INFLUENCE OF CROP ROTATION AND FERTILIZERS ON THE GROWTH, DEVELOPMENT, AND YIELD OF MEDIUM-FIBER COTTON IN SOUTHERN UZBEKISTAN

Karim Tadjiev[1], Mardankul Tadjiev[2], Aslon Khaitmuratov[1], Abduzoir Shomurodov[1], Dilshod Jumanov[1], Aasik Hussain[3]

[1]Termez State University of Engineering and Agrotechnologies
[2] Research Institute of Fine-Fiber Cotton (RIFC)
[3]JNU UniversityMamlika Haryana India

ABSTRACT
Crop rotation is a scientifically based crop rotation over the years. In crop rotation, crops are sown sequentially in all fields. The recurrence of the crop rotation period is called crop rotation.
When sowing soybeans, fodder peas, triticale+fodder peas on fields freed from winter wheat, and sowing cotton on harvested fields, the proportion of vegetative and generative organs increases due to intensive growth and development. The best predecessors of cotton were winter wheat, repeated soybeans, fodder peas, triticale+fodder peas, which ensured an additional yield of 0.16-0.22 t/ha^{-1} of cotton. When sowing green manure crops (soybeans, fodder peas, triticale, triticale+fodder peas) after winter wheat, an additional yield of 0.40-0.56 t/ha^{-1} or 13.0-18.7% was obtained compared to the control. When sowing cotton after green manure crops, the green mass of intermediate crops was more effective compared to the harvested field, and an additional 0.41-0.56 t/ha^{-1} of raw cotton was obtained compared to the control variants.

Keywords. Crop rotation, green manure, intermediate crops, cotton, height, number of yield elements, bolls, opened ones, cotton yield, predecessor crops, soybeans, fodder peas, triticale, triticale+fodder peas, etc.

Introduction.
Domestic and foreign scientists have studied the influence of crop rotation and fertilization on the growth, development, and yield of cotton.

Increasing the volume of spring wheat grain production indicates the need to improve individual technological processes for its cultivation. Scientifically based selection of predecessors is very important for obtaining high yields of spring wheat and increasing the effectiveness of the crop rotation system as a whole [Morozov, Toygil'din, Sharonova 2009: 45-48].

An important direction for maintaining soil fertility and obtaining a stable yield under conditions of limited resource availability of agriculture is the use of ecological and biological factors [Lobkov 2017: 55-59; Loshakov 2015: 300; Loshchinina 2017: 140; Seminenko 2018: 89-94; Kozlova, Popov, Noskova 2020: 295-304].

In cotton cultivation, as noted in many studies, legumes and leguminous crops are the most valuable predecessors, accumulating up to 10 kg/ha^{-1} or more of biological nitrogen in the soil due to symbiotic activity. Cotton farms mainly use cotton-alfalfa crop rotation. Cultivation of cotton in areas without crop rotation leads to a decrease in humus reserves and deterioration of the structural, physical, and water-physical state of the soil. [MasnyR.S., BalakaiG.T., YurkovaR.E., SelitskyS.A. 2024].

In studies conducted in the Northern Mugan region of the Republic of Azerbaijan, it was established that after 3 years of cotton cultivation in one field, the agrophysical and agronomic properties of the soil significantly deteriorated. The obtained results show that the loss of up to 20% of humus, up to 40% of water-resistant aggregates, a threefold decrease in soil permeability, and an increase in the density of the soil layer by 7% negatively affected the cotton yield. [GyulalievCh.G., KocharliS.A., KozlovaA.A., DjafarovA.M., 2022].

In the experiments of PavlenkovaT.V., PostnikovP.A. [2024], when studying the influence of the fertilization system and crop rotation on the formation of spring wheat yield in long-term continuous field experiments in the conditions of the Middle Urals, it was established that as a result of crop rotation, the yield of spring wheat increases due to improved soil fertility.

According to the results of the conducted research, it was noted that when growing cotton in one field without crop rotation and mineral fertilizers, the number of annual and perennial weeds increases significantly, and when cotton is strictly rotated with the main predecessors in the cotton complex, weed infestation decreases significantly [Tadjiev M., Tadjiev K.M. 2023].

When sowing soybeans, peanuts, and sunflowers in the area freed from winter wheat, an increase in the amount of humus, total nitrogen, and total phosphorus in the soil composition was revealed compared to the unsown area [Tadjiev M., Tadjiev K.M. 2023].

The influence of crop rotation on the agrochemical properties and fertility of soils was studied on long-irrigated serozem-meadow soils. Alfalfa contributes to increasing the reserves of organic matter and nutrients, improving the water-physical properties of the soil, and reducing salinity. Cotton is grown in a three-field alfalfa crop rotation. In the cotton-alfalfa crop rotation, the use of intermediate crops such as rye, rapeseed, mustard, peas, soybeans, and their plowing as green manure is proposed [Ashirbekov M.J., Dridiger V.K.2018; Suleimenova N.Sh.,Tagayev A. 2008; Ashirbekov M.2011; Ashirbekov M.J. 2010].

In the short-rotation crop-grain-rotation system, when sowing peas, chickpeas, barley, and rapeseed on the area freed from winter wheat as green manure in the flowering phase, it had a positive effect on increasing soil fertility [Kenjaev Yu.Ch. and Turdibaev D.U. 2020].

As a preceding crop, alfalfa has been studied in its pure form and combined with cereal crops - barley, corn, sorghum, and Sudan grass. Their influence on the growth, development, and yield of cotton and corn in the cotton-alfalfa crop rotation was determined [Norov M.S., Sardorov M.N., Kodirov K.G. 2022].

According to the data of field experiments conducted in the south of Uzbekistan, when harvesting winter wheat and sowing fodder peas for green manure, a cotton yield of 3.52 t/ha^{-1} was obtained, which is 0.52 t/ha^{-1} higher compared to the control variant. In this case, faster boll formation was observed in the plants. It was established that the weight of one boll in the fields where the predecessors were intermediate and green manure crops was 0.7-0.9 g higher compared to the control [Tadzhiev M., Tadjiev K.M., Khalmanov B.A. 2016]. In other studies, it was found that in crop rotation systems without leguminous crops, fewer bolls are distributed in the upper third of the cotton plant. [Cordeiro C.F.S., Raphael J.P.A., Echer F.R. 2023].

The main technological processes in the autumn period include the application of organic and mineral fertilizers, basic tillage. Manure rates should not exceed 10-15 t/ha^{-1} to prevent excessive plant growth. Mineral fertilizers are introduced due to the reserves of nutrients in the soil and the planned use of organic fertilizers. For 1 ton of seed cotton, up to 45-50 kg of nitrogen, 15-20 kg of phosphorus, and more than 50 kg of potassium are consumed. Combined application of fertilizers in the ratio N:P:K 1:0.7:0.5 gives the best effect [Kuliyev K., Shammedov M.N.2016].

As a result of research conducted by scientists of the Republic of Tajikistan in the Hissar Valley, it was recommended to apply phosphorus fertilizers for growth in height, leaf surface area, number of bolls, intensity of photosynthesis, accumulation of dry mass, and high yield [AbdullaevKh.A.et al., 2018].

For obtaining high and quality cotton yields and restoring soil fertility, it is recommended to apply 10 t/ha^{-1} + N90P120K90 kg/ha^{-1} of manure [Aslanov G.A., Novruzova G.Kh. 2017].

Cotton varieties, fertilization, irrigation, inter-row cultivation methods, and many other agrotechnical measures, as well as soil and climatic conditions, influence the formation of cotton yield and fiber quality

(Echer et al., 2019, Raphael et al., 2019). Wheat-cotton crop rotation was widely used as a well-established system to increase the yield of grain and cotton (Zhang et al., 2007, Shah et al., 2016).
As a result of the research, it was established that the best yield indicators were obtained when plant residues were completely buried at a depth of 28-30 cm under conventional plowing. With this method, an additional 0.38 t/ha^{-1} of cotton yield was obtained compared to crop rotation. Due to this method of soil cultivation, the water consumption for obtaining 1 ton of yield was reduced [KarabayevI.T.et al. 2018].

Weeds cause significant damage to cotton crops, especially in irrigated areas. Many studies are aimed at finding effective methods and means of weed control. The use of agrotechnical, chemical, or mixed control methods increases soil fertility, accelerates plant growth and development, increases yield, and improves product quality [KomilovK.S.et al., 2015; Bakhromov S.L.et al., 2015; Borisenko I.B.,et al., 2023; UraimovT. 2023; Daribek U.D.et al., 2021.

In Uzbekistan, under irrigated agro-ecological conditions, the positive effect of crop rotation in the winter wheat-summer mung bean-cotton system on yields has been established [IbragimovN. et al. 2019]

Previous studies have shown that with an increase in cotton yield, fiber quality decreases (Clement et al., 2012, Shang et al., 2016). It is difficult to simultaneously increase the cotton yield and fiber quality, and significantly improving fiber quality requires a lot of work (Clement et al., 2012, Liang et al., 2013).

Studies have shown that excessive or insufficient N fertilizer leads to a decrease in yield (Luo et al., 2018, Liu et al., 2021). N deficiency in the soil leads to early aging of crops (Dong et al., 2012).

Insufficient nitrogen supply during the cotton growing season leads to a significant decrease in cotton yield. High yields of cotton can be obtained due to an increase in the number and weight of bolls when cotton is supplied with nitrogen fertilizers in moderate amounts during the flowering period (Shah et al., 2017, Luo et al., 2020).

Ma et al. (2022) concluded that with an increase in nitrogen content, the length of cotton fiber and its strength increase first of all, and with a further increase in nitrogen content, it decreases. Therefore, determining the optimal rates of nitrogen fertilizers is very important for improving cotton yield and fiber quality.

As a result of the use of large amounts of nitrogen, the soil degrades (West et al., 2014, Zhuang et al., 2020), water is polluted (Luo et al., 2022). The cotton's nitrogen requirement reaches its maximum during the flowering period (Shah et al., 2021).

Plowing with winter wheat straw is effective in increasing the content of organic carbon, nitrogen, potassium, phosphorus, and other nutrients in the soil (Ma et al., 2019).

Research Methods.
Field experiments on the study of the influence of winter wheat and repeated (oilseed) crops on soil fertility were conducted according to the method "Methods of Conducting Field Experiments with Cotton" (2007) and "State Variety Testing of Agricultural Crops" (1981) developed at the Research Institute of Cotton Growing of Uzbekistan. Cotton yield was mathematically processed according to the method of B.A. Dospekhov (1985).

Field and laboratory studies were conducted on takyr-like low-humus and slightly saline soils in the experimental farm of the Surkhandarya Scientific Experimental Station of the institute. Two long-term experiments were conducted. The soils of the experimental plot are heavy loamy by mechanical composition, groundwater is located at a depth of 1.5-2.0 mm, slightly saline, poorly supplied with humus and other nutrients, rich in carbonates (8-10%). The experiments were conducted in three repetitions. The area of one plot is 240 sq. m, the length is 50 m, and the width is 7.2 m. The total area occupied by the experimental plot is 2.0 ha.
Research results and discussion.

After harvesting winter wheat, repeated crops were irrigated for quality tillage. After the soil ripened, the fields were softened twice with a chisel, followed by leveling for sowing seeds of repeated and green manure crops.
In the second half of October, winter wheat was sown. After sowing, furrows were cut for irrigation, which ensures uniform germination of winter wheat. Phenological observations before harvest and plant height 95.5-98.7 cm, number of leaves 5.4-5.7 pieces, spike length 14.5-15.3 cm, spike weight 1.2 g, number of grains per spike 45-48 pieces, weight of grains per water spike 1.1 g, and weight of 1000 seeds i 48.5 g.

The average grain yield of winter wheat was 6,98 t/ha^{-1}, root and stubble residues in the plow layer were 4,08 t/ha^{-1}, in the subsoil layer 0,24 t/ha^{-1}, and in the 0-50 cm layer 4,32 t/ha^{-1}.

Root stubble residues in the 0-50 cm layer of soybeans were 3,18 t/ha^{-1}, triticale 3,28 t/ha^{-1}, fodder peas 3,37 t/ha^{-1} and fodder peas and triticale 5,15 t/ha^{-1} and corn 4,45 t/ha^{-1}.

The green mass of intermediate and green manure crops was crushed in October and early November and plowed under the plowed land.

The content of mobile phosphorus in 93% of irrigated soils, exchangeable potassium in 68.3%, humus in 79.3% of soils has fallen below average [KhalikovB.,2021].

When growing various types of green manure fertilizers as a single, two, and three-component mixture and plowing them as green manure, it positively affects the biological properties of the soil and increases the number of microorganisms in the soil, including bacteria, fungi, actinomycetes, nitrogen fixers, dinitrifying agents, and oligonitrophiles by 3-6 times compared to the control variant [KhalmanovN., 2019].

The sowing of mung bean and soybeans as a repeated crop of leguminous crops creates favorable conditions for microorganisms, as well as for maintaining and increasing soil fertility. Due to the sowing of these crops, the fixation of nitrogen in the form of organic compounds and the loss of humus are reduced, and due to a decrease in the amount of oligotrophic and pedotrophic indices and denitrifying agents in the soil, the process of decomposition of humus and nitrogenous organic substances in the soil is reduced, while an increase in the number of bacteria, ammonifiers, and oligonitrophilic microorganisms that assimilate mineral nitrogen creates the basis for the accumulation of a greater amount of carbon and nitrogenous organic substances [KhalikovB., RasulovaF., 2019].

According to the research results of MirzayevL. [2021], after applying mineral fertilizers at a rate of N180R120K90 kg/ha for winter wheat, it is recommended to use mineral fertilizers at a rate of N200R140K100 kg/ha when planting cotton the following year in fields without repeated crops. For fields where sunflower was planted as a repeated crop with N180R120K90 kg/ha fertilizer application, it is advised to apply mineral fertilizers at a rate of N240R170K125 kg/ha for cotton cultivation in the subsequent year.

The research results showed that different legumes and cereals sown after winter wheat have different effects on the growth, development, and yield of cotton (Table 1).

In the experiment, the Bukhara-102 medium-fiber cotton variety was sown, the fiber quality of which meets all the requirements of international standards.

The plant height in the control was 84.0 cm, with 9.6 bolls per plant. When cotton was sown in a field where green mass of soybean was harvested for livestock after winter wheat, the plant height reached 86.9 cm with 10.3 bolls per plant, which is 2.9 cm taller and 0.7 bolls more than the control.

Table 1.
Influence of winter wheat and repeated crops on the growth, development, and fruiting of cotton

No	Variant name	September 1					
		plantheight, cm	the number of fruit crops, piece	quantity of fruit elements ,pcs	of which are boxes, pcs	Including opened ones, pieces	plant density, thousand /ha $^{-1}$
1.	Cotton after winter wheat (control)	84.0	15.1	14.5	9.6	8.2	78.1
2.	Cotton after winter wheat harvest with soybean crops (green mass for livestock feed)	86.9	15.2	14.5	10.3	8.2	77.7
3.	Cotton after harvesting winter wheat with sowing soybeans for green manure	88.4	15.4	15.6.	11.0	8.0	76.9
4.	Cotton after harvesting winter wheat with sowing fodder peas (green mass for livestock feed)	85.5	15.3	15.0	10.4	8.1	75.8
5.	Cotton after harvesting winter wheat with sowing fodder peas for green manure	90.3	15.5	14.0	11.6.	7.9	76.5
6.	Cotton after harvesting winter wheat with triticale (green mass for livestock feed)	86.0	15.5	15.4	10.6.	8.4	75.7
7.	Cotton after harvesting winter wheat with triticale (green mass for green manure)	90.1	15.8	15.9	11.7.	8.9	76.5
8.	Cotton after harvesting winter wheat with sowing triticale+feed peas (green mass for green manure)	89.0	16.5	16.6.	11.8.	7.6	75.9
9.	Cotton after harvesting winter wheat with corn for silage	82.0	15.0	15.1	9.4	7.9	77.4

When cotton was sown in a field where soybeans were planted and used as green manure after harvesting winter wheat, the cotton plant height was 88.4 cm with 11.0 bolls, which is 4.4 cm taller and 1.4 bolls more than the control.

When cotton was sown in a field where winter wheat was harvested and green mass of fodder peas was collected for livestock, the cotton height was 85.5 cm with 10.4 bolls, which is 1.5 cm taller and 0.8 bolls more than the control.

When cotton was sown in a field where winter wheat was harvested and fodder peas were used as green manure, the cotton plant height was 90.3 cm with 11.6 bolls, which is 6.3 cm taller and 2.0 bolls more than the control.

When cotton was sown in a field where winter wheat was harvested and triticale was collected for livestock, the height was 86.0 cm with 10.6 bolls, which is 2.0 cm taller and 1.0 bolls more than the control.

When cotton was sown in a field where winter wheat was harvested and triticale was used as green manure, the height was 90.1 cm with 11.7 bolls, which is 6.1 cm taller and 2.1 bolls more than the control.

When cotton was sown in a field where winter wheat was harvested and triticale+fodder peas were used as green manure, the height was 89.0 cm with 11.8 bolls, which is 5.0 cm taller and 2.2 bolls more than the control.

When cotton was sown in a field used for corn silage after harvesting winter wheat, the height was 82.0 cm with 9.4 bolls, which is 2.0 cm shorter and 0.2 bolls fewer than the control. When corn is used for silage, it absorbs a large amount of nutrients from the soil, which negatively affects the growth and development of subsequent crops.

When various green manure fertilizers are cultivated as single, two, and three-component mixtures and plowed under as green manure, it positively affects the biological properties of the soil and the microorganisms in the soilIt has been determined that the quantity, including the number of bacteria, fungi, actinomycetes, nitrogen fixers, denitrifiers, and oligonitrophiles, increased by 3-6 times compared to the control variant [KhalmanovN., 2019].

When determining the plant density in the experiment, no significant difference was observed between the variants.

Winter wheat and repeated crops had a significant impact on the cotton yield (Figure 1).

A relatively low cotton yield was also obtained in the control variant with corn for silage after winter wheat harvest - 2.75-3.01 t/ha^{-1}. In the variants where green mass was used as feed for livestock, the cotton yield was (variants 2.4,6) -3,18-3,32 t/ha^{-1}.

This is explained by the fact that when repeatedly sown, it forms a high yield of silage mass, but absorbs more nutrients from the soil.

The highest cotton yield was obtained in the variants grown after the cotton green manure variants (3,5,7,8) with a yield of 3,40-3,56tonnes per hectare. In the experiment, the highest cotton yield was 3,56 t/ha^{-1}, and after winter wheat, triticale+fodder peas were sown as a green manure crop. In this variant, compared to the control, an additional cotton yield of 0,19-0,56 t/ha^{-1} was obtained, while in the variant where cotton was sown with corn as a repeated crop after winter wheat, compared to the control, a decrease in cotton yield of 0,25 t/ha^{-1} or 8.5% was observed.

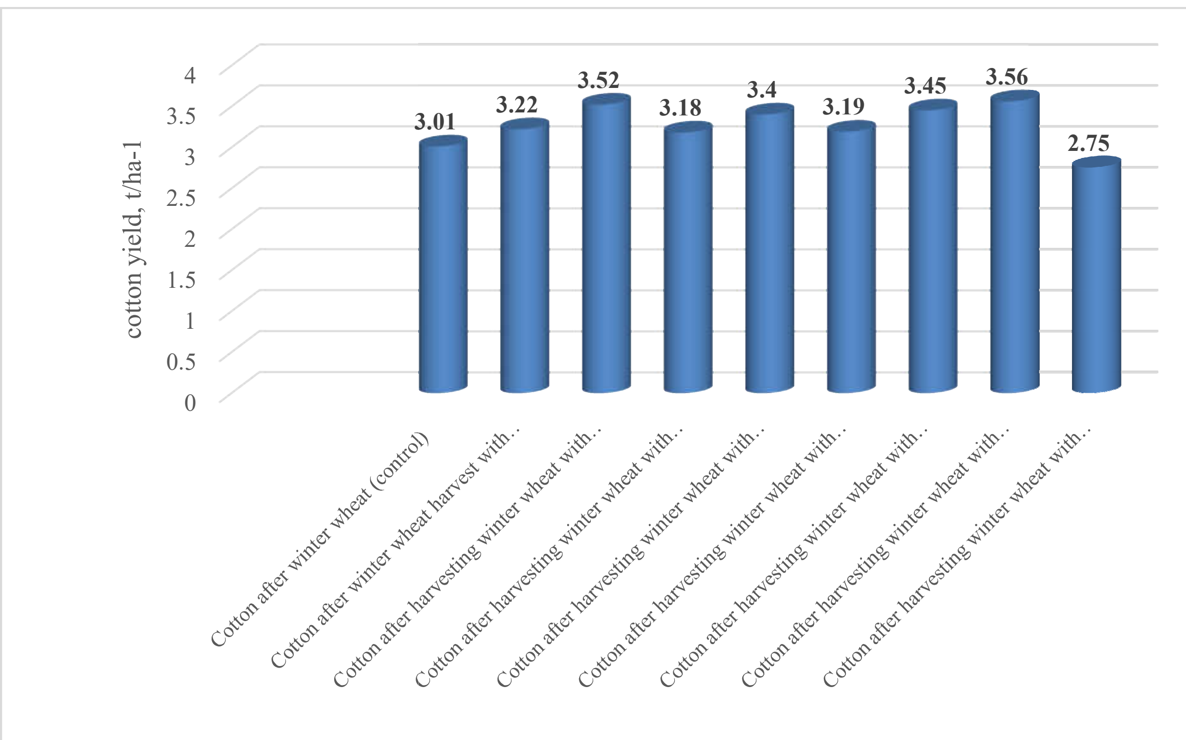

Figure 1. *Influence of winter wheat and repeated crops on the yield of raw cotton*

In conclusion, it can be said that, the best predecessors for cotton were winter wheat, double-cropped soybeans, fodder peas, and triticale+fodder peas mixture, which provided an additional cotton yield of 0.16-0.22 t/ha. When green manure crops (soybeans, fodder peas, triticale, and triticale+fodder peas mixture) were sown after winter wheat, an additional yield of 0.40-0.56 t/ha or 13.0-18.7% was achieved compared to the control. Sowing cotton after green manure crops proved more effective than planting it in fields where the green mass of intermediate crops had been harvested, resulting in an additional 0.41-0.56 t/ha of raw cotton yield compared to the control variants.

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