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GROWTH, DEVELOPMENT AND YIELD OF COTTON AT IRRIGATION WITH WASTE WATER FROM POULTRY FACTORIES

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Annotation

The article discusses the composition and suitability of wastewater from poultry farms, their suitability for irrigation purposes of cotton variety C-6524 in the meadow soils of Tashkent region, the impact of wastewater use on the growth and productivity of cotton. Wastewater is characterized by a slightly alkaline reaction (pH = 7.1–7.3), dissolved and undissolved organic and mineral substances in them is 530–730 mg/l., total nitrogen 60.8–86.3 mg/l., total phosphorus - 1.2–2.2 mg/l., gross potassium - 16.7–22.4 mg/l. In terms of nitrogen content, wastewater is characterized by a high fertilizing value. For example, in the composition of river water, the content of total nitrogen makes 4.2–7.5 mg / l., and in the composition of wastewater this indicator varies within 60.8–86.3 mg / l., i.e. with each 1000 m^3 of wastewater the field receives 60.8–86.3 kg of nitrogen, about 1.3–2.2 kg. phosphorus and 16.7–22.4 kg kli. The coli-titer of sewage is 10^{-6} and the total number of microbes in them is $64.6x10^6$ pcs / ml. The suitability of wastewater for irrigation was determined by generally accepted methods, the results of which showed that wastewater from poultry farms is quite suitable for irrigation without any additional reclamation measures.

Keywords: meadow soils, wastewater from poultry farms, fertilizer value of wastewater, irrigation of cotton with wastewater, growth and productivity of cotton.

Introduction

The Republic of Uzbekistan is one of the countries with a high population growth rate. The area of irrigated land per capita is declining year by year, while water withdrawal for irrigation is increasing. In connection with global warming in recent decades, relatively often observed a decrease in the supply of water in some years. If until 2000, years with little water supply in Central Asia were observed every 6-8 years, now this is repeated every 3-4 years. In order to mitigate the shortage of irrigation water in agriculture, a number of measures are being developed and implemented for the efficient use of available water resources.

Anthropogenic transformations of water in the Central Asian region have already reached global proportions: the intensive development of irrigated agriculture in the second half of the 20th century led to a significant increase in water intake from the Syrdarya and Amudarya basins, which caused the Aral Sea to become shallow. A. Kurtov argues that the lack of water for the Republic of Uzbekistan is a catastrophe in the truest sense of the word: due to the lack of water in a number of regions of the republic, especially in Karakalpakstan, one can already talk about a social and economic crisis [9]. There is not enough water not only for agricultural purposes, but also for just household needs. If until 2000, water-poor years in the region were observed every 6–8 years, now this phenomenon is repeated every 3–4 years. Water availability in 2019, 2020 and 2021 has sharply decreased [12].

In this regard, at present, the protection of open water reservoirs from pollution and depletion is becoming a more acute problem, it is becoming more and more urgent every year and is a matter of great national importance that requires urgent solution. In conditions of irrigation water shortage, special attention is paid to the development and application of water-saving technologies and crop irrigation techniques.

The volume of formed water resources on the territory of the Republic of Uzbekistan is only 11.53 km^3/year, which is only 20% of the entire needs of the national economy (56-60 km^3 year). Irrigated agriculture (4.3 million hectares) occupies a leading place in ensuring the food security of the republic, where 97% of agricultural products are grown [8].

Despite the more careful use of water resources in the region, the issue of water supply for the national economy of the republic is expected to become even more complicated in the near future.

The adopted Laws and decisions of the Government of the Republic contribute to a more efficient use of land and water resources in agriculture, increasing the productive capacity of the irrigated hectares. More than 80 laws and regulations have been put into effect, directly or indirectly related to nature protection and regulating the management of the rational use of natural resources [1, 2, 3].

To fulfill the tasks set by the President of the Republic of Uzbekistan, in the document "On the State Program for the Development of Irrigation and Ameliorative Condition of Lands in 2018-2019" dated November 27, 2017, it is planned to carry out a number of irrigation and reclamation works, the introduction of water-saving irrigation technologies on a large scale [1, 2, 3].

Simultaneously with the increase of wastewater volumes year after year, under purification from a sanitary and hygienic point of view, their qualitative composition changes, and their degree of harmfulness increases. The organization of numerous farms focused on animal husbandry and the organization and operation of treatment facilities, intended for these farms, at an insufficient level, the lack of appropriate specialists lead to an increasing of pollution of open water bodies with undertreated wastewater, that does not meet sanitary and hygienic standards [4, 5]. Unfavorable sanitary and hygienic conditions in the republic are observed in areas where wastewater is formed in huge volumes and is contaminated with pathogenic energy bacteria, enteroviruses, helminth eggs and salmonoses, various chemicals [6].

As a result of discharge of undertreated wastewater into open reservoirs spoils a huge amount of natural water and the ability of reservoirs to self-purify often becomes insufficient.

In this regard, soil disposal of wastewater seems to be very promising from the national economic and hygienic standpoint - a natural process of biological treatment based on the ability of the soil to self-purify due to the complex biological processes of organic substances mineralization occurring in it. Particularly promising is the use of wastewater for irrigation of fodder (alfalfa, corn grown for grain and silage), wheat and industrial crops (kenaf and cotton).

On a national scale, it is possible to organize wastewater irrigation of poultry farms on an area of 10-12 thousand hectares of crops. However, the issues of using wastewater from poultry farms should be resolved by conducting special studies, taking into

account the biological characteristics of the crop irrigated by them, the soil and hydrogeological conditions of the area where they are used [7].
In conditions of a severe shortage of irrigation water, the staff of "Farming and Melioration" department of Tashkent State Agrarian University pays special attention to conducting scientific research on the efficient use of additional water resources, including wastewater from poultry factories and developing appropriate recommendations for their rational use.

The degree of the issue study. In the CIS republics, including the former All-Union Scientific and Production Association AUSPA "Progress" (All-Union Research Institute for the Agricultural Use of Wastewater), the Volgograd Agricultural Institute, the Moscow University of Peoples' Friendship, the Ukrainian Hydromeliorative research institute, the Uzbek Research Institute of Sanitation, Hygiene and Occupational Diseases and other institutions have conducted numerous studies, mainly to study the suitability of industrial, domestic and livestock wastewater for irrigation of fodder crops [3, 4, 5, 6]. However, scientific research on the issue of studying the possibility of using wastewater from poultry farms to irrigate the cotton plant has not been carried out. [4, 6, 8, 12].

The purpose of the research: the main goal of the performed experimental researches was to study the possibilities of using wastewater from poultry farms for irrigation of cotton variety C-6524 in the conditions of meadow soils of Tashkent region, as well as the optimal ratio of their dilution with river water, which helps to increase the yield of cotton, allows the protection of open reservoirs from pollution by uncontrolled discharges of wastewater into them.

Research tasks: the main objective of the experimental research conducted in the period 2019, 2020 and 2021 were the study of the composition and suitability of wastewater from poultry farms for irrigation of the medium-fiber cotton variety C-6524, their influence on the growth, development and yield of cultivated crops in the conditions of meadow soils of Tashkent region as an effective measure to protect the environment and increase productivity in the conditions of the republic and development of appropriate recommendations for production on the effective disposal of wastewater by their agricultural use.

Objects of research: Wastewater from the poultry farm "Urtachi-rchikparranda", located on the territory of Srednechirchik district of Tashkent region and the medium-fiber cotton variety C-6524 irrigated by them.

Material and research methodology. The materials of the conducted studies are the wastewater of "Urtachirchik parranda" poultry farm, located in meadow soil conditions of Tashkent region of the Republic of Uzbekistan.

The intended purpose and tasks in the work were solved by conducting theoretical and laboratory studies, field experiments. All biometric studies, laboratory analyses, water countings, all phenological observations of plant growth and development, calculation of raw cotton yield were carried out in accordance with generally accepted methods.

Field experiments were carried out according to the scheme given in Table. 1 were carried out in 4 replicates. The plots were placed in one tier in a systematic way. The area of each plot was 360 m^2 (length 50 m, width 7.2 m), the total area of the experimental plot was 7200 m^2. Each plot had 8 rows of cotton, of which four rows in the middle were accounting and two rows along the edges were protective.

Table 1 Experiment scheme

№ п/п	Experiment options	Irrigation scheme	Irrigation rate, m^3/ha
1.	Irrigation with river water	1-2-0	3600
2.	Irrigation with river water + NPK*	1-2-0	3600
3.	Irrigation with mixed wastewater diluted by river water in the ratio 1:1 + NPK*	1-2-0	3600
4.	Irrigation with diluted wastewater at a ratio of 2:1 + NPK*	1-2-0	3600
5.	Wastewater irrigation + NPK*	1-2-0	3600

(Note: N - 150 kg/ha, P2O5 - 100 kg/ha and K2O - 60 kg/ha).

The practical value of the work: recommendations for the effective disposal of wastewater from poultry farms in the conditions of meadow soils of Tashkent region have been developed for the first time and which can be successfully used in this region. Their suitability for irrigation, the optimal ratio of their dilution with river water have been established.

Agrotechnical methods, adopting on the experimental site. On the experimental plot, agrotechnical measures, generally accepted for the cultivation of cotton in the conditions of meadow soils of Tashkent region were carried out.
According to the recommended irrigation regimes for cotton, 3 furrow irrigations with variable streams were carried out every year. Irrigation dates were assigned when soil moisture was reduced before irrigation to 70-75-65% of the soil MFMC. Irrigation norms during the years of research varied within 1450–1240 m^3/ha, and irrigation norms averaged 3500–3700 m^3/ha.

Research results: Efficiency of using wastewater for cotton irrigation directly depends on its chemical composition. The composition of wastewater is highly variable, contains various substance.
Poultry farm wastewater is characterized by a slightly alkaline reaction (pH = 7.1–7.3), organic and inorganic substances dissolved and undissolved in them makes 530–730 mg/l., total nitrogen is 60.8–86.3 mg/l., total phosphorus - 1.2-2.2, gross potassium - 16.7-22.4, calcium - 59.3-80.3, magnesium - 54.4-74.3, sodium - 18.7-30, 3, chlorine - 20.8-32.4, sulfates - 73.6-86.7 and bicarbonates 336.1-384.5 mg/l. According to the nitrogen content, they have a high fertilizer value. If the content of total nitrogen in river water is 4.2–7.5 mg/l., in the composition of wastewater, it varies within 60.8–86.3 mg/l, i.e., with every 1000 m^3 of wastewater the field will receive 60.8–86.3 kg of nitrogen, 1.3–2.2 kg of phosphorus and 16.7–22.4 kg of potassium.
Data on the bacteriological composition of wastewater for an average of 3 years are shown in the table 2, from which it can be seen that the wastewater from the poultry farm belongs to the type of very polluted water.

Table 2 Bacteriological composition of wastewater

№ п.п.	Water type	Coli-titer		Total number of microbes (pcs/ml)	
		25.05	June-September	25.05	June-September
1.	Wastewater	10^{-6}	10^{-6}	64,6 x 10^6	68,6 x 10^6
2.	River water	0,0002	0,0003	2,6 x 10^6	3,8 x 10^6

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Water-physical properties of soil: Maximum field moisture capacity (MFMC) in 0–30 cm horizon is 21.7% of the dry soil weight, in the 0–50 cm layer is 21.8%, in the 0–70 cm layer is 21.9 % and in the 0–100 cm layer, on average, is 22.1%. The maximum field moisture capacity of the soil in the 0–30 horizon is 28.0%, in the 0–50 cm layer is 28.6%, in the 0–70 cm layer is 29.3%, and in the
0–100 cm layer is 30.0%. Soil moisture reserves corresponding to soil MFMC in the 0–70 cm layer is 2052.6 m^3/ha and in the 0–100 cm layer is 2998.8 m^3/ha.

The effect of the use of wastewater on cotton irrigation on the volumetric mass of the soil was shown as follows: if the volumetric mass of the soil on the eve of the experiments in the 0–30 cm horizon was 1.36 g/cm^3, in the 0-50 cm was 1.39 g/cm^3 and in the meter soil layer was 1.39 g/cm^3. The use of a number of agrotechnical measures, such as carrying out pre-sowing irrigation, preparing the soil for sowing and carrying out it, and a number of agrotechnical measures on cultivation of cotton, such as cutting furrows, loosening row spacing, and vegetation irrigation, strongly influenced the value of the volumetric mass. For example, if the volumetric mass of the soil at the beginning of the growing season in the 1st variant of the experiment in the 0–30 cm horizon was 1.50 g/cm^3 and in the 0–50 cm layer was 1.52 g/cm^3, then in the 3rd variant, respectively, 1 .48 and 1.49 g/cm^3, in variant 5- 1.47 and 1.49 g/cm^3, which is 0.03 g/cm^3 less than in the absolute control 1 option. Thus, under the influence of wastewater containing a significant amount of organic matter, the volumetric mass of the soil decreases to a certain extent. The implementation of the above measures leads to a decrease in the bulk density of the 0–30 cm soil horizon to 1.40–1.42 g/cm^3 (or by 0.4–0.6 g/cm^3 at the beginning of the experiment), in the horizon 0– 50 cm the volumetric mass of the soil increases to 1.42–1.44 g/cm^3 or by 0.3–0.5 g/cm^3. The values of the bulk density in a meter layer of soil according to the experimental variant were almost the same - 1.41–1.42 g/cm^3.

The results of researches on the study of soil water permeability indicate that 6 hours before cotton sowing, its value was 813.2 m^3/ha. If for 1 and 2 hours the value of this indicator was the highest (237.4 and 168.0 m^3/ha), at the next observation times their value gradually decreased in the following observations. For example, at 6 hours of observation, it was only 93.9 and 81.5 m^3/ha, which is explained by a decrease of soil water permeability by compaction of soil horizons under the influence of irrigation (Table 3).

WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 3, Issue 3, Mar., 2022

Table 3 Change in soil water permeability under the influence of river and waste water irrigation (m^3/ha)

Observation time	At the beginning of the experiments (average)	At the end of the growing season in separate variants		
		1	3	5
1	2	3	4	5
1- hour	237,4	104,7	113,1	122,6
2- hours	168,0	86,9	86,5	96,6
3- hours	128,6	69,3	75,0	81,8
4- hours	103,8	63,0	73,1	76,4
5- hours	93,9	55,5	61,6	61,4
6- hours	81,5	54,8	54,7	56,3
Всего:	813,2	434,2	464,0	495,1

To determine the effect of irrigation with wastewater on the bulk density of the soil, special studies were carried out at the beginning of the growing season at 5 points. The results of the studies showed that in the 0–10 and the 0–30 cm of soil horizons, the volumetric mass of the soil was 1.285 and 1.323 g/cm³, and in the layers the 0–50, 0–70 and 0–100 cm, respectively, it was equal to 1.368; 1.407 and 1.21 g/cm³, i.e., in these horizons, the volumetric mass of soil in the 0–30 cm of horizon by 0.045; 0.084 and 0.098 g/cm³ are heavier.
Soil moisture in the soil horizon 0–30 cm averaged 15.65%, in the 0–50 cm layer 17.00%, 0–70 cm - 17.80%, 0–100 cm - 18.63%. It was found that soil moisture in the 0–100 cm layer was for 2.98% more than in the plow horizon (0–30 cm), for 2.11% more than in the 0–70 cm soil layer, i.e. soil moisture in soil layers of 0–70 and 0–100 cm was 17.8% and 18.6% of the dry soil weight, respectively, and at the time of the necessary irrigation, soil moisture was significantly higher than 60% or 70% of the soil MFMC (95.6 va 99.8 %).
The maximum field soil moisture (MFMC) in spring in the 0–30 cm layer was 22.0% from the dry soil mass, in the 0–50 cm layer it was 21.4%, and in the 0–70 cm layer it was 21.2%. In general, the pre-irrigation soil moisture in the experimental plot was maintained at the level not lower than 70-70-65% of the maximum field moisture capacity.
In general, polys of medium staple cotton variety C-6524 were carried out every 18–19 days by one-time norms of 874.5–891.8 m³/ha.
On the experimental plot, the effect of irrigation with wastewater from a poultry farm on the plant density was studied. It was established that the plant density at the beginning of the growing season was 88.9–93.3 thousand plants/ha, and at the end of the growing season it was 88.8–92.2 thousand plants/ha (Table 4).

The results of phenological observations on the growth and development of cotton, carried out on June 1, July 1, August 1 and September 1 showed that the use of water with different composition for irrigation had a different effect on plant growth, the number of generative branches and bolls in one plant (Table 5). Observations carried out on June 1 showed that the height of cotton plants according to the variants of the experiment was 17.0–19.6 cm, i.e., no significant difference was found between the variants of the experiment.

Table 4 Density of cotton (average for 3 years), thousand plants/ha

№ option	At the beginning of the growing season (29.05)				At the end of the growing season (25.09)			
	By repetition							
	I	II	III	average	I	II	III	average
1	88,9	90,0	93,3	90,7	88,8	89,5	92,2	90,2
2	89,3	92,5	91,5	91,1	89,3	91,8	90,7	90,6
3	91,1	93,3	88,4	90,9	90,0	92,2	88,4	90,4
4	90,7	89,3	91,5	90,5	90,7	89,3	90,4	90,1
5	90,3	91,5	90,4	90,7	89,4	90,9	89,0	89,7

Observations, carried out on July 1, was defined that the height of the plants according to the variants of the experiment was 51.2–56.5 cm, i.e., according to the variants of the experiment, there were almost no significant differences. The results of observations carried out on August 1 showed that the tallest plants - 88.9 cm - were noted in the 3rd variant of the experiment, and on September 1, in this variant, the height of the plants was 92.4 cm. The plants with the lowest growth (77.8 cm) were observed in the 1st variant of the experiment. And in the 2nd variant of the experiment, where irrigation with river water was carried out and full norms of mineral fertilizers were applied, this indicator was 85.9 cm.

By this time, 10.6 generative branches and 9.2 fruit elements were formed at each cotton bush. In the 6th variant of the experiment, the height of the plants was for 6.5 cm lower compared to the 5th variant of the experiment. This phenomenon was also observed between variants 1 and 2 of the experiment: the height of plants in these variants was 56.5 and 52.6 cm, respectively, there were 10.6 and 10.1 generative branches, 8.3 and 7.9 fruit elements. However, the differences between the experimental variants were within the limits of experimental errors.

Table 5 Growth and development of cotton under irrigation with river and waste waters

№ option.	Plant growth, cm				Reproductive branches, pcs/plant			Number of bolls, pcs/plant		
	1.06	1.07	1.08	1.09	1.07	1.08	1.09	1.08	1.09	ochilgani
1	17,0	51,2	76,2	77,8	10,0	12,7	12,9	11,0	11,4	9,5
2	18,8	54,4	83,9	85,9	10,1	13,8	13,4	12,0	12,9	9,9
3	19,6	56,5	88,9	92,4	10,6	14,1	14,3	13,8	14,7	10,9
4	18,4	55,9	86,0	88,5	10,5	13,0	13,2	12,9	13,2	10,2
5	18,2	55,3	80,4	83,3	10,4	12,9	13,0	12,1	12,8	10,8

The number of bolls in one plant (14.7 pieces, of which 10.9 pieces were opened) in the 3rd variant of the experiment, where irrigation was carried out with wastewater diluted with river water in a ratio of 1:1 and full norms of mineral fertilizers were applied. These indicators in the 2nd variant of the experiment, where irrigation with river water was carried out and the full norm of mineral fertilizers were applied, amounted to 11.4 and 9.5 pieces, respectively.

The cultivation of high, high-quality and guaranteed yields of raw cotton mainly depends on a number of factors: natural and economic conditions, including climatic, soil, hydrogeological conditions of the area, the biological characteristics of the cotton variety and the applied agricultural practices. The quality of water used for irrigation plays an important role here.

In the 1st variant of the experiment, where river water was irrigated and mineral fertilizers were not applied, the raw cotton yield was 27.0 centners / ha, and in the 2nd variant of the experiment, where river water was irrigated and mineral fertilizers were applied (N - 150 kg /ha, P_2O_5 - 100 kg/ha and K_2O - 60 kg/ha) the yield of raw cotton was 29.9 c /ha, and in the 3rd variant with the use of mineral fertilizers and the use of river water, diluted with wastewater for irrigation in a ratio of 1:1 - 33.4 c/ha, in variant 4, where irrigation was carried out with diluted wastewater in a ratio of 2:1 and mineral fertilizers were applied - 30.6 c/ha. and in the 5th variant, where irrigation with wastewater was employed and the full norm of mineral fertilizers was applied, the cotton yield was 33.1 c/ha (Table 6).

In the 1st variant of the experiment, where watering was carried out with river water with an irrigation rate of 3600 м³/ha according to the scheme 1-2-1, the water consumption for the formation of 1 centner of crop was 107.1 м³, the profitability level was 22.0%. And in the 2nd variant, where irrigation with river water was conducted and mineral fertilizers were used, these figures were 109.6 м³ and 31.0%, respectively,

WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
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in the 3rd variant - 95.6 м3 and 33.1%, in the 4th variant - 98.5 м3 and 36.0%, in the 5th variant - 101.9 м3 and 43.2%.

Table 6 Harvest of raw cotton when for irrigation river water and wastewater were used, c/ha (average over 3 years)

№ option.	Raw cotton yield, c/ha			Raw cotton yield by repetition of the experiment, c/ha			
	1- collect	2- collect	total	I	II	III	average
1	23,4	3,6	27,5	30,0	27,9	29,2	27,5
2	26,3	3,6	29,9	31,3	31,7	32,6	29,9
3	29,3	4,1	33,4	34,5	36,1	35,7	33,4
4	26,7	3,9	30,6	32,5	32,0	33,4	30,6
5	24,7	8,4	33,1	33,7	33,1	32,4	33,1

Table 7 Raw cotton harvest, water consumption for crop unite and the level of profitability when using wastewater for irrigation

№ option	Raw cotton harvest, c/ha	Water consumption for 1centner crop formation, m3	Profitability level, %
1.	27,5	107,1	22,0
2.	32,9	109,6	31,0
3.	33,6	95,6	33,1
4.	33,6	98,5	23,7
5.	33,1	101,9	23,8

Conclusions

The results of many years of research have shown that wastewater from poultry farms is characterized by a high fertilizer value in terms of nitrogen content: with every 1000 м3 of wastewater, 60.8–86.3 kg of nitrogen, about 1.3–2.2 kg of phosphorus and 16.7–22.4 kg of potassium were poured per hectare. The use of wastewater for irrigation does not have a negative effect on plant density.

The use of water of various compositions for cotton irrigation has a significant impact on growth and development: phenological observations carried out on September 1 showed that the tallest plants in terms of cotton growth - 92.4 cm - were observed in the 3rd variant of the experiment, where irrigation was carried out with diluted wastewater in a ratio of 1:1 and NPK were used, the lowest plants in terms of growth (77.8 cm) were noted in the 1st variant of the experiment, where cotton was irrigated with river water and mineral fertilizers were not used. In this variant, the number of bolls per 1 plant was 12.8, of which 10.8 were opened. In the 3rd variant of the experiment, where irrigation was carried out with wastewater diluted with river water

WEB OF SCIENTIST: INTERNATIONAL SCIENTIFIC RESEARCH JOURNAL
ISSN: 2776-0979, Volume 3, Issue 3, Mar., 2022

in a ratio of 1:1 and the employment of NPK, the number of bolls in 1 plant was 14.7, of which 10.9 were opened. The highest yield of raw cotton (33.4 c/ha) was grown in the 3rd variant of the experiment, where irrigation was carried out with wastewater diluted with river water in a ratio of 1:1 and the full rate of mineral fertilizers was applied. The profitability of raw cotton production in this variant was the highest (33.1%) in comparison with other variants of the experiment.

The water consumption for the formation of 1 centner of raw cotton in this variant was the lowest (95.6 $м^3$/c) in comparison with other variants of the experiment.

Thus, in the conditions of meadow-boggy soils of Tashkent region with groundwater at a level of 1.5-2 m, it is considered expedient to irrigate cotton of C-6524 variety with wastewater from poultry farms diluted with river water in a ratio of 1:1. In this case, the irrigation scheme is 1-2-1.

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