Effect of using repeated and siderate crops on soil fertility, yield of cotton varieties, and technological quality indicators of cotton fiber in short rotation cropping systems

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Abstract. In the 1:1 (cotton:grain) system of short-rotation, soybean, bean, mung bean crops were harvested as a repeat crop after winter wheat. Their stem crop and mixed siderate crops (perco, oats, green peas) were planted in the second half of August, and the blue mass crop grown in October-November was harvested for livestock. The lower 15-20 cm part of the stem was plowed under the plow as a blue manure, at the end of one rotation, the amount of organic carbon in the soil increased by 0.041-0.073%, and the total nitrogen content by 0.012-0.016% compared to the initial values. The highest rate of dry mass accumulation of cotton was observed when using short-row rotation 1:1, winter wheat + mixed siderate crops (perco, oat, green pea):cotton system. The dry mass of the leaves of the Navroz variety of cotton was 22.6 g, the dry mass of the stem was 33.4 g, the dry mass of the bolls was 18.5 g, and the dry mass of the cotton was 48.0 g. The total dry mass of 1 plant was equal to 122.5 g. In the 1:1 (cotton:grain) system of short-rotation, when cotton was grown as a repeat crop after legume-cereal (soybean, mung bean) and mixed siderate (perco, oat, green pea) crops, it provided a higher and better quality cotton yield. Cotton yield was 3.2-5.8 tons/ha, fiber output was 1.0-1.5 percent, and 1000 seed mass was 9.0-11.0 g/ha. Besides, the length of the fiber was found to be higher by 1.4-2.0 mm.

1 Introduction

The introduction of leguminous crops as a repeated, intermediate and siderate crop after winter wheat into the short-row rotation systems implemented in large areas of Uzbekistan helps to increase the yield of cotton and cotton-complex crops and improve its quality indicators [1]. This, in turn, becomes important in maintaining and increasing the fertility of the soil, and increases the efficiency of using irrigated areas. In this regard, a number of scientific and research works have been carried out on the introduction of repeated and intermediate crops to the areas freed from winter wheat after the changes in the structure of agricultural crops in Uzbekistan, their effectiveness in increasing soil fertility and crop yield, and recommended for different soil and climate conditions [2-4].

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A technology that positively changes the agrochemical and agrophysical properties of soils has been introduced to farms with small and large land areas operating in the conditions of typical gray, barren and meadow-alluvial soils of Uzbekistan [5]. That is, it increases the amount of humus in the soil by 0.045-0.056%, the amount of total nitrogen by 0.030-0.042%, the yield of cotton by 10-12% (32-36 tons/ha), and the yield of winter wheat by 15-20% (50-55 tons/ha) [6]. Short-row rotation was applied. For typical gray and barren soils 1:1 (winter wheat + repeated crop (mung bean) + catch crop (rye): cotton), 2:1 (winter wheat + repeated crop (mung bean):winter wheat + repeated crop (mung bean) + intercrop (rye):cotton), 1:1:1 (winter wheat + repeat crop (mush) + intercrop (triticale):cotton + intercrop (triticale):soybean, 2:1 (cotton + intercrop (rye) cotton: winter wheat + repeated crop (mung bean), new systems such as 1:1:1 (winter wheat + repeated crop (mung bean) + intercrop (triticale):soybean:cotton) were recommended for meadow-alluvial soils [7, 8].

Many studies have studied the relationship between the assimilation of free nitrogen from the air by the nodular bacteria in the roots of legumes and the effect of the agrotechnical measures used in the process of their maintenance [9-12]. The biological, physiological, and biochemical bases of assimilation of free nitrogen in the air by means of nodular bacteria living in the roots of leguminous plants have been developed [1, 5, 9, 10].

In short-rotation (1:1, 2:1) cropping systems, mung bean as a repeat crop and triticale as an intermediate crop have left 9-10 tons/ha of root and shoot residues in the soil in one rotation. It improves the growth and nutrition of the cotton planted after it. This, in turn, ensures an increase in the yield of cotton planted next year by 2.0-2.5 tons/ha [13].

25, 50, 100% of winter wheat plant residues were left before planting repeated crops in the conditions of typical gray soils of Tashkent region. Continuous and year-round plowing improved the agrophysical and agrochemical properties of the soil, and in the options maintained using 100% plant residues, 2.3 tons/ha of mung bean, 3.8 tons/ha of winter wheat, and provided an additional yield of 4.8 tons/ha from cotton [14].

Crop rotation systems with short rotation have been introduced in the conditions of grassland alluvial soils of the Republic of Karakalpakstan. Repeat crop after winter wheat in fields fed with mineral fertilizers at the rate of N30 P80 K60 kg/ha, feeding cotton with mineral fertilizers at the rate of N 160-200, P100-140, K75-100 kg/ha 33.3-34.0 quintals/ha cotton provided the harvest [15].

In short-rotation cropping systems, repeat and catch crops planted after winter wheat were harvested. Then, in the following year, when cotton was maintained after winter wheat, an additional yield of 2.4-3.6 tons/ha was obtained compared to the control option where no repeat crop was planted. After the green pulp of siderate crops was plowed into the ground as green manure, an additional cotton yield of 5.3-7.4 tons/ha was obtained from cotton [16].

Also, the effect of leguminous grain crops from repeated crops planted after winter wheat on the change of the general and mobile forms of humus, nitrogen, phosphorus and potassium content of the soil has a special place. Because of the amount of root and root residues left from leguminous crops, they quickly turn into various forms of nutrients. It was determined that it has a positive effect on the fertility of the soil and the increase in the yield of the next year's crops [3, 13, 17, 18].

Due to the planting of repeated and intermediate crops after winter wheat in short-rotational cropping systems, root-root residues of these crops remain in the soil layers in a certain amount. They turn into different forms of nutrients under the action of microorganisms over a certain period of time, and lead to the maintenance of soil fertility. In this case, humus has a great effect on the maintenance of soil fertility, and it has been observed that it synthesizes and increases the amount of root and root residues left in the soil.
2 Materials and methods

During 2019-2021, our research was carried out in the fields of the Experimental site of the Scientific-Research Institute of Cotton Selection, Seeding and Cultivation (Uzbekistan). This area is located in Qibrai district of Tashkent province of Uzbekistan 7-8 km away from the Chirchik river, on the right side of the Boz water channel.

According to the data provided by Pankov [14], Besedin and Suchkov [2], one third of the soils of Central Asia consist of gray soils, the parent rock of which is not uniform. The sizot waters, which used to be irrigated, are located at a depth of 18-20 meters.

Typical gray soils are distinguished from other soils by their low humus content and carbonation. However, the amount of humus in these soils is higher compared to the amount of humus in light gray soils.

Another agronomic property of this type of soil is that the amount of total nitrogen in the soil is directly related to the amount of humus in the soil. The amount of total nitrogen in the soil varies from 0.05% to 0.15%. Typical gray soils are very favorable for nitrification. The main part of nitrogen is found in the soil in the form of nitrates, and the nitrogen absorbed by the plant is in the same form. In most cases, the amount of total phosphorus is greater than the amount of total nitrogen. The amount of total phosphorus in the upper layers of the soil is 0.2%-0.3%.

Field experiments of short rotation rotation 1:1, winter wheat+repeated crop soybean:cotton, 1:1, winter wheat + repeated crop alfalfa:cotton, 1:1, winter wheat+repeated crop bean:cotton, 1:1, autumn wheat+mixed siderate crops (perko+oat+green pea): cotton were carried out. The experiment consisted of 10 options (5 in repeated and mixed siderate crops), the area of each plot was 120 m², the area to be considered was 60 m². The experiment consists of 4 repetitions and is arranged in 4 tiers.

In the experiment, medium fiber of cotton "Navroz", "Omad", winter wheat "Moskvich", repeated crops of soybean "Orzu", mung bean "Pobeda-104", bean "Altin Soch", green pea "Vostok-84", "Uspx" variety of oat are planted.

Our research was carried out in field and laboratory conditions, in which the placement of field experiments, calculations and observations were carried out based on the existing methodical manuals "Methods for conducting field experiments", soil and plant analysis [4, 11].

From mineral fertilizers in crop care: ammonium nitrate (N 33-34%), ammophos (N 11-12%, P₂O₅-46%), suprephos (N 5-6%, P₂O₅-32%), potassium chloride (K₂O-60%) was used.

3 Results and discussion

It is known that the good growth and development of agricultural crops, high yields and good quality indicators of the crops obtained from them also depend on the amount of nutrients in the soil. In short-rotational cropping systems, the correct selection of the types of repeated crops grown in areas freed from autumn grain crops is important in maintaining the fertility of the soil.

According to the data obtained from our research on the effectiveness of leguminous-cereal crops grown as repeated and mixed siderate crops in short-rotation rotation systems in growing high-quality cotton crops compared to cotton varieties, the amount of organic carbon in the soil is 0.476% in the tillage layer (0-30 cm) of the soil. in the subsoil layer was 0.425%, the amount of nitrogen was 0.074-0.065%, and the amount of phosphorus was 0.162-0.144%. The amount of mobile forms of nutrients N-NO₃ in the 0-30 cm layer of the soil was 4.3 mg/kg, the amount of P₂O₅ was 10.8 mg/kg, and the amount of K₂O was 220 mg/kg.

It can be seen that the soil of the field where our research was carried out was provided with nitrogen and phosphorus at a very low level, and with potassium at an average level.
In our research, it was found that leguminous grain crops cultivated as repeated and mixed siderate crops after winter wheat affected the amount of nutrients in the soil. At the end of the growing period of cotton, i.e., in the 1:1 (grain:cotton) system of short rotation rotation, when the amount of organic carbon in the soil is determined (in the 0-30 cm layer) at the end of one rotation, the highest indicator is followed by winter wheat as a repeated crop of beans and mixed siderate crops (perco, oats, green peas) were observed in options 3 and 5. Compared to the initial indicators, it increased by 0.061-0.073%, and it was found that it increased by 0.041-0.042% in options 2 and 4, where soybean and mung bean were planted as repeated crops after winter wheat. In the control variant, the amount of organic carbon in the soil was 0.480%, and it was found that it increased by 0.004% compared to the initial indicator.

The main reason for the increase of organic carbon in the soil in options where leguminous crops are planted as repeated and mixed siderate crops is that after harvesting the grain yield of soybeans, beans, and mung beans planted as repeated crops, their stalks were plowed under the autumn plow as organic mass. The green mass produced by the mixed siderate crops (perco, oats, green peas) was also plowed under the plow as blue manure. According to the results of the analysis of the total nitrogen content of the soil, the highest rate was observed when beans (option 3) and mixed siderate crops (option 5) were planted as a repeat crop after winter wheat. It was found that it increased by 0.012-0.016% in the 0-30 cm layer of the soil. In the remaining options, the regularities in determining the amount of organic carbon in the above soil were observed. These laws were preserved during the remaining years of the experiment.

It is known from many studies that any agricultural crop takes away nutrients from the soil significantly during the period of operation. After the plant is harvested or harvested, a certain amount of nutrients return to the soil as organic matter through the stem (residual stem) and root of the plant. In addition, some roots of crops planted as repeated or intermediate crops end their activity during the period of operation and turn into organic matter.

Leguminous crops grown as repeated crops also have a high impact on soil fertility. When legumes are planted as a repeated crop, they enrich the soil with clean organic matter, as a result of which the biological activity of the soil increases, the amount of water-soluble organic matter and new, mobile substances that form humus increases. This has a positive effect on the growth, development and productivity of the crop planted as a follower crop, and creates a basis for the improvement of the quality of the cultivated crop.

In our research, it was observed that the growth, development, cotton yield and quality indicators of cotton varieties were affected by previous crops. According to the data obtained from our research, in 2019, 2020, 2021, in accordance with the experimental system, after winter wheat, it was plowed without sowing any repeated crops, and after soybeans, beans, mung bean and mixed siderate crops (perco, oat, green peas), cotton was planted. At the beginning of the treatment period, there were almost no differences in cotton growth and development between the variants. According to the data obtained in 2020, the height of the plant was found to be between 10.2 cm and 11.6 cm.

According to the data obtained at the end of the period of operation, the height of the cotton in the Navroz variety was 85.4-88.7 cm, and the number of bolls was 8.9-11.7. In the "Omad" variety, the average height of the cotton was 71.4-76.3 cm, and the number of bolls was 7.4-8.5 pieces. In short-row rotation 1:1, winter wheat+black plow:cotton system, in which cotton was planted after autumn wheat without any repeated cropping, plant height was 85.4 cm and the number of bolls was 8.9 in "Navroz" variety. In the "Omad" variety, these indicators were 71.4 cm and 7.4 pieces, respectively (Figure 1).
According to the results of the experiment, the highest indicators in the development of cotton were observed in the 5th and 6th variants of the experiment, that is, when the 1:1, winter wheat + repeated crop (bean):cotton system of short-row rotation was used. It was observed that the length of the cotton was 3.3 cm higher and the number of bolls increased by 2.8 in the "Navroz" variety compared to the control variant. In the "Omad" variety, these parameters were found to be 3.9 cm, and the number of pods was 0.9 more. In the 9th and 10th variants of the experiment, i.e. 1:1 of short-row rotation, winter wheat + mixed siderate crops (perko, oat, green pea): when the cotton system is used, the length of the cotton in the "Navroz" variety is 88.3 cm, the number of bolls is 10.4 formed a piece. Compared to the control variant, the height of the plant was 2.9 cm, and the number of pods was 1.5, while in the "Omad" variety, it was 76.3 cm, and the number of pods was 8.5. This ensured that the height of the plant was 4.9 cm, and the number of pods was 1.1 more than the control version.

It was observed that repeated and mixed siderate crops in short-row rotation systems affected the dry mass accumulation of cotton (Figure 2).

According to the data obtained at the end of the period of operation, in the short-row rotation 1:1, winter wheat + black plow: cotton system, in the options where cotton was planted without any repeated cropping after autumn wheat, the dry mass of cotton leaves was 20.1 g, the stem was 20.1 g. dry mass was 31.8 g, dry mass of sorghum was 17.0 g, and dry mass of cotton was 44.2 g. The total dry mass of 1 plant is 113.1 g and equal to In the same system, the dry mass of cotton leaves was 18.8 g, the dry mass of stems was 30.2 g, the dry mass of bolls was 18.2 g, and the dry mass of cotton was 43.4 g in the "Omad" variety of cotton. The total dry weight of 1 plant was equal to 110.6 g. It was determined that the weight of the vegetative part of the cotton was 68.9 g in the "Navroz" variety, and 67.2 g in the "Omad" variety.

The highest rate of dry mass accumulation of cotton is observed in short-row rotation 1:1, winter wheat + mixed siderate crops (perko, oat, green pea): when the cotton system is used, the dry mass of cotton leaves is 22.6 g in the "Navroz" cotton variety. dry mass of stem was 33.4 g, dry mass of pods was 18.5 g, and dry mass of cotton was 48.0 g. The total dry mass of 1 plant was equal to 122.5 g. In the same system, the dry mass of cotton leaves was 20.5 g, the dry mass of stems was 31.9 g, the dry mass of bolls was 19.3 g, and the dry mass of
cotton was 46.3 g. The total dry mass of 1 plant was equal to 118.0 g. In this case, it was determined that the weight of the vegetative part of the cotton was 74.5 g in the "Navroz" variety, and 71.7 g in the "Omad" variety. This, in turn, ensured that the total dry weight of cotton at the end of the period was 9.4 g higher in the Navroz variety and 7.7 g higher in the Omad variety than in the control option, where cotton was grown without any repeated cropping after winter wheat.

In the 1:1 (cotton:cereal) system of short-rotation rotation, the cultivation of legume crops (soybeans, beans, mung beans) as a repeat crop after winter wheat also provided a 3.0-8.2 g higher total dry weight of cotton compared to the control option.

According to the data obtained from the experiments, the cotton yield after winter wheat as a repeated and mixed siderate crop after leguminous grain crops in 2010 compared to the control variant provided an additional cotton yield of 3.2-5.8 quintals/ha. In the "Omad" variety of cotton, 3.4-5.7 quintals/ha of additional bolls were obtained. The highest cotton yield was obtained from variants 5 and 6, in which cotton was planted after winter wheat+repeat beans in the 1:1 system of short-row rotation. Cotton yield of 38.4 tons/ha was obtained from option 5, where "Navroz" variety of cotton was planted, and 37.2 tons/ha of cotton was obtained from option 6, where "Omad" variety of cotton was planted. This provided additional cotton yield in the amount of 5.8 and 5.7 tons/ha in the "Navroz" and "Omad" varieties of cotton, respectively, compared to the control option. When using the 1:1 short-row rotation, winter wheat + mixed siderate crops (perko, oat, green pea):cotton system, the yield of cotton from the Navroz variety is 37.6 tons/ha, and from the Omad variety 36.9 tons/ha cotton crop was obtained. It was observed that the cotton yield was 3.2-5.8 tons/ha less than the other options in the control options using the 1:1, winter wheat+black plow:cotton system of short-row rotation (Figure 2).

Fig. 2. Correlation between cotton dry mass accumulation and cotton yield formation.

It was observed that the planting of leguminous crops as a repeat crop after winter wheat influenced the improvement of tenological quality indicators of cotton fiber (Figure 3).

According to the data obtained from the experiment, it was found that in the first variant of the experiment, in which the "Navroz" variety of cotton was planted on the background of plowed fields after autumn wheat, the yield of fiber was 37.0%, and the mass of 1000 seeds was 117.0 g. In the second option, where the "Omad" variety of cotton was planted on the same background, the yield of fiber was 34.5%, and the mass of 1000 seeds was 119.5 g. Soybean was planted as a repeat crop after winter wheat, and in the third option, in which the cotton variety "Navroz" was planted on this background, the fiber yield was 38.5%, compared to the control option, 1.5%. The mass of 1000 seeds was 126.0 g, compared to the control
variant by 9.0 g. In the fourth option, where the cotton variety "Omad" was planted on the same background, the fiber yield was 35.0%, compared to the control option by 0.5%, and the mass of 1000 seeds was 130.0 g. Compared to the control variant, it was found to be 11.0 g higher.

![Graph](image)

**Fig. 3.** Effect of repeated and mixed siderate crops on technological quality parameters of cotton fiber.

The highest rate of fiber yield was observed in options 7 and 8, where cotton was planted on the background of mung bean, as a repeat crop after winter wheat. It was 40.0-35.0%, respectively. Legumes as a repeat crop after winter wheat were observed in options 3 and 4, where cotton was planted on the background of soybeans (41.5-37.5%). The highest rate of 1000 seed mass was observed in options 5 and 6, where cotton was grown next year on the background of leguminous grain crop as a repeated crop after winter wheat, and it was 127.0-130.0 g.

According to the fiber length data, the highest value was observed in the variant where beans were planted as a repeat crop after winter wheat, followed by cotton. The average fiber of cotton was 32.8 mm in the "Navroz" variety, and 35.0 mm in the "Omad" variety. A closer result was obtained from options 5 and 6, where mixed siderate crops were planted after winter wheat and cotton was grown after these crops, and it was 32.3 mm in the "Navroz" variety, and 34.9 mm in the "Omad" variety. It was found that the fiber length of "Navroz" variety was 31.9 mm, and the length of "Omad" variety was 33.6 mm.

### 4 Conclusions

In the 1:1 (cotton:grain) system of short rotation rotation, soybeans, beans, and mung bean crops were planted as repeat crops after winter wheat, after the grain harvest, their stalks and mixed siderate crops (perco, oat, green peas) were planted in the second half of August. The green pea crop grown in October-November was harvested for livestock. The lower 15-20 cm part of the stem was plowed under the plow as a blue manure, at the end of one rotation, the content of organic carbon in the soil increased by 0.041-0.073%, and the total nitrogen content by 0.012-0.016% compared to the initial values.

The highest rate of dry mass accumulation of cotton was observed when using short-row rotation 1:1, winter wheat + mixed siderate crops (perco, oat, green pea):cotton system. The dry mass of the leaves of the Navroz variety of cotton was 22.6 g, the dry mass of the stem was 33.4 g, the dry mass of the bolls was 18.5 g, and the dry mass of the cotton was 48.0 g. The total dry mass of 1 plant was equal to 122.5 g. This, in turn, resulted in 9.4 g higher total...
dry mass at the end of the period compared to the control option where cotton was grown in a plowed background without any repeat cropping after winter wheat.

In the 1:1 (cotton:grain) system of short rotation rotation, cotton was grown as a repeat crop after legume-cereal (soybean, mungbean) and mixed siderate (perco, oat, green pea) crops, which provided a higher and better quality cotton yield. Cotton yield is 3.2-5.8 tons/ha, fiber yield is 1.0-1.5%, 1000 seed mass is 9.0-11.0 g/ha, and fiber length is 1.4-2.0 It was found to be higher by mm.

In short-rotation 1:1 (cotton:grain) system, cotton is grown as a repeated crop after legumes (soybean, mung bean, mung bean) and mixed siderate crops (perco, oat, green pea) to obtain good quality cotton fiber. provides.

References


