Organic-mineral fertilizer based on chicken manure and phosphorite from central Kyzykum

ABSTRACT.

Background. At present in Kyzykum phosphorite combine wastes in form of off-balanced ore (13-15 % P₂O₅) and phosphorite sludge (10-12 % P₂O₅) are generated during the beneficiation of high calcareous Central Kyzykum phosphorite. The total volume of produced phosphorite has already reached 13 billion tonnes. One of the actual and rational ways of processing low-grade phosphorites is their usage during the preparation of composts based on chicken manure. Mechanism of activation is phosphorus transfer from low-grade phosphorite into acceptable for plant form during the composting with chicken manure and transformation of manure organic matter into humic substance take into account nitrogen and organic matter losses in the atmosphere.

Purpose. It has been studied that the effect of organic-mineral fertilizer obtaining based on chicken manure and mineralized mass from Central Kyzykum phosphorite by composting.

Methodology. It has been obtained that compost was made by mixing chicken manure with a mineralized mass of Central Kyzykum phosphorite in a wide range of weight ratio. The composition of resulting composts by well-known methods depending on time process has been studied.

Originality. At the first time, there have been explored the rate and kinetics of transition of manure organic part in humic substances and transfer of P₂O₅ into acceptable for plant form. It was established that decrease of organic matter and nitrogen emission into the atmosphere during the composting manure by mineralized mass from Central Kyzykum phosphorite. In addition, some chemical equations processing during the composting manure by phosphate were described.

Findings. There have been prepared the composts based on manure and mineralized mass from Central Kyzykum phosphorite when weight ratios of Dung: phosphorite (from 100: 2 to 100: 25). In prepared mixing, some water was added based on calculation to reach humidity till 70%. There have been determined the kinetics and rate of transformation of manure organic parts in humic substances and unacceptable form of phosphorus into an acceptable form for the plant in mineralized mass. The level releasing organic matter and nitrogen into gas phase has been determined during the composting manure with mineralized mass from Central Kyzykum phosphorite. It was shown that with increasing duration of composting all ratios formation of humic substances and mobile phosphorus are grown while with increasing amount of mineralized mass in the compost organic matter and nitrogen losses are reduced, as well as the transformation rate of manure organic parts in humic substances. It has been found that when weight ratio of Dung : phosphorite = 100 : 2 during the composting losses of organic matter and nitrogen are 20.36% and 25.42 % respectively, as relative P₂O₅acceptable by EDTA and 2 % solution of citric acid make up 69.44 % and 61.11%, while at 100: 25 the losses of organic matter and nitrogen are 8.75 and 13.26 %, as relative P₂O₅acceptable by EDTA and 2 % solution of citric acid constitute 43.81the and 42.38 %, respectively.

Keywords. chicken manure, mineralized mass, composting, phosphorus, organic-mineral fertilizer.

1. INTRODUCTION.

The soil fertility mainly depends from organic matter playing role in soil formation processes and improvement of soil physicochemical properties, the supply of plants by nutritional and biologically active substances. The soil is exhausted rapidly without organic fertilizers especially under intensive methods of agriculture. Nutrients of organic matter as a nitrogen-nutrient source and others once releasing them, will apply into the soil a lot. The soil practice and results numerous agrochemical Researches show that application the same mineral fertilizer has negatively an effects to soil properties: humus content is decreased, amount and composition of microorganisms' are reduced. Chanen get the direction of chemical and biological reaction is changed, as a result, the fertility of the soil is reduced. When there is a high content of soil matter due to more favorable agrophysical properties, the return from fertilizer increases in 1.5-2 times [1].

Therefore, it is important when the use of the fertilizers to includes reserves of humus in the soil. Maintenance of the humus reserves in the-arable soil can be exercised by regular application of organic and organo-mineral fertilizers. Compost prepared based on waste from chicken...
Many countries the composting organic wastes have already become an important sector in processing composts into fertilizers. Some enterprises having farm management, and scientific production associations work composting. In Uzbekistan, there is no single science-based approach to the preparation of the composts based on wastes from stock farms. The obtained product the additives are acceptable for plants form [2]. Chicken manure composting with the addition of phosphorite flour is an effective approach. When composting chicken manure with phosphorite flour humification rate of organic- chicken manure- is increased, the nitrogen losses from- it- decreased, but phosphorus- from- phosphorite flour transfers into acceptable form due to interaction it with humus acid. The reaction among the humus acid and phosphates can be presented the following way:

$$2R \text{COOH} + \text{Ca}_3(\text{PO}_4)_2 \rightarrow (\text{R} \text{COO})_2\text{Ca} + 2\text{CaHPO}_4$$
$$2R \text{COOH} + 2\text{CaHPO}_4 \rightarrow (\text{R} \text{COO})_2\text{Ca} + \text{Ca}(\text{H}_2\text{PO}_4)_2$$
$$2R \text{COOH} + \text{Ca}(\text{H}_2\text{PO}_4)_2 \rightarrow (\text{R} \text{COO})_2\text{Ca} + 2\text{H}_3\text{PO}_4$$

The production of a novel type of organic-mineral fertilizer with increased ecologically friendly value and effectiveness based on waste of livestock farm is an actual issue. Application of such fertilizers allows to reduce considerably dose for fertilizer introduction balances ratio of nutrition, reduces engineering expenditures for usage and storage. [3]

All over the world processing livestock farm waste in organic or organic-mineral fertilizers is implemented either by composting or waste is piled up and introduced under the soil in fresh form.

In [4] shown shows that when composting chicken manure large amount of nutrient is lost, especially nitrogen due to wrong block storage. On a basis of the All-Union research institute on fertilizer and agrology data was found that the losses of total nitrogen constitute 20-25%, organic matter 25-30% for 3 months of composting. In that case, nitrogen and organic matter losses take place because of urea, hippuric acid, urinary acid and other low-molecular organic matter decomposition containing in the liquid of chicken manure. Urea is decomposed quickly according to the following equation below:

$$\text{CO(NH}_2\text{)}_2 + \text{H}_2\text{O} \rightarrow (\text{NH}_2\text{)}_2\text{CO}_3$$

$$(\text{NH}_2\text{)}_2\text{CO}_3 \rightarrow \text{NH}_3\text{CO}_2 + \text{NH}_3$$

Further, hippuric acid is decomposed into benzoic and amine-acetic acids and amine-acetic is decomposed either into oxy-acetic or acetic acids and ammonia describing below:

$$\text{C}_6\text{H}_5\text{CO-NH-CH}_2\text{-COOH} + \text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_5\text{COOH} + \text{CH}_2\text{NH}_2\text{-COOH},$$
$$\text{CH}_2\text{NH}_2\text{-COOH} + \text{H}_2\text{O} \rightarrow \text{CH}_2\text{OH-COOH} + \text{NH}_3$$

Uric acid is decomposed much slowly, which first converts allantoin subsequent the latter is decomposed with generation glyoxylic acid and urea presenting below:

$$\text{C}_5\text{H}_4\text{N}_2\text{O}_6 + \text{O} + \text{H}_2\text{O} \rightarrow \text{C}_5\text{H}_4\text{N}_2\text{O}_5 + \text{CO}_2,$$
$$\text{C}_5\text{H}_4\text{N}_2\text{O}_5 + 2\text{H}_2\text{O} \rightarrow \text{COH-COOH} + 2\text{CO}(\text{NH}_3)_2.$$ Hence, all nitrogen-containing substances are decomposed till ammonia, which is a total form of nitrogen during the storage of chicken manure. At once, nitrogen-free compounds namely sugar, starch, pectin, and other organic matter are decomposed, as well. It is necessary to note that nitrogen-free generate carbon dioxide and water in an aerobic condition. For instance, cellulose is converted into substances below:

$$(\text{C}_6\text{H}_10\text{O}_5)_n + \text{nH}_2\text{O} + 6\text{nO}_2 \rightarrow \text{n}(6\text{CO}_2↑ + 6\text{H}_2\text{O});$$
$$(\text{C}_6\text{H}_10\text{O}_5)_n + \text{nH}_2\text{O} \rightarrow \text{n}(3\text{CO}_2↑ + 3\text{CH}_4↑).$$

During the decomposition process, such gases as ammonia, carbon dioxide, and other organic matter are released. Thus, an enormous amount of nitrogen and organic matter are lost gradually leading to a reduction of nutrient in chicken manure during the storage. Formation of humus from organic matter in the compost is exceptional complex process conducting as a result of life activity of microorganisms, as well as physical and chemical processes. The most valuable humus in the compost from livestock farms is generated at neutral pH, under ambient temperature under medium wetting and creation of optimal condition. For obtaining composts with high quality some mineral fertilizer, phosphorite powder, limestone and so on usually

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are added to chicken manure. These substances it is necessary to support pH medium and as nutrient elements for various microorganisms [5-6].

Composting chicken manure with the addition of phosphorite powder is the most effective way. In [7] it was presented that during the decomposition of chicken manure with phosphorite powder fair quantity of organic acids piled up forming ammonium, potassium salts and others in the compost. These salts interact with phosphorite powder generating insoluble organic compounds of calcium and more movable compounds of phosphorus with ammonium and potassium.

It is necessary to note that in 2016 JSC “Uzkimyosanoat” produced 153.8 thousand tonnes of phosphoric fertilizers (based on 100% of P2O5). As regards, the need for agriculture in Uzbekistan is 691.7 thousand tonnes of P2O5. These figures indicate that provision of agriculture for phosphoric fertilizer is insufficient. Today, at Kyzylkum phosphorite combine there are produced waste in form of off-balanced ore (13-15 % P2O5) and phosphorite sludge (10-12 % P2O5) during the beneficiation process of Central Kyzylkum phosphorite. Total number produced waste phosphorite has already reached 13 billion tonnes. One of the most rational approaches of low-grade phosphorite processing is the usage of compost technology based on chicken manure.

Early we [8-10] carried out research on obtaining organic-mineral fertilizers on the basis of manure of chicken, avian litter with the addition of slime phosphorite of the Central Kyzylkum. It was shown that with increasing composting time, the formation of humus substances and mobile forms of phosphorus increases in all ratios.

The purpose of the present research is a transfer of unassimilable P2O5 in the mineralized mass of Central Kyzylkum phosphorite into assimilating form for plant, as well as investigation of losses, a decrease of nitrogen and organic matter into the atmosphere in compost. Goal attainment allows increasing the amount of phosphorus-containing humus fertilizers that are a large lack in Uzbekistan soils. As the amount of humus acids in our soil ranges from 1.5 to 5%.

2. METHODS AND MATERIALS.

In laboratory as an object it was used that mineralized mass content (weight. %): P2O5 - 14.33; P2O5 acceptable by EDTA - 16.57; CaO – 43.02; Al2O3 – 1.18; Fe2O3 – 1.38; MgO – 1.19; CO2 – 14.7; F – 1.85. Dispersion is the following: (-0.315 + 0.2 mm) – 0.4%; (-0.2 + 0.16 mm) – 43.8%; (-0.16 + 0.1 mm) – 41.6%; (-0.1 + 0.05 mm) – 9.4%; (-0.05 mm) – 4.8%. Chicken manure (weight. %): moisture – 64.74; ash – 11.19; organic matter – 23.97; humic acid – 1.24; fulvic acids – 5.27; water soluble organic substances – 1.19; P2O5 – 1.21; N – 1.02; CaO – 1.58.

Composts were prepared under a weight ratio of Dung : Phosphorite equal to 100 : 2; 100 : 4; 100 : 5; 100 : 8; 100 : 10; 100 : 12; 100 : 16; 100 : 21 w 100 : 25. In prepared mixing, it was poured water based on calculation to reach 70%. The obtained mix was placed in a vessel with 0.5 l then from above thin layer earth was poured. Subsequently, vessels were placed and incubated in a thermostat at 25°C. Every 15 days some samples were selected to determine for composition then the required a quantity of water was poured subsequent stirring and setting in the thermostat more.

The content of P2O5 (total), P2O5 acceptable by EDTA and 2 % solution of citric acid were defined according to the procedure in [11].- Ash content according to State standard 26714-85, nitrogen by State standard 26715-85, humidity by State standard 26712-85, organic matter by State standard 27980-80. Water-soluble fraction content of organic matter recovered from the product by water was determined by filtration and evaporation in a water bath, drying solid residue to constant weight subsequent burning to calculate ash content. Humic acids were leached processing product by 0.1 N solution of alkali and acidification of obtained solution by mineral acid [12-13]. The solid phase after separating from it alkali-soluble organic matter is residual organic matter. The latter was washed carefully by distiller water then dried to constant weight and determined outlet in towards to organic weight. Difference between the amount of alkali-soluble organic matter and humus acid gives us the content of fulvic acids in the compost.

3. RESULTS AND DISCUSSION.

In figures 1-5 given gives the data of the acceptable form of P2O5 and humic substances changing depending on composting duration and weight Dung: Phosphorite. So, when weight ratios of Dung: Phosphorite equal to 100 : 2 for 90 days relative content of P2O5 acceptable by EDTA and 2 % solution of citric acid increase from initial 16.57 and 9.01 % to 71.43 and 63.03%, while a ratio of 100 : 25 P2O5 acceptable by EDTA and 2 % solution of citric acid grow to 45.02 and 43.54 % respectively. Whereas, in figures 3-5 the changing results of humic acids, fulvic acids, and water-soluble organic matter are given.
As seen from figures that under ratio of Dung : Phosphorite = 100 : 2 after 15 days the content of humic acids, fulvic acids, and water-soluble organic matter constitutes 0.88%, 4.16%, 0.98%, but after 90 days has already reached 2.67%, 6.27%, 2.07% respectively. With weight ratio of Dung : Phosphorite = 100 : 25 after 15 days content above is 0.61%, 2.99%, 0.7%, and after 90 days is 2.03%, 5.34%, 1.68% respectively.

At figures 6 and 7 total, there are presented the changing total content of organic matter and nitrogen in the composts depending upon weight ratio of Dung: Phosphorite. Thus, when weight ratio of Dung : Phosphorite 100 : 2 for 90 days losses of organic matter and nitrogen into atmosphere is 26.57 and 21.75%, and at 100 : 25 that of indicated substances make up 14.22 and 9.87%, that is with increased content of mineralized mass in the compost losses of the substances are reduced in gas phase.

Furthermore, the results of the research show that conversion of phosphorus in mineralized mass into an acceptable form, decrease of emission ammonia and organic matter takes place due to the interaction of organic acids with phosphates. In literature, there is some information about the decomposition of urea, hippuric acids and other organic acids to ammonia and more low-molecular acids, as well as till CO₂ and H₂O during the worsen packing. These substances possess all properties of a carboxylic acid, which generate salts of complex ethers and amides. However, their anhydrides are unstable due to the presence of NH₂-groups. In case, composting chicken manure with mineralized mass the organic acids interact with phosphates and generate an acceptable form of phosphorus such as monobasic calcium phosphate and water-insoluble compounds of calcium with organic acids. Due to interaction monobasic calcium phosphate with ammonia mono-ammonium phosphate and acceptable form of phosphorus as dicalcium phosphate is generated.
Fig. 3. Humic acids content in the composts depending upon curing time and weight ratio of Dung: Phosphorite

Fig. 4. Fulvic acids content in the composts depending upon curing time and weight ratio of Dung: Phosphorite

Fig. 5. Water-soluble organic matter content in the compost depending upon curing time and weight ratio of Dung: Phosphorite

Fig. 6. Nitrogen losses in the composts based on mineralized mass from Central Kyzylikphosphorite and chicken manure.
Thus, investigation of composts prepared in a range of weight ratios of Dung : Phosphorite = 100 : (2-25) have shown that when composting chicken manure with mineralized mass because of interaction of organic acids with phosphorite movable phosphorus content increases while losses of organic matter and nitrogen reduce considerably, which promote finally growth of product outlet. In addition, it was established that increasing the curing time of composts leads to raise acceptable form of phosphorus, humic and fulvic acids, as well as water-soluble organic matter while increase mass fraction of phosphorite in towards to chicken manure promotes to grow conversion rate of organic matter into humic acids, fulvic acids, and water-soluble organic matter. There has been found the limit ratio and composting time. It has been shown the optimal ratio of Dung: Phosphorite is 100—(8-12) in which organic-mineral fertilizers with maximal humus substances content and acceptable $P_2O_5$ can be generated. Fertilizer obtained after drying to the air-dry condition is defined the following figures on quality (weight. %): $P_2O_5$total – 1.19-2.71; $P_2O_5$acceptable by EDTA – 0.85-1.22; $P_2O_5$acceptable 2 % solution of citric acid– 0.72-1.13; humic substances – 11.01-9.05.

CONCLUSION.

REFERENCE