Agricultural Sciences, 2022, 13, 1285-1290
https://www.scirp.org/journal/as
ISSN Online: 2156-8561
ISSN Print: 2156-8553

# Humus Content in Soil and Yield in the Permanent Cotton Cultivated Fields

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**How to cite this paper:** Meylikovich, K.B., Makhmudovich, B.K., Teshaevna, N.S. and Khaydorovich, M.U. (2022) Humus Content in Soil and Yield in the Permanent Cotton Cultivated Fields. *Agricultural Sciences*, **13**, 1285-1290.
https://doi.org/10.4236/as.2022.1312078

**Received:** October 11, 2022
**Accepted:** December 2, 2022
**Published:** December 5, 2022



## Abstract

The article presents the data of a long-term experience on the reproductive capacity of the soil during the permanent cultivation of cotton, which has been carried out for 96 years at the Institute of Breeding, Seed Production and Agrotechnology for Growing Cotton in the Kibray district of the Tashkent region. The article presents the results of analyses by determining the content of humus, from which it can be seen that the decrease in humus was more marked on the control variant without fertilizers, and the amount of humus decreased after 20 years compared to the initial indicator by 11.4 t/ha, after 40 years 16 46 t/ha, after 60 years by 19.05 t/ha, after 80 years by 26.29 t/ha and after 96 years by 29.17 t/ha. It was also determined by the decrease in humus content in option 2, where NPK 250:175:125 kg/ha was applied annually, respectively: 6.487 t/ha; 9.225 t/ha; 10.09 t/ha; 16.95 t/ha; 19.65 t/ha; with an annual application of 30 t/ha of manure + 25 kg/ha of $P_2O$ in option 1, respectively: 0.335 t/ha; 3.683 t/ha; 11.40 t/ha; 22.44 t/ha; 32.58 t/ha. In addition, the article also provides data on the yield of cotton by options for permanent cultivation. It was determined that in the control variant, the yield decreased from 16.8 centners per hectare to 9.9 centners per hectare; in the variant where NPK was applied every year 250:175:125 kg/ha was 31 - 34 c/ha, where 30 t/ha of manure + 25 kg/ha $P_2O$ 29 - 32 c/ha were used every year.

## Keywords

Crop Rotation, Permanent Cotton, Soil Fertility, Humus, Quantity, Norm, Organic Residue, Microorganisms, Nutrients, Cotton Yield

## 1. Introduction

Soil and its fertility are the scientific basis of farming. In farming, the condition of the soil for growing products from agricultural crops has always been evaluated by its productivity, because it is known to everyone that obtaining a high and quality harvest from crops depends on the amount of nutrients in the soil, moisture, soil structure and other agrochemical and agrophysical factors.

One of the main indicators of soil fertility is the amount of humus in the soil and nutrients that can be taken by plants. In our republic, the high air temperature accelerates the humus formation-humification process in the soil, and at the same time, the decomposition process is very active. In today's widely used cotton-cereal short rotation system, planting repeated and intermediate crops is one of the important solutions to activate the humification process [1].

One of the main and important problems in modern farming is to maintain the existing soil fertility, increase productivity and giving product. As mentioned above, humus is the main quality indicator of soil fertility, and this indicator plays an important role in soil agrocenosis and affects all other factors in the soil [2] [3] [4].

Indeed, one of the only issues in improving soil fertility is the problem of humus formation in the soil. Humus is considered the most important element of the biosphere and serves to synthesize and increase the amount of biomass in the soil. The increase in the amount of humus in the soil depends on the amount of organic residues remaining in the soil [5].

When assessing the state of humus in the soil, the main attention is paid to its fraction-group composition, which forms humus in the soil and represents the genetic origin of the soil. Because, the harvest taken from crops is grown at the expense of macroelements, NPK and humus. This issue of the composition of humus in all soils and the regularity of changes in it were fully studied and explained in the research conducted by L.N. Aleksandrova [6], I.V. Tyurin [7], M.M. Kononova [8], M.M. Kononova., N.P. Belchikova [9].

This experiment, conducted at the Scientific-Research Institute of Cotton Selection, Seeding and Cultivation, was founded by A.F. Makarov in 1926, and P.V. Starov is its first executor. In the following years, I.A. Dorman and I.F. Sokolov, V.G. Berezovsky, P.M. Bodrov, Z.S. Tursunkhodzhaev and A.L. Toropkina, A.S. Bolkunov, R.Sh. Tillaev, B. Muhitddinov, V.E. Kurochkin [10] [11] worked.

## 2. Materials and Methods

This experiment, which has been carried out for almost a century, is being carried out in the conditions of old irrigated, typical sierozem soils of the Tashkent region, with a mechanical composition of medium loamy, underground waters located at a depth of 18 - 20 meters. The experiment consisted of 8 options without repetitions, option 1 is monoculture, which is used 30 t/ha manure + 30 kg/ha phosphorus every year, option 2 is monoculture + NPK 250:175:125 kg/ha

every year, option 3 is monoculture, absolute no fertilizer, control, option 4 is monoculture + NPK 150:100:50 kg/ha, annually, option 5 is 3:7 alfalfa-cotton rotation + NPK 150:100:50 kg/ha, option 6 is 3:7 alfalfa-cotton rotation + NPK 150:100:50 kg/ha + 30 t/ha fertilizer, option 7 is 3:7 alfalfa rotation without fertilizer, control, 3:7 alfalfa-cotton rotation+10 t every year/ga consists of options such as manure. The area of each option is 2000 $m^2$. The total area is 1.6 hectares.

The amount of humus in the soil was determined by the method of I.V. Tyurin, taken from the 0 - 30 and 30 - 50 cm layers of the soil from all options at the beginning and end of the application period. Calculations of humus in the soil in tons were calculated based on the weight (mg) of the 0 - 30 cm layer of 1 cm cube of the specified area volume unit.

The "Методика полевого опыта" method [12] of B.A. Dospekhov was used for conducting field experiments.

## 3. Results and Discussion

The experiment conducted since 1926 at the Scientific Research Institute of Cotton Selection, Seed Breeding and Cultivation Agrotechnologies on the topic of "Soil Fertility Capability in Permanent Cotton and Crop Rotation Fields" is considered the only unique experiment in Central Asia that determines soil fertility and provides scientific answers to questions arising in this direction.

Based on this, in this long-term field experiment, the data obtained on changes in the amount of humus in the soil during permanent planting of cotton for 96 years, and the effect of this process on cotton productivity were analyzed. In the analysis of the data, there are three variants of the experiment, in which cotton is continuously cultivated, Option 1, in which 30 t/ha of manure + 25 kg/ha of $P_2O$ is applied annually, Option 2, in which mineral fertilizers NPK 250:175:125 kg/ha are applied annually, and without fertilizer, control Option 3 was selected.

According to the results of the analysis, the initial amount of humus in the 0 - 30 cm layer of the soil in the first year of the experiment was 1.84% in the 1st option or 68.45 t/ha (after adding 30 tons of manure), it was 53.25 t/ha or 1.42% in the 2nd and 3rd options, respectively. 20 years after the start of the experiment, in 1946, in the 1st Option of the experiment, the amount of humus in the 0 - 30 cm layer decreased by 335 kg per hectare and made 1.83%, in the 2nd Option, it decreased by 6 tons to 487 kg, and in the 3rd control Option, it was determined that 11 tons decreased by 400 kg. The trend of reducing humus in options was also observed in the following years, and the decrease in the amount of humus in 1966 (after 40 years) according to options was 3 t or 683 kg; 9 t or 225 kg; 16 t or 460 kg, in 1986 (after 60 years) it was 11 t or 400 kg; 10 t or 90 kg; 19 t or 50 kg, in 2006 (after 80 years) it was 24 t or 440 kg; 16 t or 950 kg; 26 t or 290 kg, and in 2022 (after 96 years) it was 32 t or 580 kg; 19 t or 650 kg; 29 t or 170 kg.

When analyzing the data obtained on cotton yield, the highest yield among the options in all periods of the experiment was determined in the option where the norm of NPK 250:175:125 kg/ha of mineral fertilizers was used every year,

and the average yield was 29.7 - 37.8 c/ha. It was found 27.5 - 32.7 c/ha that 30 t/ha of manure + 25 kg/ha of $P_2O$ was applied annually, and 9.9 - 16.8 t/ha in the control option without fertilizer.

It should be noted that in the Option of the experiment where 30 t/ha of manure + 25 kg/ha of $P_2O$ was used every year, it was found that the cotton yield was almost unchanged over the years (there was only a difference of 3 - 4 c/ha). For example, after 20 years from the start of the experiment, the productivity averaged 29.2 c/ha, after 40 years 32.6 c/ha, after 60 years 31.4 c/ha, after 80 years 27.5 c/ha, and after 96 years it was 32.7 c/ha.

Annually, the yield obtained in the option where the rate of NPK 250:175:125 kg/ha of mineral fertilizers was used was sharply different from each other. In 1946 (after 20 years), the average yield of cotton was 31.3 c/ha, in 1966 it was 37.8 c/ha, in 1986 it was 32.5 c/ha, in 2006 it was 29.7 c/ha, in 2022 it was found 33.9 c/ha. It can be considered that the appearance of productivity in this way is the result of different climatic conditions observed in different years and the effect of applied agrotechnical measures.

In the control, fertilizer-free Option of the experiment, it can be observed that the yield has decreased sharply over the years. According to the obtained data, the yield in the first year of the experiment was on average 16.8 c/ha, and in the following years it was 15.4 c/ha from 13.3 c/ha. However, in recent years (2006-2022), a sharp decrease in yield was observed, and averaged 9.9 c/ha (almost 50% less than the initial productivity). This situation can be attributed to the natural fertility of the soil and the amount of nutrients in the soil.

In the next analysis options, we will analyze the total yield obtained for 96 years and the amount of humus used to grow 1 kg of cotton.

In our previously published article, analyzing the data, it was concluded that "a large part of the humus formed from the manure applied to the soil goes to the formation of the cotton crop" now we clarify this conclusion.

According to the results of the analysis, the total gross yield obtained during 96 years in the 1st option of the experiment was 306.8 tons, in the 2nd option it was 330.4 tons, and in the 3rd option it was 141.0 tons. Taking into account the lost humus in the soil during these years, when calculating the amount of humus used for the 1 kg cotton yield, the figures were as follows. 1 kg in each year of the experiment in which 30 t/ha manure + 25 kg/ha $P_2O$ was applied. it was found that the average annual consumption of mineral fertilizers was 0.108 g for the cotton yield, 0.059 g in the option with NPK 250:175:125 kg/ha, and 0.206 g in the control option without fertilizer. Taking into account that 20% - 25% of the humus in the soil is used for various chemical and microbiological processes in the soil, it can be said that 1 kg of cotton yield is cultivated for every year with 30 t/ha of manure, average 75 - 80 g of humus to get a cotton crop, 42 - 47 g every year when high (NPK 250:175:125 kg/ha) norm of mineral fertilizers is used, and 150 - 160 g amount of humus is used when cultivation is taken without fertilizers (**Table 1**).

**Table 1.** Changes in the amount of humus (in the 0 - 30 cm layer) and cotton yield in fields with long-term permanent cultivation of cotton.

| № | Options | The initial amount of humus, (1926 year) | | | After 20 years, (1946 year) | | | After 40 years, (1966 year) | | | After 60 years, (1986 year) | | | After 80 years, (2006 year) | | | After 96 years, (2022 year) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | % | t/ha | Cotton yield c/ha | % | t/ha | Cotton yield c/ha | % | t/ha | Cotton yield c/ha | % | t/ha | Cotton yield c/ha | % | t/ha | Cotton yield c/ha | % | t/ha | Cotton yield c/ha | Total gross yield in 96 years | The amount of hummus for 1 kg cotton yield |
| 1 | Every year 30 t/ha manure + 25 kg/ha $P_2O$ | 1.84 | 68.45 | - | 1.83 | 0.33 | 29.2 | 1.74 | 3.68 | 32.6 | 1.53 | 11.40 | 31.4 | 1.18 | 24.44 | 27.5 | 0.964 | 32.58 | 32.7 | 306.8 | 0.108 |
| 2 | NPK 250:175:125 kg/ha | 1.42 | 53.25 | - | 1.24 | 6.48 | 31.3 | 1.27 | 9.22 | 37.8 | 1.07 | 10.09 | 32.5 | 0.96 | 16.95 | 29.7 | 0.878 | 19.65 | 33.9 | 330.4 | 0.059 |
| 3 | Without fertilizer (control) | 1.42 | 53.25 | - | 1.11 | 11.4 | 16.8 | 0.98 | 16.4 | 13.3 | 0.91 | 19.05 | 15.4 | 0.71 | 26.29 | 15.1 | 0.642 | 29.17 | 9.9 | 141.0 | 0.206 |

## 4. Conclusions

Based on the obtained scientific results, the following can be concluded:

1) It was determined that the annual yield of cotton obtained by applying only 30 tons of manure per hectare for nearly 100 years of permanent cotton cultivation in the conditions of old irrigated typical sierozem soils will be between 27 and 32 centners per hectare, depending on the climatic conditions. The cotton crop is mainly formed due to the humus content of the soil. About 75 - 80 g of humus is used for 1 kg of cotton crop. It can be said that for the formation of the above-mentioned cotton crop every year, if only 30 tons of manure per hectare is given and when cotton is continuously cultivated for in one field, 200 - 240 kg of humus per hectare will be absorbed by the plant. In this option, the amount of humus is reduced by almost 50% compared to the initial amount, but the annual cotton yield does not decrease. It can be concluded that more than 80% - 90% of the humus in the soil is absorbed for the cotton crop, which is formed only when 30 tons of manure per hectare is given for a long time in one field, and more than 80% of the cotton crop is formed at the expense of humus.

2) When cotton is continuously cultivated in one field for many years and mineral fertilizers NPK 250:175:125 kg/ha are applied per hectare, cotton yield is on average 29 c/ha to 37 c/ha. In this option, 1 kg of cotton yield is on average 42 - 47 g humus absorbed by the plant. So, for the formation of the above-mentioned crop, in the case of permanent cotton cultivation in one field, when mineral fertilizers NPK 250:175:125 kg/ha are applied, 120 - 150 kg of humus per hectare per year is absorbed by the plant. In this case, during the formation of cotton

crop, 20% - 25% of the available humus in the soil is absorbed by the plant, 15% - 20% of the formed cotton crop is formed due to humus, and the remaining 80% - 85% of the crop is formed due to mineral fertilizers.

3) When cotton is grown in one field for a long time without fertilizers, the cotton yield can be on average 10 c/ha to 17 c/ha due to the natural fertility of the soil. For the formation of this crop, plant absorbs 150 - 160 g humus from soil is needed for 1 kg of cotton yield. If we take into account that the amount of humus in this option has decreased by 55% compared to the initial amount during 96 years, it means that when cotton is cultivated without any fertilizers, 40% - 45% of the cotton yield is formed due to the natural humus that appeared in the soil.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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