

ORGANIC FERTILIZER FROM TECHNOGENIC COAL WASTE – IN ISSUES OF SOIL FERTILITY AND YIELD PRODUCTIVITY

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Annotation. *One of the man-made formations during coal mining at the Angrensky open-pit mine is coal-containing waste. Such carbon-containing wastes are excellent resources for producing organic fertilizers. The agricultural sector of Uzbekistan is developing rapidly, and issues of soil fertility are becoming more pressing. The article discusses some aspects, in particular organo-mineral fertilizers obtained from technogenic carbon-containing waste. The results of agrochemical research, the technological possibility of obtaining a pilot batch of organic fertilizer "Superhumus" on the field conditions of the production site of the Angrenskaya lignite open-pit mine are presented.*

Key words: *organic coal fertilizers, man-made formations - carbon-containing coal waste, humus, humins, soil fertility, inoculation, "base" fertilizer, "catalyst" fertilizer*

Introduction. In the Republic of Uzbekistan, the agricultural sector - agriculture, horticulture and vegetable growing - is currently developing at a rapid pace. Intensive cotton-wheat crop rotation is widely used; over 3 million tons of raw cotton and more than 6 million tons of wheat are produced annually.

As a result of the long-term implementation of the "Cotton-wheat" crop rotation, a decrease in soil fertility (the content of the humus layer in it) is observed on large areas of irrigated land. The average for the republic is now 0.8 - 1.0%, moreover, it continues to decline. At the same time, millions of tons of organic matter (mainly humic nutrients) are carried away, both with the crop and in stems, straw and weeds. The application of large doses of mineral fertilizers on soils with a humus content of 0.8-1.0% does not have a large effect on cotton yield. At the same time, due to the reduction of livestock in the republic, the amount of manure applied to fields has decreased by several times the annual requirement. This increases the deficit of organic matter returned to the soil for the development of humus and increasing soil fertility.

The cheapest and most effective way to increase soil fertility by 1.5 times within 3-4 years is to use organo-mineral fertilizer, and thereby increase crop yields by 10-15%. [1-7].

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The conducted analytical studies of literary and static data show that there is a large resource potential of the Republic, there are new, environmentally friendly and economically profitable technologies for producing organic and organo-mineral fertilizers [8-20]

Object and methods of research. So, under the leadership of Professor Aripova (Mavlyanova) F.M. a scientific basis for obtaining a new ecologically pure organo-mineral fertilizer “Superhumus” was developed. To obtain “Superhumus”, carbon-containing waste from the Angrensky coal mine was used by using the method of inoculating (uniformly infecting) an association of anaerobic microorganisms and an association of soil microorganisms into carbon-containing waste.

The technological process for producing environmentally friendly organo-mineral fertilizer consists of several stages:

A. 1 stage - creation of the “main part” - processing of organic matter of coal waste by the first association of microorganisms.

B. 2 stage - creation by the second association of microorganisms of a “concentrate of microorganisms”»

C. 3 stage - the “main part” and the “concentrate of soil microorganisms” are mixed at a ratio of 10 to 1 and an environmentally friendly organo-mineral fertilizer is obtained. To obtain 1 part of organo-mineral fertilizer, you need 0.9 parts of the “main part” and 0.1 parts of the “concentrate of microorganisms” (fig. 1).

To obtain a base fertilizer, wet technogenic formations stored in a settling tank are inoculated with an aqueous suspension containing a bacterial association of microorganisms with the addition of organic substances. Inoculated man-made formations are kept for 8-12 months

As a result of inoculation, significant activation and growth of the first bacterial association of microorganisms occurs, which process a significant part of the organic substances of coal waste into organic acids.

The main goal of producing the 1st part of the fertilizer, the “base” fertilizer (90-95% of the total volume) is to create optimal nutrition and development conditions for the second association of microorganisms contained in the 2nd part of the fertilizer: the “catalyst” fertilizer.



fig. 1. Ready-made environmentally friendly organo-mineral fertilizers “Superhumus”.

To obtain a “catalyst” fertilizer, the “base” fertilizer is inoculated with an aqueous suspension containing a second bacterial association of microorganisms and microorganisms of the “base”

fertilizer, with the addition of organic substances. The “base” fertilizer inoculated with the second association of microorganisms is laid in a layer of 0.5-1.0 m and kept for 5-10 days..

To obtain the final fertilizer, you need to thoroughly and evenly mix the “catalyst” fertilizer with the “base” fertilizer.

Producing fertilizer in this way, that is, by the processes of separately obtaining each part of the fertilizer, and not in one continuous process, allows you to produce quickly, cheaply and in large quantities the “base” fertilizer, on the basis of which the “catalyst” fertilizer is prepared, and which is the main part of the finished fertilizer . Fertilizer “catalyst” is obtained in 10 days.

The fertilizer contains two mixed parts, and one of the objectives is to obtain an environmentally friendly organo-mineral bacterial fertilizer with increased biological activity based on coal waste.

The finished fertilizer contains two bacterial associations of microorganisms contained in both parts of the fertilizer, the main purpose of which is to accelerate the processes of soil humification - increasing soil fertility for a long period.

As a result of inoculation of coal waste, the resulting “base” fertilizer contains significantly more humus, humic acids and especially fulvic acids, as well as a low pH than the raw material - coal waste. The “catalyst” fertilizer, obtained on the basis of the “base” fertilizer, contains more humus, humic and humic acids than the “base” fertilizer..

The finished fertilizer is mixed in a ratio of 1 part (“catalyst”) and 9 parts (“base”) and contains a significant amount of humus, humic and fulvic acids, and an almost neutral pH, which has a positive effect on soil fertility and crop productivity.

Results and discussion. To identify the agrochemical and other properties of the new fertilizer, full-fledged field scientific and production tests of an experimental batch of fertilizers were carried out and positive results were obtained.

Thus, when introducing organo-mineral fertilizer into the soil, in all cases it increased the quality of the upper aeration zone and reduced the risk of groundwater contamination with residual amounts of mineral fertilizers, as evidenced by a decrease in the content of mobile forms of nitrogen, phosphorus and potassium in the underlying soil layers. The content of mobile compounds of nitrogen, phosphorus and potassium in the arable horizon of the studied soils is significantly higher than in the control variants (without the addition of “Superhumus”).

The main results of the field test work are shown in Table 1. Thus, in the eastern part of Uzbekistan, when “Superhumus” was applied at a rate of 10 tons/ha on meadow-saz soils of the Fergana branch of the Institute of Cotton Growing, the nitrate content in the arable layer was 23.88% versus 19.60% in a similar layer in the control variant. At the same time, the nitrate content in the underlying horizons of the variant with the addition of “Superhumus” ranged from 6.0 – 8.6 mg/kg, with the lowest values (6.0 mg/kg) in the deep layers. And in the corresponding layers of the control variant, its content varied between 8.0-11.6 mg/kg, with the highest values (11.0 mg/kg) in deep layers, which indicates a stronger migration of nitrates down the soil profile in control variant (without adding “Superhumus”).

In the west of the republic, in meadow alluvial soils of the Khorezm branch of the Institute of Cotton Growing and in the north of the republic, on typical gray soils of the Tashkent region, the same pattern is observed. That is, the downward migration of nitrates along the soil profile, as in the meadow saz soils of the Fergana branch, decreases when “Superhumus” is added. The application of “Superhumus” to agricultural land helps to increase the content of humus, nitrogen, phosphorus and potassium in the soil, thereby creating a favorable nutrition regime for plants. Research results have shown that the application of 10 tons per hectare of “Superhumus” helps to increase the content of humus and plant nutrients in the soil. The humus content in the arable layer of meadow soil of the Fergana branch of the Institute of Cotton Growing when applying “Superhumus” was 1.77%, which

is 0.205% more than the control and 0.27% more than the initial state. Enrichment of the soil with humus is observed throughout the entire soil profile. In the arable layer of meadow alluvial soil of the Khorezm branch of the Institute of Cotton Growing and typical gray soils of the Tashkent region, the same pattern is observed. In the variant where 10 t/ha of “Superhumus” fertilizer was applied, the humus content was 0.97% versus 0.875% in the control, which is 0.095% more. The increase in humus content in the soil when adding “Superhumus” was accompanied by an increase in the total content of nitrogen, phosphorus and potassium in the soil in both experimental areas, both in Fergana (on meadow saz soils), and in Khorezm (on meadow alluvial soils) and Tashkent (on typical gray soils) areas.

Table 1.

The influence of “Superhumus” on the humus content in the soil

Options	Depth, cm	Humus, %
Meadow-saz soils Fergana branch of the Institute of Cotton Growing		
N ₂₀₀ P ₁₄₀ K ₁₀₀ (<i>controlareas</i>)	0-30	1,565
	30-50	0,85
	50-75	0,74
	75-100	0,60
N ₂₀₀ P ₁₄₀ K ₁₀₀ + Superhumus 10 t/ha	0-30	1,77
	30-50	0,95
	50-75	0,75
	75-100	0,62
Meadow-alluvial soils Khorezm branch of the Institute of Cotton Growing		
N ₂₀₀ P ₁₄₀ K ₁₀₀ (<i>controlareas</i>)	0-30	0,875
	30-50	0,72
	50-75	0,65
	75-100	0,50
N ₂₀₀ P ₁₄₀ K ₁₀₀ + Superhumus 10 t/ha	0-30	0,97
	30-50	0,78
	50-75	0,60
	75-100	0,55
Typical gray soils of the Tashkent region, Yukorichirchik district		
N ₂₀₀ P ₁₄₀ K ₁₀₀ -(<i>controlareas</i>)	0-30	1,30
	30-50	0,75
	50-75	0,73
	75-100	0,61
N ₂₀₀ P ₁₄₀ K ₁₀₀ + Superhumus 10 t/ha	0-30	1,4
	30-50	0,85
	50-75	0,75
	75-100	0,63

The application of 10 tons of an experimental batch of organomineral fertilizer "Superhumus" per 1 hectare has a positive effect and significantly accelerates the growth and development of plants from the initial phases to full maturity on meadow-saz, meadow-alluvial soils and typical gray soils. Table 2 shows the yield of cotton on experimental plots with different soil structures

Table 2

Cotton yield in experimental plots, c/ha

Region	The soil	BACKGROUND control - without adding "Superhumus"	Experienced – BACKGROUND + 10 t/ha of "Superhumus"	Difference, c/ha
Fergana	meadow-saz	33,8	36,7	2,9
Khorezm	meadow-alluvial	32,2	35,5	3,3
Tashkent	typical gray soil	29,5	35,2	5,7
Syrdarya	gray-meadow	36.6	38.4	1,8

As can be seen from Table 2, the cotton yield on meadow-saz rose from 33.8 c/ha (control plots) to 36.7 c/ha (experimental plots), or a percentage increase of 8.6%. On meadow-alluvial soils, cotton yield as a result of the influence of "Superhumus" increased by 10.2% (from 32.2 to 35.5 c/ha). On typical gray soils it increased by 11.9% (from 29.5 to 35.2 c/ha). And on gray-meadow soils it increased from 36.6 to 38.4 c/ha.

Table 3.

Average yield of winter wheat in, c/ha

Region	Control (without deposit)	Experienced (with the introduction 10 t/ha)	Difference, c/ha
Tashkent	52,6	59,4	+6,8 (13%)

In field tests conducted at the experimental site of the Tashkent region on winter wheat (Table 3), "Superhumus" the yield increased by 13% (from 52.6 c/ha to 59.4 c/ha).

There, at the experimental site of the Tashkent region, comprehensive technological research was also carried out according to the "cotton-wheat-cotton" crop rotation scheme and good results were obtained (Table 4).

Table 4

Economic indicators for a one-time application of "Superhumus" in 2005 per 1 hectare of irrigated land in the amount of 10 t/ha

years	Products	average yield	additional increase in yield when applying "Superhumus"	income per 1 hectare, thousand UZS
2005	Cotton	30 c/ha	10% or 3 c/ha	164,7
2006	Wheat	55 c/ha	10% or 5.5 c/ha	140,9
2007	Cotton	30 c/ha	8% or 2.4 c/ha	131,9
2008	Wheat	55 c/ha	8% or 4.4 c/ha	112,6
2009	Cotton	30 c/ha	7% or 2.1 c/ha	115,3
income in just 5 years				648,8

If we consider the coverage of irrigated areas with the successful implementation of industrial production of organo-mineral fertilizer in the amount of 200 thousand tons during a calendar year (at

an application rate of 10 tons/hectare), it will completely cover the needs of the Tashkent region. The positive effect time of 10 t/ha of organo-mineral fertilizer is 5 years from the time of application.

Taking into account the importance of obtaining environmentally friendly, effective organic fertilizer for the national economy (in terms of food security problems being solved), the project “Production of organo-mineral fertilizer from carbon-containing waste of the Angren lignite deposit” was developed. The project was included in the Decree of the President of the Republic of Uzbekistan - PP-1442 dated December 15, 2010 “On the priorities for industrial development of the Republic of Uzbekistan in 2011-2015”, (*Appendix No. 4 “List of industrial investment projects”*). The annual capacity of the proposed enterprise is 200 thousand tons of environmentally friendly organic fertilizer processed by microbiological method.

As part of this Resolution, a project passport and an investment proposal were developed and approved by the government of the Republic of Uzbekistan to attract potential partners and investors. In accordance with this, the Association of Enterprises of Alternative Types of Fuels and Energy expressed interest in the project as an implementation partner and search for an investor.

Based on the results of scientific and practical field tests at the testing grounds of the Scientific Research Institute of Cotton Growing with the participation of other research institutes of the Republic, it was decided to create an experimental industrial one-time production on the basis of the «Uzbekkumir» Joint Stock Company. For this purpose, together with the Association of Enterprises of Alternative Types of Fuel and Energy, the “Measures for the production of a pilot batch of “Superhumus” based on waste carbon-containing raw materials” were developed and approved.

With the participation of specialists, Candidate of Technical Sciences *S.I. Yakubov* and Candidate of Technical Sciences *A.R. Sarynsakhodjaev*, with the support of the management of Uzbekcoal JSC and the Association of Enterprises of Alternative Types of Fuel and Energy, production at the pilot site of «Uzbekkumir» JSC, a pilot batch of a new organomineral fertilizer was developed, in the amount of 150 tons, from carbon-containing technogenic formations of the Angrensky coal mine.

The resulting new fertilizer in experimental industrial conditions requires testing in the field on farms, both on cotton and wheat, and on other crops.

On the recommendation of the Ministry of Agriculture and Water Resources of Uzbekistan, «Uzbekkumir» JSC, together with the Association of Alternative Fuel and Energy Enterprises, selected farms from the Akhangaran, Pskent and Bostanlyk districts of the Tashkent region. At the same time, cotton and wheat were chosen as the main crops, and rain-fed grapes, greenhouse tomatoes and cucumbers, irrigated potatoes and corn were selected as promising ones. In addition, «Uzbekkumir» JSC’s own sowing fields were identified

According to the concluded Cooperation Agreements with the farm "SagdullaevaKomila" (for cotton and wheat), the farm "HUMSON AGRO FRUIT" (for a vineyard), LLC "SEVAR SHAHNOZ BARAKA" (for tomatoes and cucumbers), the farm "DONISHMAND UVAK" (for corn and others) 20 tons of carbon-organic fertilizers were transferred. In accordance with the agreement, work will be carried out on farms to determine the effectiveness of the new fertilizer, increase soil fertility and crop yields.

Key findings and conclusion. The results of testing a new organic fertilizer on experimental farm fields will make it possible to resolve the issue of creating industrial production of “Superhumus”.

Based on the results of the research and field tests of “Superhumus”, the following were established:

- ◆ application of organomineral fertilizer “Superhumus” has a positive effect and significantly accelerates the growth and development of plants from the initial phases to full maturity;

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- ◆ the yield of winter wheat increased in the experimental plots to 10-12%;
- ◆ cotton yield increased in experimental plots to 12-15%;
- ◆ under the influence of the new organo-mineral fertilizer “Superhumus”, the content of humus (organic matter) and nitrogen in the soil, assimilable forms of basic plant nutrients, increases, and the mineral nutrition of plants improves. The content of total nitrogen in the soil also increased under the influence of the new fertilizer, which indicates an increase in the activity of soil microflora, especially nitrogen-fixing microorganisms;
- ◆ As a result of the analysis of various soils in the east, west and north of the republic, it was revealed that at the depth of the arable layer (0-30 cm) when applying new fertilizer, the fertility of irrigated soils (humus content) increased from 7 to 10%. At the same time, the increase in raw cotton yield averaged from 5 to 12%;
- ◆ As a result of the introduction of technology for producing organomineral fertilizers from coal waste, innovative industrial production “Superhumus” was mastered for the first time in the Republic;
- ◆ For the first time in Uzbekistan, substandard thermal coals - carbon-containing technogenic wastes - were used as raw materials to obtain organically valuable fertilizer for the ecosystem, soil fertility and increase productivity.

In addition, the value of the new organo-mineral fertilizer “Superhumus” lies in:

- a) organically harmless component composition;
- b) environmentally effective impact;
- c) enrichment with beneficial microorganisms;
- d) ensuring an increase in soil fertility for 5 years;
- e) increase in productivity within 5 years;
- f) organic and microbiological compatibility with the soil environment;
- g) enrichment with fully assimilated organic nutritional components;
- h) reclamation and structure-forming effects on soil.

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