OBTAING ORGANOMINERAL FERTILIZERS ON BASE OF LOCAL RAW MATERIALS AND NITROGEN-FIXING MICROORGANISMS

ABSTRACT

The article presents results of research on the production of organomineral fertilizers based on local raw materials cattle manure (CM), Kyzylkum phosphorite flour (FF) and Navbahor bentonite (NB) and nitrogen-fixing microorganisms (NFM). CM:NB:NFM=100.0:2.5:(0-4) and CM:NB:FF:NFM=100.0:5.0:2.5:(0-4) in obtaining new types of organomineral fertilizers ratios are used. Composting time is taken from 1 day to 60 days. The physico-chemical and commercial properties of the obtained new type of organomineral fertilizers were studied. The contents of organomineral fertilizer samples were analyzed by modern physico-chemical methods.

Composting local ores (FU and NB) with cattle manure and processing the resulting mixture with a solution containing nitrogen-fixing microorganisms led to an increase in humic substances, a plant-available form of phosphorus and, most importantly, an increase in nutrient components. Determined that the amount of nitrogen in the organomineral fertilizer obtained due to the biofixation of atmospheric molecular nitrogen is 3.2-4.1 times higher than in the case where NFM was not applied.

Keywords: Kyzylkum phosphorite flour, Navbahor bentonite, cattle manure, humic substances, organomineral fertilizers, molecular nitrogen.

1. INTRODUCTION

Due to the rapid increase in the number of people in the world, providing them with sufficient food products is one of the important problems. In order to solve this problem, it is necessary to find ways to obtain high yields from agricultural crops. One of these ways is the extensive use of organomineral fertilizers (OMF). One such organomineral fertilizer is organomineral fertilizers obtained through nitrogen-fixing microorganisms. To create an optimal nutrient environment for nitrogen-fixing microorganisms, it is important to research in the direction of achieving the maximum nitrogen fixation in the air and creating a flexible technology for producing OMFs enriched with various components.

The analysis of the studied literature and scientific articles shows that the employees of the Institute of General and Inorganic Chemistry of the Academy of Sciences of the Republic of Uzbekistan have studied various processes of obtaining OMF based on lignite from the Angren mine. OMF with the following composition (wt., %) was obtained by oxidation of Angren lignite with nitric acid and subsequent decomposition of Central Kyzylkum (CK) phosphorites with nitric acid-coal slurry: $P_2O_{5total(t.)}$ - 9.41; $P_2O_{5acceptable\ by\ citric\ acid\ (ac.c.a.)}$ - 7.71; $P_2O_{5acceptable\ by\ trilon\ B.(ac.trB)}$ - 4.78; $CaO_{water\ solubility\ (w.s.)}$ - 11.27; N - 7.75; OM - 23.62 [1].

Processes for obtaining liquid and solid nitrogen-humic fertilizers by gradual oxidation of lignite are presented in [2].

In [3, 4], lignite is oxidized with nitric acid in the presence of phosphogypsum, and then the oxidized products are neutralized by ammonia, which contains 14.19% nitrogen, 20.70% humic acids (HA), 32.26% organic substances (OS), 5.38% water-soluble SO_3 and OMFs containing 2.31% water-soluble CaO were obtained. Currently, the degree of use of phosphorus fertilizers is, on average, 15-25%.

U.Sh.Temirov, A.M. Reymov and Sh.S.Namazov carried out scientific-research works on obtaining organomineral fertilizers based on phosphate waste, nitric acid, cattle manure and poultry waste [5-10].

In these works, several options for obtaining OMFs were developed: cattle manure and phosphorites; poultry waste and phosphorus; cattle manure, phosphorites, various mineral fertilizers, phosphogypsum and bentonite; based on poultry waste, phosphorites, various mineral fertilizers, phosphogypsum and bentonite. Experiments were conducted on the preparation of phosphorous fertilizers based on mineralized mass and cattle manure. In addition, options for obtaining OMF by composting phosphorites (FF) with a mixture of poultry waste recycled with nitric acid and activating phosphorites with nitric acid and then processing with poultry waste were studied. The economic efficiency of obtaining OMFs was calculated and agrochemical tests were carried out on cotton plants on ordinary gray soils. However, this scientific research work has not been applied to the industry. As can be seen from the above information, the creation of rational technologies for producing OMFs based on low-grade phosphorites with high agroecological value and efficiency and based on nitrogen-fixing microorganisms are urgent tasks.

In our previous work [11], obtaining organomineral fertilizers based on cattle manure, bentonite, phosphorite flour, $(NH_2)_2CO$, $(NH_4)_2SO_4$, KCl and nitrogen-fixing microorganisms and study of fertilizer production processes, several experiments were conducted on this. Technical and economic indicators of obtained organomineral fertilizers are considered. Another series of experiments on the production of organomineral fertilizers were conducted. These experiments are prepared based on manure and phosphorite, in which the ratio of manure: to phosphorite is selected from 100:5 to 100:30 [12].

2. METHODS AND MATERIALS

To quickly and easily achieve the intended goal of conducting scientific research and experiments, it is necessary to know how to choose the analysis methods correctly. In particular, when obtaining organomineral fertilizers based on local raw materials, it is advisable to use fast, modern, and highly accurate analytical techniques to determine various physical and chemical parameters of raw materials and finished products.

The main raw materials used in laboratory work for scientific research were CM, FF from CK phosphate raw materials, and various bentonite samples[13]. The main chemical composition of these raw materials is presented in Table 1.

Table 1: The main chemical composition of cattle manure, phosphorite flour and bentonite

Raw materials are available	Humidity	OS	HA	FA	WSOS	WIS	P_2O_5	N	K_2O	CaO	Others
Cattle manure	55.4	26.53	7.1	3.67	2.52	13,24	0.28	0.51	0.58	0.59	16.11
FF	P_2O_5	CaO	Al_2O_3	Fe_2O_3	MgO	F	CO_2	SO_3	i.r.	$P_2O_{5\,tr.B.}$ / $P_2O_{5\,tot.}$ %	CaO/ P_2O_5
	17.75	47.52	0.95	0.73	1.78	2.0	17.03	3.27	5.27	17.74	2.67
Navbahor bentonite	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	N	K_2O	P_2O_5	SO_2	Others
	57.9	0.35	13.69	5.10	1.84	0.48	1.53	1.75	0.43	0.75	16.17

Microorganisms of the type Azotobacter chroccocum were used for fix molecular nitrogen from the air. In addition, urea, ammonium sulfate, and potassium chloride from mineral fertilizers produced at chemical enterprises in our country were used to obtain organomineral fertilizers with different nutrient components.

3. RESULTS AND DISCUSSION

The obtained results from our side were first studied the quantities of organomineral fertilizers based on cattle manure, bentonite and nitrogen-fixing microorganisms. CM, NB and NFMs of the type Azotobacter chroccoum were used for laboratory research. For this, cattle manure : bentonite ratios were taken in the range of 100 : (2.5-10) and the resulting mixture was treated with nitrogen-fixing microorganisms (NFM) grown in Fedorov medium in the ratio of 100 : (2.5-10):0.5-4.0 process.

The obtained results are presented in table 2 . An increase in humic and fulvic acids, water-soluble organic substances (WSOS) is observed in the fertilizer samples obtained due to the processing of the mixture of FF and bentonite with NFMs. For example, in the mix of organomineral fertilizers on the day of preparation, the amount of HA, fulvic acids (FA) and WSOS is 2.80%, 2.93% and 2.78%, respectively, and when NFMis processed with microorganisms, it is 2.73-2, respectively, depending on the change of proportions. 2.73-2.79%, 2.86-2.92% and 2.71-2.76%, but after 60 days, this situation is 3.92-4.33% , 4.10-4,53% and 3 equal to 3.89-4.29% .

Table 2: Chemical composition of organomineral fertilizer samples obtained based on cattle manure, bentonite and nitrogen-fixing microorganisms (CM:NB:NFM =100:2,5:(0-4))

Ratoi of FF:NB: NFM	$P_2O_{5t.}$ %	CaO %	OS, %	HA, %	FA, %	WSOS , %	K_2O, %	$N_{t.}$ %	Humidity , %
After 1 day									
100 : 2.5 : 0	0.243	0.555	20.79	2.80	2.93	2.78	0.546	0.350	66.20
100:2.5:0.5	0.242	0.552	20.70	2.79	2.92	2.77	0.544	0.349	66.34
100 : 2.5 : 1	0.241	0.550	20.61	2.78	2.91	2.75	0.542	0.347	66.48
100 : 2.5 : 2	0.239	0.545	20.44	2.76	2.88	2.73	0.537	0.345	66.76
100 : 2.5 : 4	0.237	0.541	20,27	2.73	2.86	2.71	0.533	0.342	67.04
After 60 days									
100 : 2.5 : 0	0.310	0.709	22,23	3.73	3.90	3.70	0.698	0.333	56.78
100:2.5: 0.5	0.314	0.717	22.61	3.92	4.10	3.89	0.706	1.083	56.30
100 : 2.5 : 1	0.317	0.725	23.03	4.12	4.31	4.08	0.714	1.220	55.81
100 : 2.5 : 2	0.319	0.729	23,31	4.22	4.42	4.18	0.718	1.310	55.56
100 : 2.5 : 4	0.321	0.733	23.65	4.33	4.53	4.29	0.722	1.442	55.31

It also increased nitrogen content in manure samples recycled with NFMs, because nitrogen was basic nutrient element for plants..The nitrogen content of the fertilizer sample taken without treatment with NFM on the day of preparation is 0.35%, and after 60 days, it is 0.33% in the same condition, that is, in this case, the total nitrogen content is slightly reduced, but with treatment with NFM on the day of preparation, it in the range of 0.342-0.349% depends on the change of CM:B:NFM ratios, and after 60 days it is 1.083-1.442%. It can be seen that the amount of nitrogen in the obtained fertilizer samples increases 3.17-4.13 times.

They are given in table 3. As can be seen from the results of table 3, when the mixture made of phosphorite flour, cattle manure and bentonite is processed with nitrogen-fixing microorganisms (NFM), NFM affects increasing the content of HA, FA and WSOS and nitrogen in the obtained organomineral fertilizers. For example, when CM:NB:FF:NFM ratio is 100:5:2.5:0.5, 0.576% P_2O_5 total in compost one day after preparation. And the amount of its relatively acceptable form is equal to 22.72%, these values in the obtained compost (ready organomineral fertilizer) after 60 days are equal to 0.732 and 71.04%, respectively. In which not only $P_2\,O_{5t.}$ increases, but also increases its relative acceptable form. HA, FA, WSOS, K_2O, and nitrogen in compost prepared in the same proportions are 2.57, respectively; 2.69; 2.55; will be equal to 0.558 and 0.408%.

Table 3

The main chemical composition of organomineral fertilizers obtained based on cattle manure, bentonite, phosphorite flour and nitrogen-fixing microorganisms (CM:NB:FF:NFM =100:5:2,5:(0-4))

Ratio of CM:B:FF:NFM	P_2O_5 t., %	$P_2O_{5ac.trB}$ amount (%)	CaO t., %	OS, %	HA, %	FA, %	WSOS, %	K_2O, %	$N_{t.}$ %	Humidity, %
After 1 day										
100:5:2,5:0	0.576	22.44	1.54	19.53	2.58	2.70	2.56	0.561	0.410	62.21
100:5:2.5:0.5	0.574	22.72	1.53	19.46	2.57	2.69	2.55	0.558	0.408	62.36
100:5:2.5:1	0.571	23,28	1.53	19.38	2.56	2.68	2.54	0.556	0.406	62.51
100:5:2.5:2	0.567	23.59	1.52	19,23	2.54	2.66	2.52	0.552	0.403	62.81
100:5:2.5:4	0.562	24.03	1.50	19.07	2.52	2.64	2.50	0.547	0.400	63.10
After 60 days										
100:5:2,5:0	0.724	62.21	1.94	20.55	3.69	3.86	3.66	0.705	0.424	52.47
100:5:2.5:0.5	0.732	71.04	1.96	20.88	3.87	4.04	3.83	0.712	1.379	51.99
100:5:2.5:1	0.739	72.17	1.98	21.25	4.05	4.23	4.01	0.720	1.551	51.49
100:5:2.5:2	0.743	73.94	1.99	21.50	4.14	4.33	4.10	0.723	1.665	51.24
100:5:2.5:4	0.759	76.10	2.03	22.15	4.31	4.50	4.27	0.739	1.862	50,21

After 60 days, in the composition of organomineral fertilizers, the amounts of HA, FA, WSOS, K_2O and nitrogen are 3.87, respectively, in the composition of organomineral fertilizers obtained in the same ratio; 4.04; 3.83; will be equal to 0.712 and 1.379%. General patterns of this type are also observed in other ratios of CM:NB:FF:NFMs. In addition, the following can be seen from this table: with an increase in the amount of NFMs, the amount of the relative absorbable form of phosphorus increases, and the amount of nitrogen in the obtained organomineral fertilizers also increases. For example, when the ratio of CM:NB:FF:NFMs is 100:5:2.5:0.5 and the value of the relative absorbable form of phosphorus in the compost obtained after 60 days is 71.04 % and the amount of nitrogen is 1.379%, when the ratio of CM:NB:FF:NFMs is 100:5:2.5:4.0, it is equal to 76.10 and 1.862 % .

The physico-chemical and product properties of the obtained new type of organomineral fertilizers were studied, because physicochemical (dispersibility, natural slope angle, etc.) and commodity properties (hygroscopic point, grain strength, etc.) are important properties of solid and powder fertilizers used in agriculture. Because these properties, especially commodity properties, determine the conditions of storage of fertilizers in warehouses, transportation in vehicles and direct application.The obtained results are presented in Table 4.

Organomineral fertilizer samples were taken to determine hygroscopic points: 1 – 3.05%; 2 - 3.27%. The hygroscopic points of these samples were as follows: sample 1 – 81%, sample 2 – 78 %.

Table 4

Main chemical composition of organomineral fertilizers

Samples of fertilizes	Humidity, %	Chemical composition						
		$P_2O_{5t.}$	$P_2O_{5ac.trB}$	OS, %	$CaO_{t.}$, % .	K_2O, %	$N_{t.}$	Hygroscopic point, %
Based on CM:NB:NFM	3.05	0.321	-	23.65	0.733	0.722	1.442	81
Based on CM:NB:FF:NFM	3.27	0.759	76.10	22.15	2.03	0.739	1.862	78

As can be seen from these values, the obtained organomineral fertilizer samples correspond to the average atmospheric humidity, but during storage in the autumn-winter and winter-spring periods, when the relative humidity is very high, they absorb water; that is, they become wet. Therefore, it is recommended to store and transport them in polypropylene bags.

Some physicochemical properties (dispersibility, natural slope angle, etc.) of powdered organomineral fertilizer samples were determined. The dispersibility of organomineral fertilizers was determined using the Mering funnel. The experiments were carried out as follows: first, the outlet of this flask was checked for cleanliness and its suitability, that is, it was not damaged and not bent, then the flask was installed on three legs and its bottom hole was closed with a metal plate or cardboard paper while holding it by hand, and a sample of 100 g of organomineral fertilizer was drawn into the funnel. The powder was added. After that, the covering metal plastic or cardboard paper was removed and at the same time, the stopwatch was started. The stopwatch was stopped when the last powder fell from the funnel hole. The dispersion of fertilizer samples was calculated in points [14, 15].

Table 5

Some physicochemical indicators of new types of organomineral fertilizers

Fertilizer samples	H_2O, %	Pile weigh, g/cm^3	Density, g/cm^3	Grain streght, mPa/ cm^2	Flowability, point	Natural slope angle, ^{o}	Fluidity, s
Based on CM:NB:NFM	3.05	0.612	0.84	1.73	7.9	40.4	42
Based on CM:NB:FF:NFM	3.27	0.615	0.94	1.85	8.1	42.1	45

The obtained results are presented in Table 5. The results showed that the dispersibility of the fertilizer samples was 7.9, respectively, equal to 8.1 points. This shows that the values have a good dispersion in the ten-point system. In addition, the natural slope angle of the free surface of the samples plays an important role in evaluating the mobility of fertilizer particles: the smaller the natural slope angle, the more mobile the powdery substance. The natural slope angles of the above organomineral fertilizer samples are 40.4^o and 42.1^o. This shows that the mobility of these samples is close to each other. The weight of organomineral fertilizers characterizes their movement rates in storage warehouses and modes of spillage from bunkers and supply equipment. The purpose of determining the bulk weight is to calculate the dimensions of the hoppers, the efficiency of the transport and supply equipment, and to determine the pressure exerted on the opening and closing mechanism of the container and the walls of the dispersable substances. The bulk weight of these 2 organomineral fertilizer samples is 0.612 and 0.615 g/cm^3, respectively, and fully meets the general requirements of production plants [16]. In our subsequent works, the mineral composition of the above-obtained organomineral fertilizers was studied through elemental and X-ray phase studies [17; 18].

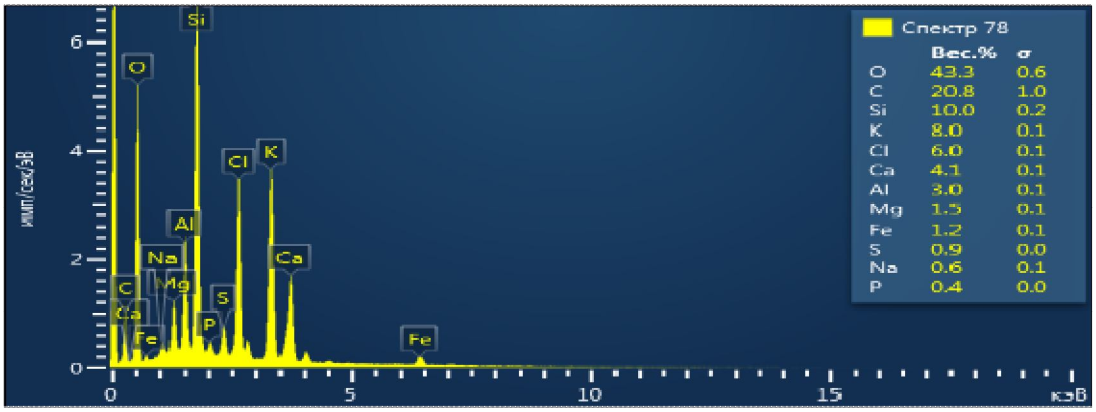

Figure 1. Elemental composition of the organomineral fertilizer sample obtained in the ratio CM:NB:NFM=100:2.5:4.

The obtained results are presented in Figures 1 and 2 (organomineral fertilizer obtained in the ratio of CM:NB:NFM=100:2.5:4). The results presented in Figure 1 fully confirm the results obtained in laboratory conditions. Figure 2 shows the X-ray analysis of this organomineral fertilizer, which shows the mineral content of the fertilizer.

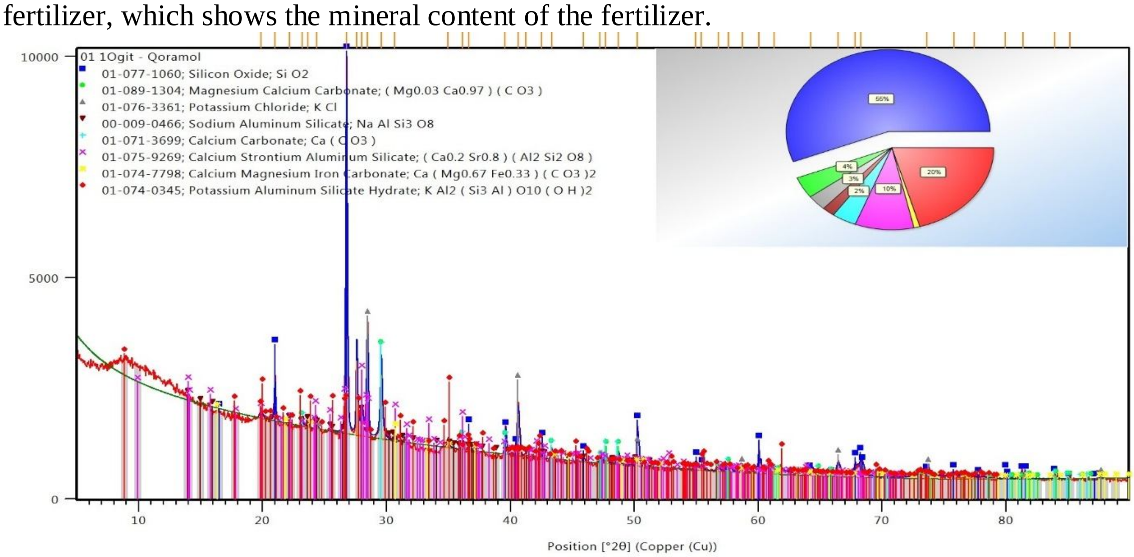

Figure 2. X-ray analysis of the inorganic part of the sample of organomineral fertilizer obtained in the ratio CM:NB:NFM =100:2.5:4.

As can be seen from these results, the inorganic part of the organomineral fertilizer sample obtained in the ratio CM:NB:NFM=100:2.5:4 contains 55% SiO_2 , 4% dolomite, 3% potassium chloride, 2% sodium aluminum silicate, 20% potassium hydrosilicate, 10% calcium strontium silicate, 6% calcium carbonate and calcium magnesium iron carbonates are present. Figures 3 and 4 show the elemental composition and X-ray analysis of the organomineral fertilizer obtained in the ratio CM:NB:FF:NFM =100:5:2.5:4 . The results presented in Figure 3 fully confirm the results obtained in laboratory conditions. Figure 4 shows the X-ray analysis of this organomineral fertilizer, which shows the mineral content of the fertilizer.

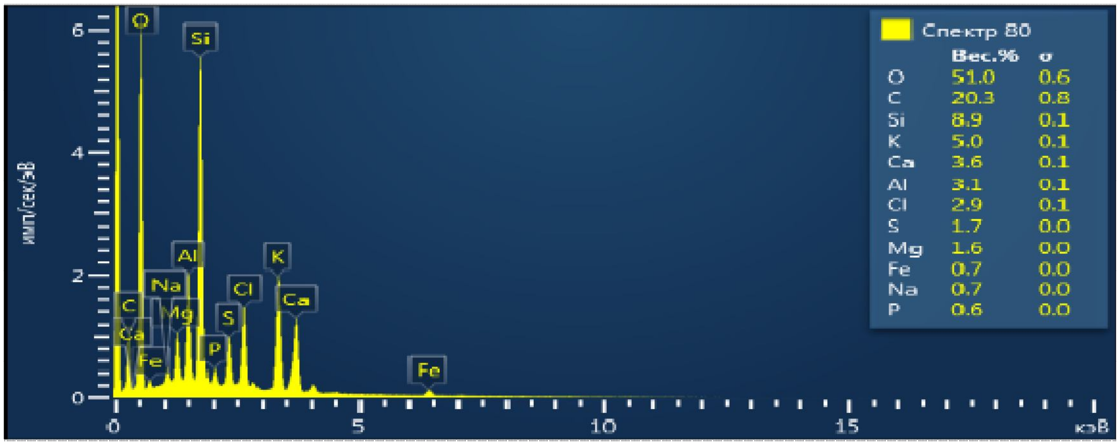

Figure 3. CM:NB:FF:NFM=100:5:2.5:4 elemental composition of the organomineral fertilizer sample taken in proportion.

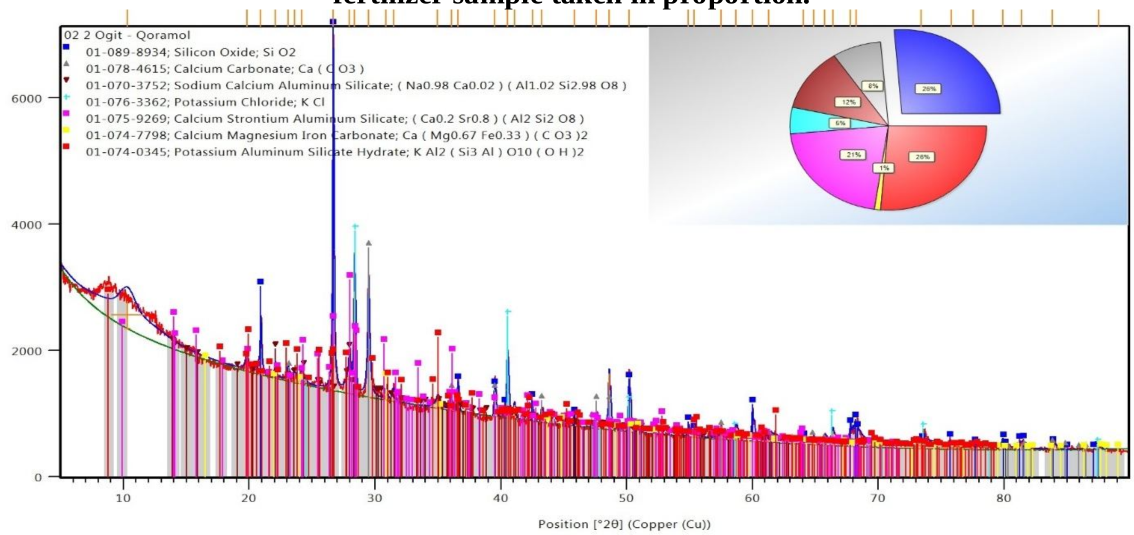

Figure 4. X-ray analysis of the inorganic part of the sample of organomineral fertilizer obtained in the ratio CM:NB:FF:NFM=100:5:2.5:4 .

As can be seen from these results, the inorganic part of the organomineral fertilizer sample taken in the ratio CM:NB:FF:NFM=100:5:2.5:4 contains 26% SiO_2 , 5% potassium chloride, 12% sodium calcium aluminum silicate, 26% potassium aluminum hydrosilicate, 21% contains calcium strontium aluminum silicate, 8% calcium carbonate and 1% calcium magnesium iron carbonates.

4. CONCLUSION

Laboratory experiments on the production of organomineral fertilizers based on nitrogen-fixing microorganisms, cattle manure and bentonite were carried out and their optimal ratios were determined: depending on the change of the CM:NB:NFM ratio, it is in the range of 0.342-0.349% , and in the case, after 60 days it is 1.083-1.442%. It can be seen that the amount of nitrogen in the obtained fertilizer samples increases by 3.17-4.13 times.

Processes of obtaining organomineral fertilizers based on nitrogen-fixing microorganisms, cattle manure, bentonite and phosphorite flour were studied. The optimal quantities of this type of organomineral fertilizers were determined: when the ratio of CM:NB:FF:NFMs was 100:5:2.5:0.5 and after 60 days, the value of the relative absorbable form of phosphorus in the compost was 71.04%, and the amount of nitrogen was 1.379% is equal, the ratio of CM:NB:FF:NFMs is 100:5:2.5:4.0, and it is 76.10 and 1.862%.

According to the results of the research, some physicochemical and commodity properties of 2 new types of organomineral fertilizer samples were studied. The dispersion of organomineral fertilizer samples is equal to 7.9 and 8.1 points, respectively, and has good dispersion. The natural slope angles of the above organomineral fertilizer samples are 40.4^{o} and 42.1^{o}. The bulk weight of these 2 different organomineral fertilizer samples is 0.612 and 0.615 g/cm^3 , respectively, which fully meets the general requirements of production plants. The hygroscopic points of these samples were as follows: sample 1 – 81%, sample 2 – 78%. As can be seen from these values, the obtained samples of organomineral fertilizers correspond to average atmospheric humidity. However, it is recommended to store and transport them in polypropylene bags during storage in the autumn-winter and winter-spring periods when the relative humidity is very high.

The new type of organomineral fertilizer samples was analyzed using modern physicochemical methods and their elemental and mineral contents were studied. CM:NB:NFM =100:2.5:4 ratio of organomineral fertilizer contains 55% SiO_2 , 4% dolomite, 3% potassium chloride, 2% sodium aluminum silicate, 20% potassium aluminum hydrosilicate, 10% calcium strontium silicate, 6 % calcium carbonate and There are calcium magnesium iron carbonates. CM:NB:FF:NFM=100:5:2.5:4 ratio of organomineral fertilizer contains 26% SiO_2, 5% potassium chloride, 12% sodium calcium aluminum silicate, 26% potassium aluminum hydrosilicate, 21% calcium strontium aluminum silicate, 8% calcium carbonate and contains 1% calcium magnesium iron carbonates.

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