Enhancement of availability of high calcareous phosphorite by neutralization of acid effluent and composting of cattle manure

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Abstract. In this article, the influence of acidic effluent (AE) neutralization process, the production of raw fatty acids of cotton soap stock, on the change in the applicability of phosphate powder (PP) and mineralized mass (MM), which are low-grade phosphorites of the Central Kyzylkum, has been studied. It was found that with wide changes in the mass ratios of AE : PP and AE: MM (from 100:10 to 100:40) at a temperature of 60 °C and a time duration of 30 min, the content of the relative assimilable forms of phosphorus in 2% citric acid are approximately from 1.95 to 1.63 and from 3.67 to 1.72 folds more with a content of 17.52 and 9.11% of the assimilable form of P_2O_5 for citric acid PP and MM respectively. Activated phosphorite obtained at a mass ratio of AE: PP and AE: MM = 100:20 was introduced into cattle manure at various mass ratios from 100:8 to 100:20 for composting for 3 months. The prepared mixture was moistened periodically with water to a moisture content of 65-70%. It has been established that with an increase in the content of activated phosphorite and the duration of composting time, it leads to an increase in the content of humic acids, fulphonic acids, and water-soluble organics in the compost products. On the other hand, the duration of composting tends to increase the degree humification above 60%. The approach of acid treatment and composting of carbonate phosphorites can be included as a promising technology for obtaining effective organomineral fertilizers for creating an organic garden in agriculture.

1. Introduction

The population of Uzbekistan, like the population of the world, is growing rapidly from 14 million 79 thousand people in 1975 and more than 36 million people in 2022. However, with the geometric progress of the increase in population, water supplies and arable land remain constant, even per capita fall. According to statistics, it is known that in 1970 there were 0.22 hectares of irrigated land per capita, and now this figure has decreased to the level of 0.12 hectares [1, 2].

Despite this, the government of the republic has increased over the past ten years the area from 20 million 280 thousand to 25 million 736 thousand hectares for agricultural land [3, 4]. In order to ensure food security, it is necessary to increase crop yields with the use of agricultural products, in particular mineral fertilizers. The share of mineral fertilizers for the growth and development of crops is on average 40-50% [1, 2].

However, the utilization rate of nutrients such as NPK by plants is not high. Nitrogen and potassium fertilizers are absorbed by plants 60-70%. Whereas phosphorus (P_2O_5) in phosphate fertilizers, plants use only 20-25% of phosphorus in the year of application, and only 40% in the next two or three years. The rest of the phosphorus is fixed in the soil and becomes unavailable to plants. [5].

For the conditions of Uzbekistan, this causes concern among agricultural specialists regarding phosphorus fertilizers. This is due to the fact that the chemical enterprises of JSC "Ammophos-Maxam" and a number of commercial enterprises such as JSC "Indorama", JV "Electrokhimzavod" and others annually produce only 120-130 thousand tons of phosphorus fertilizers (monoammonium phosphate, Suprefos-NS, enriched superphosphate, simple superphosphate and others) in terms of 100% P_2O_5. Unfortunately, this volume cannot cover the need of agriculture for phosphate

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fertilizers, which is about 759.3 thousand tons per year. This shows that the situation with phosphate fertilizers is complicated.

In general, the production of phosphate fertilizers is based on the sulfuric acid method for opening phosphate raw materials, while transferring phosphorus from an inaccessible to a form available to plants. The whole process is accompanied by the release of a huge amount of toxic fluorine gases, which is not desirable from both an environmental and economic point of view. On the other hand, the use of chemical fertilizers has a negative effect on the soil, causing its erosion. As a result, soil microflora and fauna (which give soils their natural properties) are destroyed, leading to a decrease in agricultural production after many years of application [6].

In a case of a drawback of fertilizer and, moreover, the fixation of phosphorus by soil cations [7], it is of particular importance to use organic fertilizers obtained by composting livestock waste, in combination with phosphate ore [8-11]. In this case, organic farming contributes to the provision of available phosphorus for crops.

It is known that mineral fertilizers are most effective when they are used with organic fertilizers. Because of the introduction of organic fertilizer, the humus content in the soil increases, which creates favorable agrophysical properties and improves the conditions for plant development. At the same time, the return on mineral fertilizers increases by 1.5 - 2 times. In field experiments of the Belarusian Research Institute of Soil Science and Agrochemistry, a change in the amount of humus in soddy-podzolic soil from 1.5 to 2.5-3% led to an increase in the efficiency of 1 kg of NPK fertilizers by 3 times. The use of organic and organomineral fertilizers makes it possible to mobilize soil phosphates by converting the phosphorus present in them into a mobile state [12].

In this area, a number of studies have been carried out on obtaining organomineral fertilizers based on composting of phosphorites of the Central Kyzylkum with livestock manure and poultry manure [13-15]. These studies have shown that phosphorus in phosphorites is converted into a plant-assimilable form under the action of humic acids, which are formed during composting. After 3 months of composting, organomineral fertilizers were obtained containing more than 60% of the digestible form of P_2O_5 and more than 20% of humic acids.

The purpose of this study is to obtain an organomineral fertilizer based on cattle manure and phosphorites of the Central Kyzylkum. In contrast to works [13-15], phosphorites were activated by neutralizing the waste water of the oil and fat industry.

2. Materials and Methods

As an object of study, two types of phosphate raw materials were used: phosphate powder (PP) and mineralized mass (MM) from the deposits of the Central Kyzylkum. All two raw materials were ground to a grain size of 0.25 mm.

PP had the composition (wt.%): P_2O_5 - 17.54; CaO - 47.75; MgO - 1.79; CO_2 - 16.5; Fe_2O_3 - 0.73; Al_2O_3 - 0.95; SO_3 - 4.06; F - 1.7; SiO_2 - 1.24; insoluble residue - 4.03; CaO: P_2O_5 - 2.72; $P_2O_{5acceptable}$ / P_2O_{5total} according to citric acid - 17.52.

MM contained in its composition (wt.,%): P_2O_5 - 15.09; CaO - 43.17; MgO - 1.21; CO_2 - 14.00; Fe_2O_3 - 1.34; Al_2O_3 - 1.22; SO_3 - 2.17; F - 1.7; insoluble residue - 11.24; CaO: P_2O_5 - 2.86; $P_2O_{5acceptable}$ / P_2O_{5total} according to citric acid - 9.11.

These phosphorites were activated by neutralizing the acidic effluent (AE) of JSC "Urganch yog'-moy", obtained by sulfuric acid decomposition of saponified cotton soapstock, followed by washing off the crude fatty acid of the soap production workshop. The physicochemical characteristics and composition of the AE are given in Tables 1 and 2, which were also presented in [16].

Table 1. Indicators of waste water from the first settling process of the deoxidation plant for saponified soap stock

pH of AWW	Clarity	Taste	Color	Odour	Biological oxygen demand, mgO_2/l	Chemical oxygen demand, mgO_2/l	Hardness meq / l		Dry residue mg / l		Suspended substances, mg / l
							Carbonate	Non-carbonate	Experimental	Estima-ted	
2.0					380.0	947.2	56.50	108.50	140.51	134.24	6185
	Reddish	Brine	Brown	Specific							

A study on the neutralization of acidic runoff was carried out at the same mass ratios of AE : PP and AE : MM = 100: 10, 100 : 15, 100 : 20, 100 : 25, 100 : 30, 100 : 35 and 100 : 40 at a temperature of 60°C and duration time 30 min [16].

Laboratory experiments were carried out as follows: in a thermostated glass reactor (V = 500 ml) equipped with a screw stirrer at a speed of 250-300 rpm, the calculated volume of the AE was first loaded. After completion of the

neutralization process, the contents in the glass reactor were decanted and the wet precipitate of phosphorite was separated. The wet precipitate was then dried in a muffle dryer at 100 °C to constant weight. The dried samples were analyzed for the content of components according to [17]. The results of the analyzes are presented in Tables 3 and 4.
For composting, these sediments were mixed with fresh cattle manure containing composition (wt.%): 73.20 moisture; 4.29 ash; 23.98 organics; 3.11 humic acids; 3.24 fulvic acids; 2.51 water soluble organics; 8.86 alkaline insoluble organics; 0.24 P_2O_5; 0.97 N; 0.58; 0.74 CaO.

Table 2. Chemical composition of waste water from the first sedimentation process of the saponified soap stock deoxidation workshop

Cations	mg/l	meq / l	% -eq / l	Anions	mg/l	meq / l	% -eq / l
H^+	100	100	87	Cl^-	38116	1075	50
Na^+	43158	1876.46	-	SO_4^{2-}	48145	1003.03	47
K^+	-	-	-	NO_2^-	20.01	-	-
NH_4^+	100	5.54	-	NO_3^-	840	13.55	-
Ca^{2+}	300	15	1	CO_3^-	-	-	-
Mg^{2+}	1824	150	7	HCO_3^-	3446	58.50	3
Fe^{3+}	0.3	0.01	-	Total		2148.08	100
Fe^{2+}	30	1.07	-				
Total		2148.08	100				

*Note: Table 1 and Table 2 were used from [16]

Composts were prepared at weight ratios of manure: phosphorite; 100:8; 100:10; 100: 15 and 100: 20. Thus, a certain amount of water was added to the mixture to achieve a moisture content of 65-70%. After that, the resulting mixtures were placed in jars with a capacity of 0.5 l. The conditions for preparing composts were close to natural conditions: a thin layer of soil was poured on top of the mixture. Then the jars were placed in a thermostat and kept at 25°C for 90 days. However, every 15 days, samples were taken to determine the composition and the required amount of water was added, mixed and again placed in the thermostat. The composition of samples for constituent components was determined according to the procedure [17].
Determination of P_2O_5 in the dried phosphorite sediments was carried out by a differential method on a KFK-3 device (wavelength λ=440 nm) in the form of a phosphorvanadium-molybdenum complex. SO_3 by weight - precipitation in the form of $BaSO_4$. CaO content was determined by the volume complexometric method: titration with a 0.05 N solution of Trilon B in the presence of the indicator fluorexon and dark blue chromium, respectively. The content of F was determined by the potentiometric method using a fluoroselective electrode. The assimilable form of P_2O_{5assim} was determined by solubility both in 2% citric acid and in 0.2 M Trilon B (EDTA) solution.
Determination of all forms of P_2O_5 in composted fertilizer samples was carried out by the gravimetric method by precipitating the phosphate ion with a magnesia mixture in the form of magnesium ammonium phosphate, followed by calcining the precipitate at 1000–1050°C according to State standard 20851.2-75.
The moisture content was determined according to State standard 26712-85, organic matter was determined according to State standard 27980-80. The water-soluble fraction was extracted from the products with water by heating them on a water bath for one hour. The humic acids were leached by treating the products with a 0.1 N alkali solution and acidifying the solution with mineral acid [18]. The solid phase after the separation of alkali-soluble organic substances from it is a residual organic matter. It was thoroughly washed with distilled water, then dried to constant weight, and the yield to organic mass was determined. The difference between the amounts of alkali-soluble organic substances and humic acids gives us the content of fulvic acids in the compost [16].
The humification degree of organic substances in finished composts (C_{hum}) was determined by the formula:

$$C_{hum} = (G_{HA} + G_{FA} + G_{WSO})100/G_1 \quad (1)$$

where, G_1 is the total content of organic matter in the compost, g; G_{HA} is humic acid, g; G_{FA} – fulvic acids, g; G_{WSO} - water-soluble organic substances, g,

3. Results and Discussion

Tables 3 and 4 show that after the neutralization of the oil and fat industry' AE by Central Kyzyl kum phosphorites, the obtained precipitates contain significant amounts of assimilable forms of P_2O_5.
An increase in the mass fraction of PP and MM leads to a decrease in the relative assimilable form of P_2O_5 for citric acid and Trilon B, which varies in the range of 34.23 - 28.54%, 26.93 - 23.57% and 33.45-15.68%, 26, 64-13.99%, respectively.
These indicators are the highest in comparison with the initial raw materials, which are approximately from 1.95 to 1.63 and from 3.67 to 1.72 folds more with a content of 17.52 and 9.11% of the assimilable form of P_2O_5 for citric acid PP

and MM respectively. This is due to the transition of P_2O_5 from an indigestible form to an assimilated one for plants, i.e. raw materials have been become activated.

The optimal mass ratio can be considered AE: PP and AE: MM = 100:20. In this case, we obtain activated phosphorites for PP composition (mass %): P_2O_{5total} - 14.80; $P_2O_{5assim.}$ by 2% citric acid - 4.97; $P_2O_{5assim.}$ 0.2 M solution of EDTA - 3.92; CaO - 39.05; SO_3 - 16.01; where is the relative form $P_2O_{5assim.}$ /P_2O_{5total} - 33.58 by 2% citric acid and $P_2O_{5assim.}$ /P_2O_{5total} - 26.49% by 0.2 M solution of EDTA.

As for the activated phosphorites based on MM, the composition has (mass %): P_2O_{5total} - 12.09; $P_2O_{5assim.}$ by 2% citric acid – 3,11; $P_2O_{5assim.}$ 0.2 M solution of EDTA - 3,32; CaO - 36.89; SO_3 - 6.89; where is the relative form $P_2O_{5assim.}$ /$P_2O_{5total.}$ – 25,72 by 2% citric acid and $P_2O_{5assim.}$ /P_2O_{5total} - 26.49% by 0.2 M solution of EDTA.

Further, the samples obtained at a mass ratio of 100: 20 in wet form were used for the preparation of composts.

The change in the composition of organomineral fertilizers for two types of phosphorites as PP and MM are shown in Tables 5 and 6.

Table 3. Chemical composition of the dried phosphate precipitate after neutralization of the AE by PP

Mass ratios of AE : PP	pH of10%-suspension of product	Content. %						
		$P_2O_{5total.}$	P_2O_{assim} by 2% citric acid	$P_2O_{5assim.}$ by 0.2 M EDTA	$CaO_{tota;}$	SO_{3total}	P_2O_{5assim} / P_2O_{5total} by 2% citric acid, %	P_2O_{5assim} / P_2O_{5total} by 0.2 M EDTA, %
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
100:10	4.1	13.7	4.69	3.69	36.4	19.15	34.23	26.93
100:15	4.8	14.2	5.21	4.01	38.7	17.84	36.69	28.24
100:20	5.6	14.8	4.97	3.92	39.05	16.01	33.58	26.49
100:25	5.9	15.04	4.79	3.87	40.19	14.76	31.85	25.73
100:30	6.3	15.28	4.81	3.71	40.77	12.89	31.48	24.28
100:35	6.7	15.51	4.64	3.83	41.65	10.24	29.92	24.69
100:40	7.3	15.7	4.48	3.7	42.11	8.75	28.54	23.57

Table 4. Chemical composition of the dried phosphate precipitate after neutralization of the AE by MM

Mass ratios of AE : MM	pH of 10%-suspension of product	Content. %						
		$P_2O_{5total.}$	P_2O_{assim} by 2% citric acid	$P_2O_{5assim.}$ by 0.2 M EDTA	$CaO_{tota;}$	SO_{3total}	P_2O_{5assim} / P_2O_{5total} by 2% citric acid, %	P_2O_{5assim} / P_2O_{5total} by 0.2 M EDTA, %
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
100:10	4.3	11.3	3.78	3.01	35.07	10.79	33.45	26.64
100:15	4.8	11.91	3.89	3.23	36.22	8.9	32.66	27.12
100:20	5.6	12.09	3.11	3.32	36.89	6.89	25.72	27.46
100:25	5.7	12.41	2.89	2.81	37.56	6.34	23.29	22.64
100:30	6.3	12.69	2.42	2.22	38.41	5.41	19.07	17.49
100:35	6.7	12.95	2.21	2.13	39.36	5.12	17.07	16.45
100:40	7.1	13.65	2.14	1.91	40.61	4.59	15.68	13.99

As follows from the tables, an increase in the amount of activated phosphate raw materials in relation to the manure in the compost leads to a decrease in the relative assimilable forms of P_2O_5. On the other hand, an increase in the duration of compost holding from 15 to 90 days, an increase in the total and relative assimilable forms of phosphorus is observed in all mass ratios of cattle manure to PP and MM.

For instance, at a mass ratio of cattle manure: PP = 100:8 and 100: 20 during 15 days of compost holding, the content of relative digestible forms of $P_2O_{5assim.}$ for 2% citric acid and 0.2 M solution of EDTA, varied in a range of 47.85-53.80 and 49.52-54.94%, respectively.

However, at 45 days of compost holding and at the indicated mass ratios of cattle manure: PP, we obtain more elevated relative digestible forms of $P_2O_{5assim.}$ 2% citric acid and 0.2 M solution of EDTA, which are 52.14-55.79 and 53.98-56.64%, respectively.

A similar pattern can be observed in the case of the use of MM at its mass ratio of manure cattle : MM = 100:8 and 100:20 during a half-month storage of composting, the content of relative assimilable forms of $P_2O_{5assim.}$ by 2% citric acid and 0.2 M EDTA solution vary from 42.16 to 50.08 and from 44.80 to 52.17%, respectively. Whereas, with a one and a half month storage period, we obtain relatively high values of assimilable phosphorus ranging from 45.31 to 52.11 and from 46.34 to 53.08%, respectively.

Table 5. Changes in the content of total, assimilable forms of phosphorus and calcium in composts prepared on the basis of cattle manure with the addition of PP depending on the holding time and mass ratios

Mass ratio of cattle manure : PP	P_2O_{5total}, %	P_2O_{assim} by 2% citric acid, %	P_2O_{5assim} / P_2O_{5total} by 2% citric acid, %	$P_2O_{5assim.}$ by 0.2 M EDTA, %	P_2O_{5assim} / P_2O_{5total} by 0.2 M EDTA, %	CaO_{total}. %	$CaO_{усв.}$ by 2% citric acid, %	$CaO_{assim.}$/ CaO_{total}, %
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
				After 15 days				
100 : 0	0.24	0.05	22.34	0.06	23.76	0.74	0.22	0.24
100 : 8	1.983	0.95	47.85	0.98	49.52	2.98	1.91	64.15
100 : 10	2.27	1.12	49.21	1.14	50.23	3.61	2.27	62.98
100 : 15	3.05	1.61	52.74	1.62	53.18	5.18	3.20	61.84
100 : 20	4.37	2.35	53.8	2.40	54.94	6.31	3.73	59.11
				After 45 days				
100 : 0	0.25	0.08	32.11	0.09	34.24	0.8	0.30	0.25
100 : 8	2.41	1.26	52.14	1.30	53.98	3.01	2.10	69.84
100 : 10	2.87	1.52	53.07	1.57	54.63	3.76	2.57	68.33
100 : 15	3.72	2.03	54.67	2.05	55.17	5.24	3.51	67.01
100 : 20	4.92	2.74	55.79	2.79	56.64	6.39	4.18	65.39
				After 75 days				
100 : 0	0.27	0.11	40.17	0.11	42.14	0.84	0.38	0.27
100 : 8	3.01	1.69	56.21	1.72	57.3	3.09	2.30	74.55
100 : 10	3.74	2.13	57.02	2.17	58.14	3.84	2.83	73.61
100 : 15	4.23	2.46	58.24	2.50	59.1	5.36	3.88	72.34
100 : 20	5.11	3.03	59.2	3.08	60.34	6.47	4.59	70.97
				After 90 days				
100 : 0	0.28	0.13	45.39	0.13	47.11	0.89	0.48	0.28
100 : 8	3.87	2.25	58.11	2.30	59.35	3.11	2.69	86.54
100 : 10	4.01	2.40	59.95	2.42	60.42	3.82	3.26	85.36
100 : 15	4.96	3.00	60.45	3.04	61.37	5.31	4.36	82.13
100 : 20	5.87	3.62	61.59	3.69	62.81	6.27	5.03	80.22

Table 6. Changes in the content of total, assimilable forms of phosphorus and calcium in composts prepared on the basis of cattle manure with the addition of MM depending on the holding time and mass ratios

Mass ratio of cattle manure : MM	P_2O_{5total}, %	P_2O_{assim} by 2% citric acid, %	P_2O_{5assim} / P_2O_{5total} by 2% citric acid, %	$P_2O_{5assim.}$ by 0.2 M EDTA, %	P_2O_{5assim} / P_2O_{5total} by 0.2 M EDTA, %	$CaO_{total.}$, %	$CaO_{усв.}$ by 2% citric acid, %	$CaO_{assim.}$/ CaO_{total}, %
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
				After 15 days				
100 : 0	0.24	0.05	22.34	0.06	23.76	0.74	0.22	0.24
100 : 8	1.96	0.83	42.16	0.88	44.8	2.84	1.46	51.36
100 : 10	1.77	0.80	44.95	0.83	47.16	3.36	1.70	50.56
100 : 15	2.6	1.27	48.77	1.30	50.01	4.86	2.34	48.19
100 : 20	3.4	1.70	50.08	1.77	52.17	6.15	2.87	46.66
				After 45 days				
100 : 0	0.25	0.08	32.11	0.09	34.24	0.8	0.30	0.25
100 : 8	2.13	0.97	45.31	0.99	46.34	2.92	1.70	58.36
100 : 10	2.73	1.26	46.11	1.29	47.28	3.4	1.94	57.12
100 : 15	3.02	1.50	49.81	1.55	51.17	4.903	2.75	56.03
100 : 20	3.96	2.06	52.11	2.10	53.08	6.22	3.37	54.11
				After 75 days				
100 : 0	0.27	0.11	40.17	0.11	42.14	0.84	0.38	0.27
100 : 8	2.91	1.43	49.11	1.47	50.56	3.09	1.98	64.12
100 : 10	3.53	1.76	49.98	1.81	51.17	3.51	2.24	63.94
100 : 15	3.96	2.02	50.91	2.09	52.88	5.13	3.19	62.11
100 : 20	4.65	2.42	52.12	2.51	53.94	6.34	3.86	60.85
				After 90 days				
100 : 0	0.28	0.13	45.39	0.13	47.11	0.89	0.48	0.28
100 : 8	3.17	1.63	51.42	1.66	52.36	3.12	2.26	72.43
100 : 10	4.22	2.20	52.11	2.27	53.74	3.59	2.57	71.56
100 : 15	5.32	2.87	54.03	2.92	54.92	5.14	3.63	70.6
100 : 20	5.94	3.29	55.32	3.34	56.21	6.28	4.33	68.94

The highest values of total and relative assimilable forms of phosphorus were achieved with a 3-month holding of the compost mixture. Here, organomineral fertilizers are obtained with indicators of relative assimilable forms of $P_2O_{5assim.}$ by 2% citric acid and 0.2 M solution of EDTA from 58.11 to 61.59 and from 59.35 to 62.81% in the case of PP, as well as from 51.42 to 55.32 and from 52, 36 to 56.21%, respectively, in the case of the use of activated MM.
According to the results of the research, it can be seen that organomineral fertilizers based on PP are much higher in terms of the content of total and relative forms of phosphorus. This is apparently due to the chemical, mineral composition and variety of the relative assimilable forms of phosphorus in the feedstock.
In addition, an interesting fact is that what kind of change does the organic part of cattle manure undergo when it is jointly composted with the activated PP and MM? The research results are presented in Tables 7 and 8.

Table 7. Dependence of the change in the humification degree of organic substances in composts prepared on the basis of cattle manure with the addition of PP depending on the holding time and mass ratios

Mass ratio of cattle manure : PP	Humidity, %	N, %	Organic substan-ces, %	Humic acid, %	Fulvo-acid, %	Water soluble organic substances, %	Humifica-tion degree, %
1	2	3	4	5	6	7	8
				After 1 day			
100 : 0	73.2	0.97	23.98	3.11	3.24	2.51	36.95
100 : 8	75.41	2.32	24.12	3.3	3.34	3.38	41.54
100 : 10	71.25	2.21	24.03	2.36	3.31	2.34	33.33
100 : 15	73.11	2.17	23.99	2.42	3.2	2.49	33.81
100 : 20	72.56	2.02	23.81	1.97	3.13	3.35	35.49
				After 15 days			
100 : 0	77.88	0.93	22.18	3.29	3.32	2.67	41.84
100 : 8	67.33	2.28	23.94	3.33	3.41	3.82	44.11
100 : 10	67.4	2.14	23.87	2.4	3.36	3.75	39.84
100 : 15	55.69	2.08	23.76	2.65	3.27	3.61	40.11
100 : 20	60.06	1.97	23.62	1.84	3.21	3.5	36.20
				After 45 days			
100 : 0	71.35	0.91	20.14	3.41	3.37	2.81	47.62
100 : 8	72.11	1.97	21.56	3.87	3.69	3.96	53.43
100 : 10	73.45	1.84	21.48	3.61	3.61	3.87	51.63
100 : 15	72.56	1.75	21.31	3.52	3.47	3.72	50.26
100 : 20	71.03	1.69	21.22	3.24	3.401	3.64	48.45
				After 75 days			
100 : 0	69.07	0.83	19.02	3.79	3.46	2.87	53.21
100 : 8	67.14	1.59	19.45	3.94	3.78	4.21	61.34
100 : 10	69.31	1.51	19.38	3.85	3.72	4.18	60.63
100 : 15	67.24	1.42	19.26	3.82	3.64	4.06	59.81
100 : 20	70.25	1.35	19.14	3.78	3.51	3.98	58.88
				After 90 days			
100 : 0	71.06	0.78	18.44	3.98	3.51	3.02	57.00
100 : 8	70.14	1.32	18.17	4.11	3.98	4.43	68.90
100 : 10	70.24	1.24	18.19	4.09	3.91	4.38	68.06
100 : 15	70.69	1.18	17.84	4.02	3.85	4.26	67.99
100 : 20	71.36	0.98	17.72	3.94	3.79	4.18	67.21

It is obvious that with a 3-month storage of a mixture of phosphorite in manure, it leads to a significant change in the content of valuable substances such as the amount of humic acids, fulvic acids and the degree of humification compared to the original cattle manure.
The main influencing factor was the mass ratio of cattle manure to phosphate powder and the duration of compost holding. As can be seen, with an increase in the holding time, the amount of activated phosphate in the compost contributes to a significant change in humic acids, fulvic acids and water-soluble organic substances in the composition of organomineral fertilizers.
For instance, with a mass ratio of cattle manure : PP = 100:8 and 100:20 with a holding time of 15 and 90 days, the content of humic acids, fulvic acids and water-soluble organic substances varies within 1.97-3.3; 3.13-3.34; 3.35-3.38 and 3.94-4.11; 3.79-3.98; 4.18-4.43%, respectively. The nitrogen content in the studied ranges of mass ratios and holding time varies from 0.98 to 2.32%. While the humification degree increases from 33.81 to 67.21%.

Such a change led to a decrease in the total amount of organic matter in composts from 24.12 to 23.81 and from 18.17 to 17.72%. Similar composting results can be observed in the case of composting a mixture of manure with activated MM.

Table 8. Dependence of the change in the humification degree of organic substances in composts prepared on the basis of cattle manure with the addition of MM depending on the holding time and mass ratios

Mass ratio of cattle manure : MM	Humidity, %	N, %	Organic substan-ces, %	Humic acid, %	Fulvo-acid, %	Water soluble organic substances, %	Humifica-tion degree, %
1	2	3	4	5	6	7	8
				After 1 day			
100 : 0	69.12	0.98	24.25	3.11	3.24	2.51	36.54
100 : 8	70.23	2.17	25.02	2.91	2.38	3.07	33.41
100 : 10	75.03	2.09	24.89	2.82	2.31	2.97	32.54
100 : 15	72.32	1.99	24.71	2.74	2.19	2.9	31.69
100 : 20	70.06	1.88	24.46	2.69	2.09	2.84	31.15
				After 15 days			
100 : 0	77.88	1.02	22.18	3.29	3.32	2.67	41.84
100 : 8	65.53	2.13	23.55	3.93	3.42	3.11	44.42
100 : 10	64.72	2.01	23.47	3.87	3.36	3.02	43.67
100 : 15	67.96	1.95	23.35	3.8	3.24	3.98	47.19
100 : 20	64.18	1.86	23.24	3.76	3.13	3.91	46.47
				After 45 days			
100 : 0	71.35	0.91	20.14	3.41	3.37	2.81	47.62
100 : 8	69.98	1.98	21.3	3.01	3.67	3.26	46.67
100 : 10	68.87	1.9	21.21	3.98	3.56	3.18	50.54
100 : 15	70.25	1.83	21.12	3.91	3.38	3.09	49.15
100 : 20	70.98	1.72	21.01	3.84	3.26	3.01	48.12
				After 75 days			
100 : 0	69.07	0.83	19.02	3.79	3.46	2.87	53.21
100 : 8	70.64	1.24	20.16	4.21	3.86	3.59	57.84
100 : 10	72.36	1.19	20.09	4.19	3.77	3.51	57.09
100 : 15	69.87	1.08	19.94	3.1	3.63	4.42	55.92
100 : 20	67.98	1.01	19.86	4.02	3.51	3.37	54.88
				After 90 days			
100 : 0	71.06	0.78	18.44	3.98	3.51	3.02	57.00
100 : 8	69.87	1.05	18.33	3.34	4.93	3.67	65.14
100 : 10	68.99	0.96	18.25	3.31	4.87	3.59	64.49
100 : 15	70.36	0.86	19.06	3.29	4.76	3.47	60.44
100 : 20	69.67	0.84	18.76	3.24	4.66	3.36	60.02

In all ranges of mass ratios and duration of composting, the content of humic acids, fulvic acids and water-soluble organic substances varies within 2.69-2.91; 2.09-2.38; 2.84-3.07 and 3.24-3.34; 4.66-4.93; 3.36-3.67%, respectively. Whereas the nitrogen content varies from 0.84 to 2.17%. The humification degree increases from 31.15 to 65.14%.
The content of organic matter in composts decreases from 25.02 to 24.46 and from 19.06 to 18.33%, respectively, at mass ratios of cattle manure: MM = 100:8 and 100:20 at composting holding times of 15 and 90 days.
It should be noted that during the composting process, cattle manure undergoes losses of organic matter and nitrogen, which for both types of raw materials averages 14-15 and 25-30%, respectively.

4. Conclusions

Thus, the possibility of increasing the assimilable forms of phosphorus of low-grade phosphorites of the Central Kyzyl Kum as ordinary phosphorite powder and mineralized mass has been shown. To do this, two successive methods were taken to increase the assimilable forms of phosphorus. The first is treatment of acidic effluent from oil and fat industry enterprises with pH 2, followed by separation of the phosphate precipitate by decantation. Consistently, the sediment representing activated phosphorite with at least 25% relative assimilable phosphorus was mixed with cattle manure for composting from a duration of up to 90 days. The research results showed that the product is an organomineral fertilizer containing more than 50% of the relative assimilable form of phosphorus and significant amounts of humic acids, fulvic acids and water-soluble organic matter. These types of product can be successfully used in agriculture, where there is a shortage of phosphorus and humus in the soil.

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