavy sand in the aquifer layer, which can be justified by the increase of medium and fine dust and silt particles due to irrigation with muddy waters of the Zarafshan River (Table 2).

3.3. Irrigated gray-meadow soils

Sh.Rashidov Massif, Samarkand District, Samarkand Region, "Mastura Sakhovati" farm, contour № 217, the soil cover is old irrigated gray-meadow soils, the soil appeared on alluvial deposits, medium and heavy sand with mechanical composition is not saline. It developed on the terrace of Karafshan III.

Comparative analysis of the changes of old irrigated gray-meadow soils distributed in the middle reaches of the Zarafshan River under the influence of irrigation and treatments. According to the granulometric composition of these old irrigated gray-meadow soils, it is mainly medium and heavy sand, and the amount of physical clay (<0.01 mm) in the lower layers fluctuates between 49.57 - 50.62%, large dust (0.05 - 0 .01 mm) 23.19 – 26.19%, average dust particles (0.01 – 0.005 mm) in the section of layers make up 10.09 – 13.9 %, fine dust particles (0.005 – 0.001 mm) 19, 19 - 21.44%, and il particles - 16.09 - 16.19%, compared to the data of 1963, an increase in average, fine dust and il particles was observed in the plowed layers of the soil, while it was observed to decrease in the lower layers (Table 3).

Table 3. Changes in the granulometric composition of gray-meadow soils, %

Soil section	Layer Cm	Fractional amount [%] and particle size [mm]							physical mud. < 0,01 il	Names of soils according to their granulometric composition
		sand			dust			il		
		>0,25	0,25-0,1	0,1-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001		
Gray-meadow soils (1963 y)										
231	0 – 18	4,9	1,2	22	27	12,6	20,8	11,5	44,9	Medium sand
	18 – 31	5	1,7	22,3	26,5	12,6	19,4	12,5	44,5	Medium sand
	31 – 70	5,3	1,8	23	28,1	11,8	18,4	10,6	40,8	Medium sand
Gray-meadow soils (2020 y)										
2	0 – 20	3,2	0,8	19,19	26,19	13,09	21,44	16,09	50,62	heavy sand
	20 – 35	3,59	0,9	22,75	23,19	14,19	19,19	16,19	49,57	heavy sand
	35 – 70	5,09	1,12	23,09	28,09	10,9	19,01	12,7	44,61	Medium sand

3.4. Irrigated meadow-alluvial soils

The lands of the Nurmon Abdullaev farm, M. Joraev massif, Ishtikhon district, Samarkand region are meadow-alluvial soils, and the soil cover of the farm, contour № 51 is meadow-alluvial soils that have been irrigated for a long time. It developed on the upper terrace of Zarafshan II.

Comparative analysis of changes of old irrigated meadow-alluvial soils distributed in the middle reaches of the Zarafshan River under the influence of irrigation and tillage. Meadow alluvial soils were formed in terraces I-II of the middle part of the Zarafshan river. The terraces are mainly plains, with some meso- and macro-relief views of the terrain. Soils are developed in bodies of sand and clay mechanical composition of alluvial deposits. At 1-2-2.5 meters depth there are seepage waters and at 3-4 meters there are gravels. As a result of long-term irrigation of soils with muddy water, agro-irrigation sediments accumulated in its upper part.

Therefore, one of the main morphological characteristics of these soils is the presence of an agro-irrigation thickness of 1 meter. Even at 80-100 cm, the color remains saturated. The quantity of some nutrients elements has also undergone changes. During the 60-year irrigation period, the continuous mechanical tillage of the soil has led to the reduction of some nutrients in the soil. The reason for this is mainly the leaching of these elements into seepage waters under the influence of irrigation water. According to the granulometric composition of these soils, it is mainly heavy sand, the amount of physical clay particles (<0.01 mm) in the arable layer is 52.1 - 53.3%, large dust (0.05 - 0.01 mm) is 28.5 - 27.3% is average dust (0.01-0.005 mm), 11.4-13.3%, fine dust (0.005-0.001 mm) 24.5%, and 14.3-15.5 in the plowed layer with fine particles. %, and it was found that their amount decreases in the lower layers (Table 4).

On the other hand, physical sand particles are the opposite, and their amount is less in the upper layers and increases towards the lower layers. These grassland alluvial soils are composed of heavy and medium sands, and the composition of the fraction is dominated by fine sand and large dust.

They make up 50-60% of the soil mass, and when the share of large dust reaches 30-35%, their amount decreases downwards. By now, the granulometric composition of old irrigated soils has become heavier. It can be seen that the medium sands are preserved as thin layers in the lower layers of the soil profile (Table 4).

Table 4. Changes in the granulometric composition of meadow-alluvial soils, %

Soil section	Layer. Cm	Fractional amount [%] and particle size [mm]							physical mud. < 0,01 il	Names of soils according to their granulometric composition
		sand			Dust			il		
		>0,25	0,25-0,1	0,1-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001		
Meadow-alluvial soils (1963 y)										
382	0 – 17	3,8	3,6	14,3	32,1	11,9	21,2	13,1	46,2	heavy sand
	17 – 31	3,8	3,6	14,4	32,3	11,3	22,3	12,3	45,9	heavy sand
	31 – 76	4,9	2	22,6	31,4	11,5	16,1	11,5	39,1	Medium sand
	76 – 120	5,3	1,5	23	31,5	12,1	15,5	11,1	38,7	Medium sand
Meadow-alluvial soils (2020 y)										
4	0 – 20	3,5	3,4	12,5	28,5	13,3	24,5	14,3	52,1	heavy sand
	20 – 35	3,6	3,5	12,3	27,3	13,3	24,5	15,5	53,3	heavy sand
	35 – 77	4,8	2	22,7	29	11,4	19,6	10,5	41,5	Medium sand
	77 – 120	5,3	1,6	23,1	29,1	11,4	18,4	11,1	40,9	Medium sand

4. Conclusions

According to the granulometric composition of all soil types (typical, light gray, gray-meadow and meadow-alluvial) located on terraces I - II - III of the Zarafshan oasis, it is mainly medium and heavy loam, physical clay (<0.01 mm) is large dust (0.05 – 0.01 mm), medium dust (0.01 – 0.005 mm), fine dust (0.005 – 0.001 mm) and silt particles have been reduced by irrigation for many years (60 years), dust and silt The amount of particles increased in all layers of the soil. The feldspar and mica-like elements in the sand particles are explained by the erosion and the increase of dust and silt particles in the upper layers of the soil as a result of irrigation, and certain parts are washed to the lower layers of the soil.

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Study on the Influence of Sideration on Soil Microbiological Activity

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Abstract. In the fall, siderate is used in cotton fields in its pure state; 7.81-31.38 t/ha of biomass was accumulated per heke when rapeseed and rapeseed + rapeseed were planted in a mixed state. When this biomass is crushed in siderate quality and buried in the soil, the microbiological activity increases along with the improvement of the soil properties, and the rapid and short retention of the biomass in the soil accelerates the decay, as a result, it has a positive effect on the increase in the amount of nutrients in the soil.

1. Introduction

Today, the cultivation of organic agricultural products is one of the most important issues in the world, and it is based on the use of organic fertilizers. Including; which can be achieved by using siderates. From this point of view, it is possible to meet the need for organic fertilizers by cultivating siderate crops, achieving high biomass, crushing the cultivated biomass, spreading evenly on the field, plowing the land, taking into account the natural soil and climate conditions. However, the importance of microorganisms in converting organic fertilizers into a form absorbed by plants is incomparable, and their study is one of the urgent tasks.

Cultivation of siderate crops improves soil water and air regimes. This situation is especially evident when crops with spikes are grown. Also, if the siderate crops are plowed into the ground in autumn and early spring with the biomass crushed, they perform a sanitary role in the soil and create a basis for a slight decrease in cotton diseases and pests [1, 2].

Siderates play an important role in improving soil fertility and in microbiological processes in the soil. According to data, soil microorganisms include bacteria, actinomycetes and fungi, about 70% of them are bacteria, about 27-30% are actinomycetes, and about 1-3% are fungi [3, 4, 5, 6].

If the agrophysical, water-physical properties of the soil are in moderation, the microorganisms in it are activated, as a result, soil fertility increases. Therefore, knowledge of soil microflora and biology, assessment of various agrotechnological activities is a very important issue. In particular, the use of siderates in fields freed from cotton in short-row cotton-cereal rotation affects not only the agrophysical properties of the soil, but also all the life processes occurring in the plant, as well as the microbiological activity of the soil, and therefore its study is one of the urgent issues.

It is known from the sources that siderate crops have a significant positive effect on soil fertility, including soil properties and microflora, of the land cleared from the areas where cotton, winter wheat and other crops were grown. However, in the conditions of the old irrigated meadow-alluvial soils of Samarkand region, the effect of pure and mixed cultivation of siderate crops, cultivation of biomass and application of the resulting biomass to the soil on soil microbiological activity has been determined not sufficiently studied.

Therefore, the research was conducted in 2019-2020 in the conditions of the irrigated meadow-alluvial soils of the farm "Nurmon Abdullaev", Ishtikhon district, Samarkand region, based on the short rotation.

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2. Materials and Methods

Cultivation of siderate crops, analysis and observation of them were carried out on the basis of manuals such as "Methodology for state variety testing of agricultural crops" [7], "Methodology for conducting field and vegetative experiments with fodder crops" [8].

Methodological manuals entitled "Methods of agrochemical, agrophysical and microbial studies in irrigated cotton areas" [9] were used to conduct microbiological analyzes in the experiment. Bacteria were detected in meat peptone agar (GPA), fungi in Chapek's medium (Sreda Chapeka), and actinomycetes in starch-ammonia agar (KAA).

To study the efficiency of siderat crops in cotton cultivation, after harvesting the cotton crop, the selected area was watered and prepared for planting in the fall (on October 10). Care of siderate crops was carried out according to existing recommendations [10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31]. Field experiments were conducted on old irrigated meadow-alluvial soils of Ishtikhon district, the mechanical composition of the arable layer is medium sand, the volume mass with pore structure is 1.35-1.37 g/cm^3. The experiment was carried out in 4 variants, 3 replicates in one tier, according to the following system, i.e. variants - 1-control-without siderate, 2-peas, 3-rapeseed, 4-peas+rapeseed. The surface of each plot was 240 m^2 (length 50 m, width 4.8 m), the area to be considered was 120 m^2. The statistical analysis of the experimental results was carried out according to B. A. Dospekhov [32].

3. Results and Discussion

For the experiment, the biological autumn Loris variety of one-year rapeseed belonging to the cabbage family and Asia-2001 variety of the peas plant belonging to the legume family were selected as siderate crops. On the basis of experimental schemes, peas - 40 kg/ha, rapeseed - 13 kg/ha were planted separately, and their mixtures were reduced to half. Rapeseed seeds were planted at a depth of 1.5-2 cm, and peas seeds at a depth of 6-7 cm. After planting, it was irrigated at the rate of 500-600 m^3/ha.

Fertilization of siderate crops using NRU-1.5 fertilizer spreader, 50 kg/ha of nitrogen fertilizer was applied in two periods when the plant height was 8-10 cm and close to entering the period of intensive growth. After putting the fertilizer on the ground, it was irrigated at the rate of 700-800 m^3/ha. In autumn, irrigation was carried out every 17-20 days in October-November, and 20-25 days in March-April.

Table 1. Growth, development and yield of siderate crops, 2019-2020

Variants of experience	Number of plants, thousand units/ha	Plant height, cm	Biomass, g/m^2			Ratio of parts (top/bottom)	Biomass yield, t/ha
			over the ground	underground	Total		
Control without sideration	-	-	-	-	-	-	-
Peas	194,5	83,6	6407	1406	7813*	1 : 0,18	7,81
Rape	2702,2	98,2	1942	370	2312	1 : 0,16	23,12
Peas+rape	4550,0	73,9+87,3	2730	408	3138	1 : 0,13	31,38

Note: *The crop marked with * was grown in 1.6 linear meters.*

Biomass productivity of siderate crops was determined by the mass of above-ground and below-ground parts of 1 m^2 and 1.6 linear meters in the flowering phase. The above-ground green mass of siderate crop species varied from 1942 g to 2730 g per 1 m2 with a large difference. In this case, it was found that the above-ground mass was 1942 g in the case of pure rapeseed, while the highest value was 2730 g in the case of peas + rapeseed.

Biomass productivity of siderate crops was 7.81 - 31.38 tons per hectare according to crop types.

The highest biomass yield (31.38 t/ha) was recorded in the option of mixed planting of peas+rapeseed for siderate, while the lowest biomass yield (7.81 t/ha) was observed when pure peas was planted for siderate crop (Table 1).

Burying the green biomass produced by siderate crops into the ground, during the flowering and fruiting phases of rapeseed and their mixtures, crushing it with a heavy disc harrow (BDT-2,2) and burying it in a double-layer plow (PD-3-35) was carried out and the effect on the change of soil microflora was studied.

The use of siderates in the field of short-row cotton-cereal rotation in fields free from cotton affects not only the properties of the soil, but also the microbiological activity of the soil, and its study is one of the urgent issues today.

Taking into account the importance of the issue, the effect of siderate crop species on the microflora of the soil of the experimental field was studied, and the results of microbiological analysis are presented in Table 2.

After sideration at the beginning of the growing season, the amount of bacteria in the soil of the experimental field was close to each other in all options, and 4.43 - 7.26 million piece bacteria were formed in 1 g of soil in two years. At this time, it was found that the number of bacteria in the soil was influenced by the biomass left by siderates in the soil. For example, in the experiment, at the beginning and end of the cotton growth period, the number of bacteria decreased by 0.10 million (4.32 million) 1 g of soil in the control-without siderate option. The number of bacteria in the peas+rapeseed variant is 7.26 - 7.30 million. grain increased. However, it was observed that it was 1,40 – 2,83 million and 1.60 - 2.98 million more than the control variant.

Also, in the options where siderates were used, the amount of bacteria in the soil of the experimental area was 1.60 - 2.98 million from the initial amount at the end of the vegetation period. it was determined based on the analysis that there was a lot per grain. The number of bacteria in the experimental area was the highest (7.30 million in 1 g of soil) in the peas+rapeseed variant.

At the beginning of the growing season, in the control option (in 1 g of soil) 1.18 million, if there is a piece of actinomycete, this indicator is 1.53 in the options where sideration is used; 1.28; 1.56 mln. formed a piece. The number of actinomycetes, the increase of plant biomass, that is, with the increase of soil moisture, compared to the control option, 0.1 - 0.36 million. increased to pieces.

At the end of the growth period, the number of actinomycetes in the options with siderates was multiplied compared 0.12 - 0.48 million piece to the control option (1.20 million units) increased. In this case, the number of actinomycetes in the peas+rapeseed option is 0.48 million more than in the control. it was found that there was a lot of piece. However, if the amount of actinomycetes at the beginning of the growing season and at the end of the growing season is compared, these indicators will definitely be higher than the initial amount.

At the beginning of vegetation, the number of fungi in the control variant was 20.2 thousand pieces per 1 g of soil. With the increase of the biomass accumulated in the soil, the amount of fungi in the soil increased by 21.2 - 24.5 thousand piece compared to the control option. At the end of the growing season, the amount of fungi in the soil was 20.9 thousand/g in the control option, and it was 21.6-24.3 thousand more than the amount of fungi in the siderate-applied options (Table 2).

Table 2. Effect of sideration on soil microflora (0-40 cm), 2019-2020

Variants of experience	At the beginning of the growing season			At the end of the growing season		
	bacteria, million/g in soil	actinomycetes, million/g in soil	fungi, thousand/g	bacteria, million/g in soil	actinomycetes, million/g in soil	fungi, thousand/g
Control without sideration	4,43	1,18	20,2	4,32	1,20	20,9
Peas	6,12	1,53	42,6	6,24	1,60	43,3
Rape	5,83	1,28	41,4	5,92	1,32	42,5
Peas+rape	7,26	1,56	44,7	7,30	1,68	45,2

When the relationship between the yield of siderate crops (peas, rape and their mixtures) and the bacteria in the soil is statistically analyzed, there is an inverse relationship according to the change in direction, and according to its analytical expression, there is a linear relationship, and their regression equation obeys the expression y = a – bx and the correlation coefficient r It was found to be <0.91. This situation is noted at the beginning of the growing season. It can be seen that when the plants are grown for the purpose of sidercia, it is statistically proven that the productivity and yield increase as a result of planting the crop species in pure and mixed form (Fig. 1).

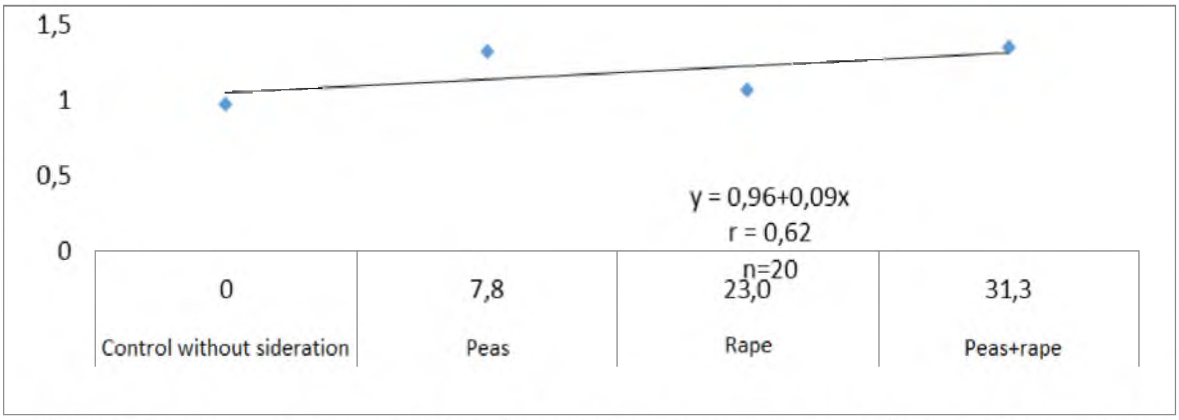

Fig. 1. Dependence of the number of bacteria in the soil on the biomass of siderate crops at the beginning of the growing season

The correlation between the number of actinomycetes and the biomass of siderate crops at the beginning of the vegetation period is 0.62. This, in turn, expresses the above-mentioned relationship (Figure 2).

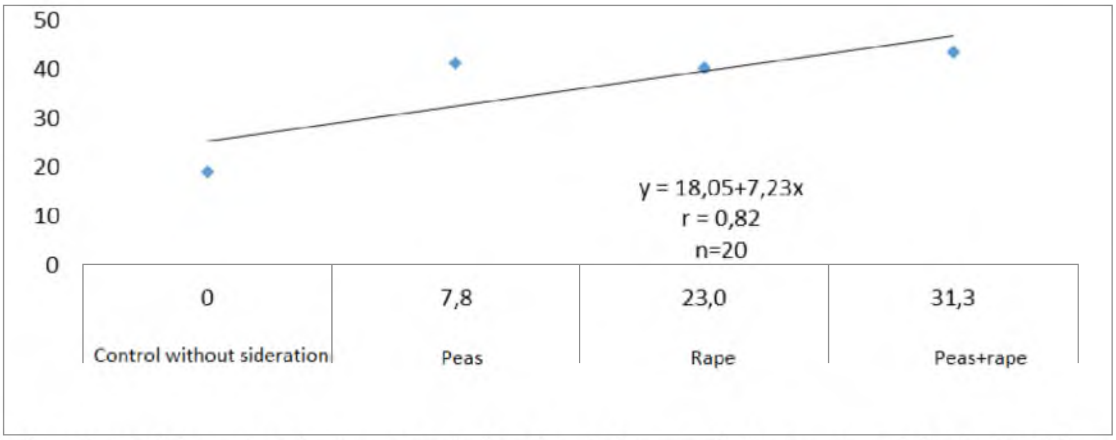

Fig. 2. Dependence of the number of actinomycetes in the soil on the biomass of siderate crops at the beginning of the growing season

Our next statistical analysis is about the dependence of the number of fungi on the biomass of siderate crops (at the beginning of vegetation). In this case, it obeys the correlative equation u=a+bx and is r=0.82. This once again proves the dependence of the number of microorganisms in the soil on the organic content, which is presented in scientific sources (Figure 3).

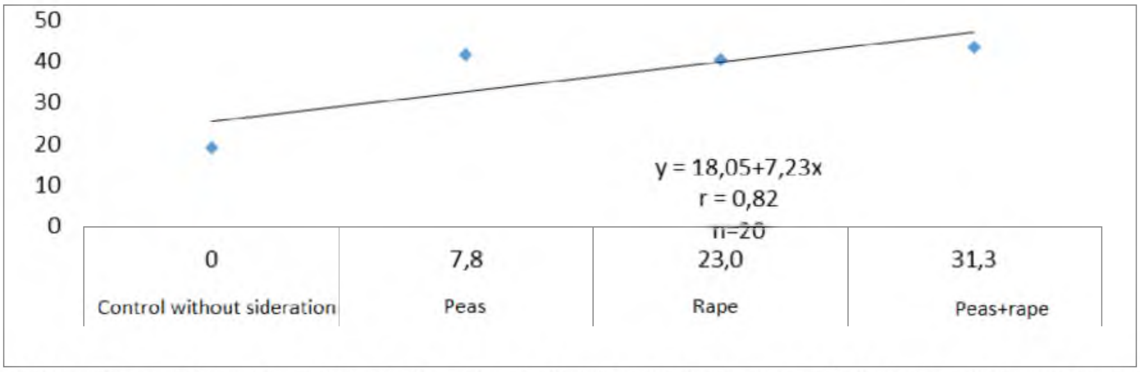

Fig. 3. Dependence of the number of fungi in the soil on the biomass of siderate crops at the beginning of the growing season

Positive effect on soil microflora when planted in a mixture with peas+rapeseed as a siderate, that is, at the beginning and end of the vegetation (in the control option, bacteria, 4.43 - 4.32 million/g, actinomycetes, 1.18 - 1.20 million/g, and fungi , 20.2 - 20.9 thousand/g of soil) compared to the control option, bacteria in 1 g of soil are 2.83-2.98 million, actinomycetes 0.36 - 0.48 million, fungi 24.5 - 24.3 thousand was found to have increased. Due to this, the biomass of siderates decomposed quickly and in a short period of time in the soil. As a result, soil fertility has improved significantly.

The number of microorganisms is significantly affected by the biomass of plants that are plowed into the ground as siderate.

Thus, when the biomass of siderate crops is plowed into the ground, the number of microorganisms in the soil is 2.83 - 2.98 million bacteria per 1 g of soil compared to the control option without siderate; actinomycetes 0.36 - 0.48 million; fungi increased by 24.5 - 24.3 thousand pieces. As a result, its microbiological activity increased and had a positive effect on soil fertility and the development and yield of agricultural crops.

4. Conclusions

1. Pure peas (7.81 t/ha) as a siderate to fields cleared of cotton in autumn (October 10); When rapeseed (23 t/ha) and peas + rapeseed (31 t/ha) were planted and cared for, the highest biomass yield was 31.38 t/ha in the option of using

peas + rapeseed, the lowest yield (7.81 t/ha) it was found to be a peas variant. The resulting biomass was comminuted as siderate in early April and buried in the soil.
2. In order to increase the fertility of the soil, the use of peas and rapeseed in their pure form and their mixtures as a siderate allows to increase the number of microorganisms in the soil. In particular, the number of bacteria at the beginning and end of the growth period of the cotton plant compared to the control was 2.83-2.98 million/g, actinomycetes 0.36-0.48 million/g, the number of fungi 24, 3 - 24,5 thousand/g increased a result, its microbiological activity increased, and as a result of rapid and short-term decay and decomposition of soil biomass, it led to a significant increase in the amount of nutrients in the soil.

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To cite this article: Yu Kenjaev and F P Davronova 2023 *IOP Conf. Ser.: Earth Environ. Sci.* **1142** 012112

IOP Conf. Series: Earth and Environmental Science 1142 (2023) 012112 doi:10.1088/1755-1315/1142/1/012112

Study on the effect of the green manure application on soil fertility

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Abstract. The natural soil and climatic conditions of green manure crops are taken into account. It is important to choose the types suitable for growing them for different purposes (as a main, repeated crop, animal feed, mulching), to increase the yield and quality of green manure crops, to achieve high green biomass by using optimal seeding periods and rootstock thicknesses. One of the urgent tasks is to carry out research in the priority areas such as increasing the soil fertility and cotton yield by crushing the cultivated green biomass and spreading it evenly on the field, plowing it into the soil at different times and depths. In order to increase soil fertility, the use of pure bean and colza and their mixtures as green manure has increased. The percentage of macroaggregates in the driving layer before the first irrigation increased by 13.0–13.45% compared to the control, and by 16.55–17.4% before the last irrigation. As a result, the volume mass of the soil is reduced to 0.02-0.04 g/cm^3, and the amount of nitrogen, phosphorus (P_2O_5) and exchangeable potassium (K_2O) in the form of ammonium (N-NH_4) and nitrate (N-NO_3) in the soil is lower than in the control-green manure and caused a slight increase compared to the option.

1. Introduction

Cultivation of green manure crops improves soil water and air regimes. This situation is especially evident when crops with spikes are grown, because of the stiffness and softness of the roots, it "splits" the soil into small pieces. This water has a positive effect on slow-draining, compacted heavy soils. In light loamy soils, green manure crop cover acts as a "living mulch", preventing nutrient leaching from top to bottom. Therefore, in such soils, if green manure crops are ground in autumn, and in spring they are plowed with green mass and ground, they perform a sanitary role in the soil and protect plants from diseases and pests [1].

According to the results of the experiment conducted by Kenjaev [2], the percentage of macrostructural aggregates with a size of 5-0.25 mm at the beginning of cotton vegetation after sideration increased by 5.31-8.55% when sideration was used compared to the control. Also, the relationship between the formation of structure, the spreading of plant roots into the soil and the amount of humus in the soil has been shown in the literature [3-7].

In addition to macrostructured aggregates, microstructured aggregates < 0.25 mm in size have a specific role in soil fertility. A favorable proportion of these aggregates in the soil structure ensures high crop yields in Central Asian (gray) soils, but air exchange is impaired in soils with a large amount of < 0.25 mm microstructured aggregates. Such soils quickly dry out, and when they dry, they become compacted and become lumpy [8].

Soil structure is one of the important agronomic properties that determine soil fertility and crop yield. Issues such as physical properties of the soil, tillage measures, water-weather regimes of the soil, general fertility and their influence on the productivity of plants have been thoroughly studied by Uzbek and international scientists. In the short-row cotton-cereal rotation, the application of green manure crops to the fields freed from cotton in the fall period and its effect on soil fertility have not been sufficiently studied.

2. Materials and Methods

The cultivation of green manure crops, their analysis and observation were carried out based on manuals such as "Methodology for conducting field and vegetative experiments with fodder crops" [9], chemical composition of green manure crops "Methods of biochemical research of plants" [10].

In the experiment, methodological manuals "Methods of agrochemical, agrophysical and microbiological research in irrigated cotton areas" [11] and "Methods of agrochemical research" [12] were used to perform agrochemical, agrophysical and microbiological analysis.

In the experiment, the following agrophysical analyzes were carried out: the mechanical composition of the soil according to Kachinsky; macro and microstructure of the soil (%) at the beginning and end of the cotton vegetation after green manures by sieving, weighing and counting from the 0-20 and 20-40 cm layers in 4 repetitions of each option; water-resistant aggregates of the soil (%) in 4 repetitions of each option in the 0-20 and 20-40 cm layers and at the beginning and end of cotton vegetation by the Savvinov method; volume mass of the soil (g/cm^3) after green manure during cotton vegetation period before the first and last watering from 0-20 and 20-40 cm layers in 4 repetitions by Kachinsky method; specific mass of the soil (g/cm^3) after green manure during cotton vegetation period before the first and last irrigation from 0-20 and 20-40 cm layers in 4 repetitions by pycnometer method; soil porosity (%) by calculation according to soil volume mass and specific mass before the first and last irrigation during cotton vegetation after green manure; soil moisture (%) was determined by drying and weighing in a thermostat for 6 hours at 105 ^{0}C, before plowing green manures, before the first and last watering of cotton during the growing season in 0-20 and 20-40 cm layers in 4 replications of each option. Also, by calculation, the soil moisture reserve (mm) was determined according to the above layers [13].

In agrochemical analyses: the amount of humus in the soil according to Tyurin; total nitrogen, phosphorus and potassium according to Maltsev and Gritsenko; amount of nitrogen in the form of nitrate according to Granwald-Lyaju; the amount of nitrogen in ammonium form in Nessler's reagent; mobile phosphorus and exchangeable potassium were determined according to Machigin.

Statistical analysis of experimental results was performed according to Dospekhov [14].

The field experiments were carried out in the conditions of the old irrigated, mechanical composition of medium loam, volume mass of 1.26 g/cm^3 in the plowed layer, typical gray soil with a porous structure of the Botany educational and scientific center of NUUz. The experiment was carried out in 4 variants, 3 replicates in one layer, according to the following system, i.e. variants - 1-control-without green manure, 2-bean, 3-colza, and 4-bean+colza. The surface of each plot was 240 m^2 (length 50 m and width 4.8 m), the area to be considered was 120 m^2.

To study the effectiveness of green manure crops in cotton cultivation, after harvesting the cotton crop, the selected field was watered and prepared for planting in the fall (on October 10). Maintenance of green manure crops was carried out according to existing recommendations [15].

As green manure crops, long-day autumn colza and leguminous bean plants, including bean Asia-2001 and biological autumn Loris varieties of colza, were selected for the experiment as green manure crops, which are somewhat cold-resistant and have high biomass accumulation. As a green manure crop, bean - 40 kg/ha, colza - 13 kg/ha separately and their mixtures were sown by hand spreading, reducing it to half. Colza seeds were planted at a depth of 1.5–2 cm, and bean seeds were planted at a depth of 6–7 cm. After planting, it was irrigated at the rate of 500-600 m^3/ha.

Nitrogen fertilizer was spread at 50 kg/ha in two periods with the help of NRU-1.5 fertilizer spreader, when the plant height was 8-10 cm and it was about to enter the intensive growth phase. After putting the fertilizer on the ground, it was watered at the rate of 700-800 m^3/ha. In autumn, irrigation was carried out every 17-20 days in October-November, and 20-25 days in March-April.
Burying the green biomass produced by green manure crops into the ground, crushing Colza and their mixtures during the flowering-fruiting phases with a heavy disk harrow (BDT-2.2) and burying it in a double-layer plow (PD-3-35) work was done. The effect of green manures on soil properties was studied.

3. Results and Discussion

Soil structure is one of the important agronomic properties that determine soil fertility and crop yield. Although issues such as physical properties of the soil, tillage measures, water-weather regimes of the soil, fertility in general and their effect on the productivity of plants have been thoroughly studied by Uzbek and foreign scientists, but in the conditions of meadow-alluvial soils of Samarkand province (Uzbekistan), short-rotation cotton-grain rotation The work on burying the biomass produced as a result of the maintenance of green manure crop types in the autumn periods in the fields freed from cotton and its effect on soil graininess has hardly been studied.
According to the work program, after green manure in spring, at the beginning and end of the cotton vegetation, samples were taken from the 0-20 cm and 20-40 cm layers of the soil from the experimental field, and the aggregate fractions were analyzed.
In the experiment, the highest (19.55-18.65%; 23.55-21.45%) percentage of large-sized (> 10 mm) megastructure aggregates in the 0-20 cm and 20-40 cm soil layers at the beginning and end of cotton vegetation control-green was observed in the variant without manure, and the lowest indicator compared to the control was recorded in colza and bean+colza variants, the amount of > 10 mm aggregates was 2.5-2.6%; 4.05 - 4.65% and 6.4 - 5.45%; It was noted that it was 6.3-6.0% less or relatively less in the bean variant.
Also, at the beginning and end of cotton vegetation, the amount of macrostructured aggregates (10-0.25 mm) in the 0-20 cm layer of the soil decreased from 60.15% to 54.20% in the control variant. In the options where green manures were used, their share increased by 9.9-13% compared to the control option. In this case, it was noted that its highest indicator is in the bean+colza variant, and relatively high indicator is in the colza variant (Table 1).
The percentage of macrostructured aggregates with a size of 10-0.25 mm in the 20-40 cm layer of the soil was different from that in the 0-20 cm layer, and it was 62.50% in the control option without green manure, while in the options with green manures, this indicator was 71.85-74.05% respectively. Its share in the 20-40 cm soil layer was higher in the bean+colza option.

Table 1. Effect of green manure on the formation of soil aggregates (% of soil mass), 2019 – 2020.

Experience options	Soil layer, cm	Aggregate size, mm					
		at the beginning of the cotton vegetation			at the end of the cotton vegetation		
		>10	10-0.25	<0.25	>10	10-0.25	<0.25
Control-without green manure	0 – 20	19.55	60.15	20.3	23.55	54.2	22.25
	20 – 40	18.65	62.5	18.85	21.45	55.0	23.55
Bean	0 – 20	17.25	70.25	12.5	19.2	69.75	11.05
	20 – 40	17.05	71.85	11.1	17.6	70.55	11.85
Colza	0 – 20	17.05	71.4	11.55	17.15	70.5	12.35
	20 – 40	16.05	72.6	11.35	16.0	71.2	12.8
Bean+colza	0 – 20	15.5	73.15	11.35	17.25	70.75	12.0
	20 – 40	14.0	74.05	11.95	15.45	72.4	12.15

In general, when various crops were planted for the purpose of green manure, the proportion of macrostructured aggregates of 10-0.25 mm size increased in the tillage layer, and water-resistant aggregates were formed. The reason is that soil particles combine with organic humus to form structural soil aggregates. It is known that the quality of granules is determined by their water resistance and mechanical strength.

In field experiments, the amount of < 0.25 mm microstructured aggregates in the 0-20 cm layer of the soil at the beginning of the cotton vegetation was 11.35-20.30%, and at the end of the cotton vegetation was 12.0-22.25%. In this case, it was found that its share was relatively small in the bean+colza option. Also, in the 20-40 cm layer of the soil, at the beginning and end of the cotton vegetation, microstructured aggregates < 0.25 mm are 11.35-18.85 according to options; 12.15-21.55%, and under the influence of green manures, their amount increased by only 0.75-1.45% at the end of the growing season compared to the beginning of the growing season, while it was found that it increased by 4.70% in the control-green manure option.

In addition, from the studied fractions, microstructured aggregates with a size of <0.25 mm were more abundant in the upper layers of the soil at the beginning of the vegetation, but by the end of the vegetation, on the contrary, it was found in the analyzes that they were formed more in the lower layer than in the upper layers. This indicator was especially high in the control-green manure-free option. This situation is explained by the fact that as a result of irrigation, microstructured aggregates are washed into the lower layers of the soil and form a colloid mass.

In the conditions of meadow-alluvial soils of Samarkand region, planting beans and colza in their pure state and mixed with colza and using them as green manure has a positive effect on soil fertility and improves its structure. As a result, the plants will grow and develop better, creating a higher yield and increasing the profitability of the field. Also, in order to determine the effect of green manures on the volume mass (density) of the soil, samples were taken and analyzed from the 0-20 and 20-40 cm layers of the soil.

After green manure, before the first and last irrigation of cotton, the volume and mass change was observed in the soil tillage (0-40 cm) layer. In field conditions, soil volume mass was determined by taking an undisturbed soil sample from the driving layer using a cylinder. The results of determining the volume mass of the soil driving layer are described in Table 2.

Before the first irrigation of cotton in 0-20 and 20-40 cm soil layers in options using green manure, its bulk mass is 0.03-0.05 g/cm^3 and 0.02-0.04 g/cm^3 less than in the option without green manure. It can be seen that the volume mass was larger in the lower 20-40 cm layer compared to the surface 0-20 cm layer. A decrease in volume mass in the tillage layer compared to the control-green manure-free option (0.05 and 0.04 g/cm^3) was observed in the options planted mixed with bean+colza as green manure. Before the last irrigation, the amount of volume and mass in the plowing layer of the soil (0-20 and 20-40 cm) is 0.02-0.03 g/cm^3 when beans and colza are planted with green manure; It was found that it decreased by 0.03 g/cm^3 (Table 2).

Table 2. Effect of green manure on soil volume mass, g/cm^3 (2019 – 2020)

Experience options	In early spring		During the growth period of cotton			
			Before the first irrigation		Before the last irrigation	
	Soil layer, cm					
	0 – 20	20 – 40	0 – 20	20 – 40	0 – 20	20 – 40
Control-without green manure	1.35	1.37	1.37	1.38	1.38	1.39
Bean	1.33	1.35	1.34	1.36	1.36	1.38
Colza	1.33	1.34	1.34	1.35	1.36	1.37
Bean+colza	1.32	1.34	1.33	1.35	1.35	1.37

Thus, in the option without control-green manure, before the first and last irrigation of cotton, the volume mass increases in the driving layer, while in the options with green manure, it was found to decrease compared to the control.
During the growing period of cotton, before the last irrigation, the increase in the driving layer was observed in the control option (1.38 and 1.39 g/cm^3), and it was found to be the least when it was used as green manure mixed with colza. Before the last watering, the lowest volume mass (1.38 g/cm^3) was observed when the bean was planted as green manure (Table 2).
Further statistical analysis determined the relationship between soil volumetric mass and green manure biomass. It turned out that the correlation is weak (R=0.94) (Figure 1).

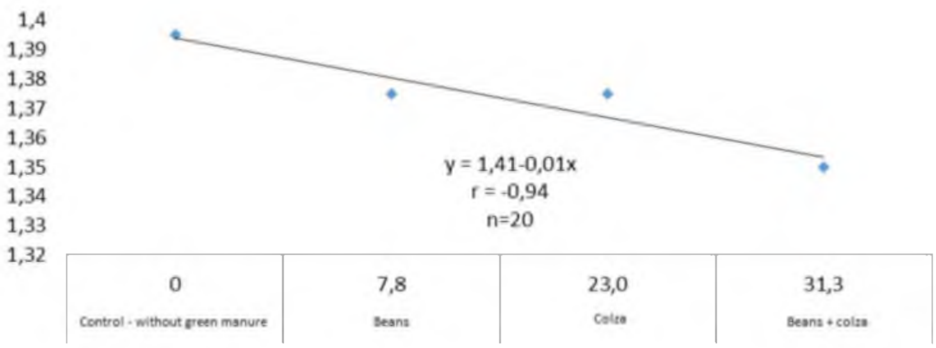

Figure 1. Dependence of soil volume mass on biomass of green manure crops

Statistical analysis of data allows obtaining objective information for the process. In general, when the bean for green manure was planted in its pure form and the bean with colza, the volume mass in the driving layer decreased the most compared to the control option, and it was observed that it was almost unchanged due to irrigation. When green manure is used, it was found that the volume mass in the driving layer is reduced by 0.05-0.04 g/cm^3. It was noted that when green manure was used, a density favorable for good growth and branching of cotton roots was created.
The change of the general physical properties of the soil, in turn, had its effect on its water physical properties, including the soil moisture (0-40 cm) during the experiment. determined before the increase. These indicators are presented in Table 3. It was found out from the conducted analyzes that green manures had a significant effect on soil moisture.

Table 3. Effect of green manure on soil moisture, % (2019-2020)

Experience options	Before plowing green manures Nov 18-24		During the growth period of cotton			
			Before the first irrigation June 9-12		Before the last irrigation Sep 2-5	
	Soil layer, cm					
	0 – 20	20 – 40	0 – 20	20 – 40	0 – 20	20 – 40
Control-without green manure	17.9	20.1	19.8	20.5	17.9	19.4
Bean	20.7	24.05	20.1	25.4	18.6	20.8
Colza	20.5	25.4	20.1	25.9	19.3	24.1
Bean+colza	21.05	26.3	21.4	25.9	19.7	24.5

During the cotton growth period, before the first watering, compared to the control option without green manure, moisture (0-20 cm and 20-40 cm) in the driving layer is 0.3-1.6% and 0.7-1.8% higher in the options with green manures. it happened. Also, higher humidity (21.4-25.9%) was noted when beans were planted mixed with Colza as compared to the control-green manure-free variant.

Even before the last watering of cotton, it was found that the humidity was the highest (19.7-24.5%) when the green manure was planted as a crop mixed with colza in the plow layer (0-20 cm and 20-40 cm). Relatively high humidity was observed in colza variant (19.3-24.1%).
In the driving layer of the soil, the moisture content before the last irrigation increased by 0.7 and 1.4% in the bean variant compared to the control-green manure variant. In the bean version, the soil moisture is 18.6%, corresponding to the layers; It was observed to be 20.8%, which is much lower than other green manures (Table 3).
When green manure is used, the accumulation of organic mass in the soil leads to the acceleration of microbiological activity, and as a result, it leads to an increase in organic humus in the soil and the preservation of moisture at an optimal level.
In general, in our study, when green manure was cultivated, beans were mixed with colza and colza was planted pure, it was observed that the humidity was the highest in the first and last irrigation layer of cotton, and it was favorable for cotton cultivation. In particular, it was found that the ability to retain moisture in the soil is high when beans are planted mixed with colza and colza alone and used as green manure.
Since the 20s of the last century, many activities have been conducted in Uzbekistan to change soils under the influence of irrigation, and to increase their productivity. According to the data obtained in the experiment, it was observed that the amount of humus decreased from year to year in the option without green manure. The use of different green manure crops had a positive effect on the amount of humus.
Among the green manures, when green manure was used as a crop mixed with bean rape, it had a positive effect on the amount of humus in the soil compared to the use of other green manure crops. It was observed in the option of planting green manure as a mixture of bean + colza, and it was noted that the amount of humus in the soil was high. At the same time, all green manure crop biomass had a positive effect on maintaining soil humus content when green manure was applied. As a result, the biomass rotted in a short period of time, the amount of humus in the soil increased by 0.005-0.006%, total nitrogen by 0.010-0.013%, total phosphorus by 0.019-0.027%, and potassium by 0.160-0.200% in 2 years.
Also, the amount of nitrogen in the form of ammonium (May) increased by 10.3-15.3 mg/kg compared to the control (19.3 mg/kg) at the beginning of the growing season, especially by June, when the highest value returned in all options.
The use of green manures increased the amount of nitrogen in ammonium form in the soil, but even in these options, its amount was the lowest in the flowering phase of the plant, which is related to the rapid assimilation of nutrients. In this case, when green manure crops were applied in a mixed manner, they had almost the same effect. However, due to the presence of leguminous crops in the mixture of green manures, their effect lasted for a long time.
In the options where green manures were used in a mixed form, the amount of nitrogen in the form of ammonium was slightly higher during the flowering and fruiting phases of cotton than in the options where green manures were used in pure form. The amount of nitrogen in the form of ammonium was 34.6 mg/kg on May 1, 41.3 mg/kg on June 1, 40.3 mg/kg on July 1, and 37.4 mg/kg on August 1 in the bean+colza option (Table 4).

Table 4. Effect of green manure on the amount of ammonium nitrogen in the soil, mg/kg (2019 – 2020)

#	Experience options	$N\text{-}NH_4$, mg/kg			
		May 1	**June 1**	**July 1**	**August 1**
1.	Control-without green manure	19.3	29.8	28	26.05
2.	Bean	29.6	37.8	35.1	33.3
3.	Colza	30.15	38.5	37.5	35.0
4.	Bean+colza	34.6	41.3	40.3	37.4

The next indicator of our statistical analysis is the correlative relationship between the amount of $N\text{-}NH_4$ in the soil and the biomass of green manure crops, which is R=0.91 and obeys the equation $u=a+b_x$ (Figure 2).

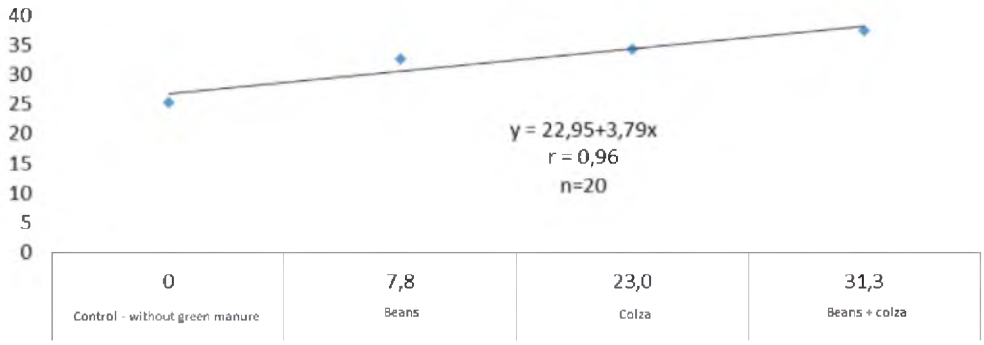

Figure 2. Dependence of the amount of $N\text{-}NH_4$ in the soil on the biomass of green manure crops (August 1)

Therefore, the combined use of green manure crops increases the amount of nitrogen in the form of ammonium in the soil and creates the most favorable nutritional regime for the growth of cotton. Such changes can also be seen in the nitrogen in the form of nitrate in the soil.

Table 5. Effect of green manure on the amount of nitrogen in the form of nitrate in the soil, mg/kg (2019 – 2020)

#	Experience options	$N\text{-}NO_3$, mg/kg			
		May 1	**June 1**	**July 1**	**August 1**
1.	Control-without green manure	16.75	20.15	18.75	17.95
2.	Bean	31.05	37.15	35.75	34.15
3.	Colza	33.45	39.75	39.45	37.05
4.	Bean+colza	37.15	42.65	41.75	40.65

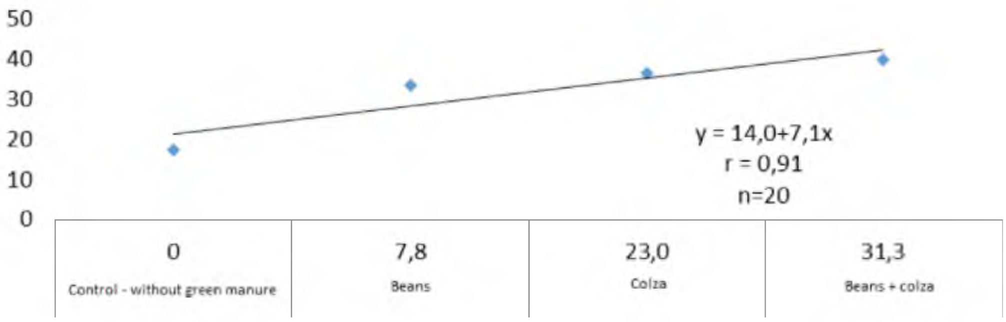

Figure 3. Amount of $N\text{-}NO_3$ in the soil green manure crops dependent on biomass (August 1)

In our research, it was found that the amount of nitrogen in the form of nitrate in the soil is the same as the amount of nitrogen in the form of ammonium. However, in the control-green manure-free option, the amount of nitrogen in the form of ammonium and nitrate changed according to the same law, that is, it increased from spring to summer until the cotton ginning period. Then, going to the phases of flowering and fruiting, their quantity decreased significantly. By the end of the growth period, the amount of nitrogen in the form of nitrate decreased somewhat. As a result of the use of green manures, changes in these laws were observed. Green manures prevented the decrease of nitrogen content in the form of nitrate in the soil in the middle of the growing season of cotton. In particular, intercropping of bean and colza resulted in significantly higher nitrogen content in the form of nitrate in the soil than the control throughout the growing season of cotton. According to the analysis, the amount of nitrogen in the form of nitrate is 16.75 mg/kg in the control-green manure-free version of the experiment on May 1; 20.15 mg/kg on June 1; 18.75 mg/kg on July 1; and on August 1 was 17.95 mg/kg. Besides, 31.05 and 33.45 mg/kg on May 1, respectively, in bean and colza variants planted as green manure; 37.15 and 39.75 on June 1; 35.75 and 39.45 on July 1; and, on August 1, it was 34.15 and 37.05 mg/kg (Table 5).

Based on the data of Figure 3, it is known that the correlation between the mobile nitrate nitrogen in the soil and the biomass of green manure crops corresponds to R=0.88.

The use of green manures in a mixed form had a stronger effect on the amount of nitrogen in the form of nitrates in the soil than in their pure form. Application of bean mixed with colza as green manure significantly increased $N\text{-}NO_3$-nitrogen in the soil, providing the highest content in the soil in this option, that is, they accelerated the assimilation of nitrogen mineralization in the soil by plants.

It was found that in the control-green manure-free version of the experiment, the amount of mobile phosphorus was less than in the other versions. In the options where green manures were used, it was noted that its amount increases during the growing season. In June, the amount of mobile phosphorus in the soil was at its maximum. By the end of the growing period of cotton, the amount of mobile phosphorus in the soil was lower than in other periods. The use of green manures increased the absorption of mobile phosphorus in the soil by plants.

Table 6. Effect of green manure on the amount of mobile phosphorus in the soil, mg/kg (2019 – 2020)

#	Experience options	P_2O_5, mg/kg			
		May 1	**June 1**	**July 1**	**August 1**
1.	Control-without green manure	21.3	23.7	20.8	18.9
2.	Bean	33.3	35.4	35.2	32.6
3.	Colza	35.3	38.1	35.9	33.1
4.	Bean+colza	38.4	41.4	39.3	36.4

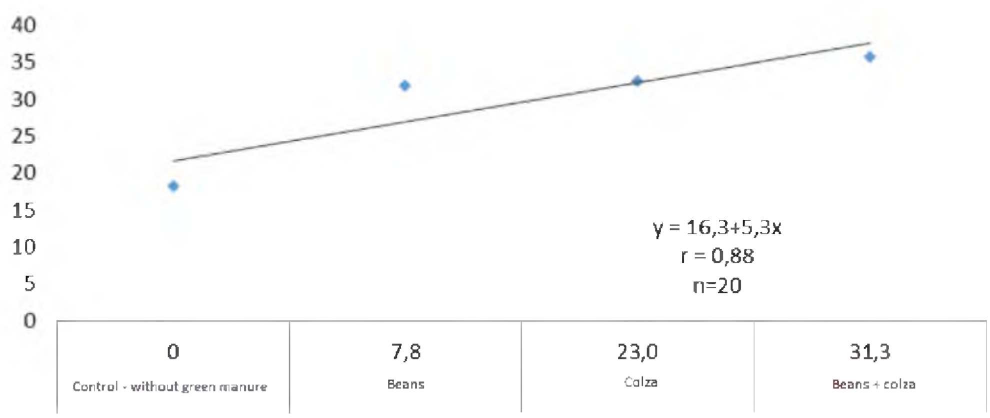

Figure 4. Dependence of the amount of P_2O_5 in the soil on the biomass of green manure crops

In the experiment, the amount of mobile phosphorus in the control version was 21.3 mg/kg on May 1; 23.70 mg/kg on June 1; 20.8 mg/kg on July 1; and on August 1 was 18.9 mg/kg. 33.3, 35.4, 35.2, and 32.6 mg/kg, respectively, in the bean variant used as green manure; 35.3, 38.1, 35.9, and 33.1 mg/kg in the colza option, 38.4, 41.4, 39.3, and 36.4 mg/kg in the mixed option (bean+colza) was found (Table 6).

It turns out that the correlation between the amount of P_2O_5 in the soil and the biomass of green manure crops is high, R=0.88. It can be concluded that the amount of mobile phosphorus in the soil indicates that green manure crop biomass increased the amount of mobile P_2O_5 (Figure 4). Therefore, green manures increase the mobilization of mobile phosphorus in meadow-alluvial soils.

During the growth period, the amount of exchangeable potassium in the soil in the control-green manure-free variant of the experiment significantly decreased by July 1. By June, it was found that the amount of exchangeable potassium in the soil is the highest. At the end of the growing season, exchangeable potassium content was observed to be the same as May 1 (Table 7).

Table 7. Effect of green manure on exchangeable potassium content in soil, mg/kg (2019 – 2020)

#	Experience options	Amount of exchangeable potassium, mg/kg			
		May 1	June 1	July 1	August 1
1.	Control-without green manure	231	252	236	231
2.	Bean	318	331	316	316
3.	Colza	341	366	346	341
4.	Bean+colza	346	381	361	356

Green manure had a stronger effect on soil exchangeable potassium content when applied as a mixture than when applied alone, and soil exchangeable potassium content was the highest.

It was determined from the obtained information that the dependence of the amount of K_2O in the soil on the biomass of green manure crops is very high (R=0.94). Green manure crops increase the mobile (water-soluble and exchangeable) form of potassium.

This is expected, because the organic mass of green manure crops partially proofs the soil environment, resulting in more exchangeable potassium going into solution. Also, a certain amount of potassium falls with green manure crops. Because potassium accumulates a lot in the young cells of the plant (Figure 5).

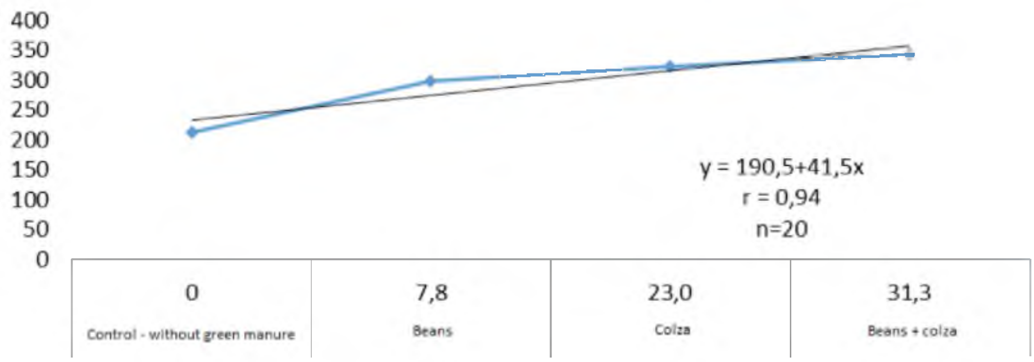

Figure 5. Dependence of the amount of K_2O in the soil on the biomass of green manure crops

In conclusion, green manure applied to cotton-free fields in a short-rotation field significantly increased the movement and uptake of humus and mobile nutrients in the soil. It is also explained by the increase in microbiological activity in the soil as a result of the increase in the amount of nutrients in the soil, especially when used in a mixed form.

4. Conclusions

1. In the fall (October 10), bean in pure state as green manure to fields freed from cotton; when colza and bean+colza are planted and cared for, the biomass yield is 31.38 tons/ha in the bean+colza variant, 23.12 tons/ha in the rape variant, and 7.81 tons/ha in the bean variant, and the highest biomass yield

indicator is bean+colza was observed in the variant. The resulting biomass is crushed as green manure and buried in the soil at the beginning of April.
2. The percentage of macroaggregates in the driving layer before the first irrigation of cotton increased by 13.0-13.45% compared to the control, and by 16.55-17.4% before the last irrigation. As a result, the volume mass of the soil decreased from 0.02 g/cm to 0.04 g/cm^3. This had a positive effect on the improvement of soil water-physical properties and high soil fertility.
3. Accumulation of organic matter due to the green manures used in the soil of the study area, their decay under the influence of microorganisms, their mineralization and their transition to a mobile form. As a result, it was found that the amounts of nitrogen, phosphorus (P_2O_5) and exchangeable potassium (K_2O) in the form of ammonium ($N\text{-}NH_4$) and nitrate ($N\text{-}NO_3$) in the soil slightly increased compared to the control-green manure-free option.

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