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ANIMAL HUSBANDRY

THE TECHNOLOGICAL PROCESS OF ACCELERATED PEAT-POULTRY COMPOST PRODUCTION

Conflict of Interest

None declared.

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Abstract

To decrease the losses of biogenous elements and to produce high-quality organic fertilizers, technological process and technical means for the accelerated composting in special constructions with active aeration (in a fermentative chamber) on the basis of organogenic waste is offered.

Keywords: *peat-poultry, compost, production.*

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1. Introduction

The main strategy for basic research in agricultural science in the field of processing animal waste and producing high-quality organic fertilizers is the development of new technologies and technological processes of their production. To obtain compost through the use of animal manure, the authors propose a technological process and technical tools to speed production in special constructions with the active aeration of the compost mass by atmospheric oxygen, the so-called aerators.

In 2012, the annual volume of waste of cattle-breeding enterprises and poultry farms in the form of liquid manure, manure and wastewater was about 700 million m3. According to the Ministry of agriculture of Russia, more than 200 million tons of liquid manure effluents of various degrees of purification need to be recycled annually. To solve this problem, the most effective way of recycling waste with simultaneous production of organic fertilizers is the production of compost based on peat.

The composting process is a complex interaction between organic waste, microorganisms, moisture and oxygen. The waste is usually mixed has its own endogenous microflora. Microbial activity increases as the moisture content and the oxygen concentration reaches the required level. In addition to oxygen and water, carbon, nitrogen, phosphorus, potassium and certain trace elements are essential sources to the microorganisms for growth and reproduction.

Compost as the end product of composting contains the most stable organic compounds, breakdown products, dead biomass of microorganisms, some amount of living microbes and the products of chemical interaction of these components.

The natural process of decomposition of substrate during composting can be accelerated by controlling not only the ratio of carbon and nitrogen, but also humidity, temperature, oxygen level, particle size, size and shape of the compost pile, and pH.

Under normal conditions, composting is an aerobic process. This means that for the microbial metabolism and respiration, oxygen is required. In Greek aero means air and bios – life. Microbes use oxygen more often than other oxidizing agents because its participation reactions occur 19 times more energetic. The ideal oxygen concentration is equal to 16,0 – 18,5 %. At the beginning of composting, the oxygen concentration in the pores is 15-20%, which is equivalent to its content in the atmospheric air. The concentration of carbon dioxide varies in the range of 0.5 to 5.0 %. In the composting process, the oxygen concentration decreases and carbon dioxide increases [1, 2].

Aeration can occur by natural diffusion of oxygen in the composting mass by mixing the compost by hand, using machines, or forced aeration. Aeration has additional functions in the composting process. The airflow removes carbon dioxide and water generated in the process of vital activity of microorganisms, and dissipates heat through evaporative heat transfer. Oxygen demand changes during the process: it is low in the mesophilic stage, rises to a maximum in the morphilic stage and drops to zero during the stage of cooling and maturation.

The time required for the maturation of the compost depends on the factors listed above. The shorter the period of maturation is associated with optimal moisture content, C:N ratio and frequency of aeration. The process slows down when there is insufficient soil humidity, low temperatures, high values of the C:N ratio, large particle size of the substrate, a high content of wood material, and inadequate aeration.

The composting process of raw material proceeds much faster if all the conditions necessary for microbial growth are met. Forced aeration of fermentable mass of oxygen leads to the predominance of aerobic processes and results in preferential development of aerobic microorganisms. By converting the initial mixture, the period of availability of organic raw material can be reduced to several days,

thereby significantly decreasing the loss of nutrients, which is inevitable in passive composting.

2. Materials and methods

Production is a manufacturing line of accelerated composting on the basis of litter manure and litter – peat, or, if necessary neutralizing materials (chalk or dolomite flour). The volume of production peat-poultry compost is 80 t/year.

To ensure the technological process of production of compost corporate logo, use the following facilities: a hard surface with a size of 20x10 (m^2) for storing a year's supply of litter manure (20tons) and peat (60 tons), as well as for pre-mixing and storing the finished compost; building the fermentation chamber with a size of 9x4x3 (108m^3).

The process of producing compost includes the following operations:

- transportation of moisture-absorbing material;
- formation of a "cushion" of peat;
- transportation of peat;
-mixing and placing components in a heap;
- loading of the mixture;
- transportation and unloading of the mixture in the fermentation chamber;
- aerobic fermentation of the mixture;
- loading, transportation, and stacking of finished compost in a pile.

The types of technological operations and technological equipment, machines, productivity in the production of compost method, and aerobic bio fermentation are shown in table 1.

Table 1 – The types of machinery and equipment

Manufacturing operation	Machine, equipment	Productivity
Transportation of moisture-absorbing material	Truck KamAZ	4,0 t/hour
The formation of a "cushion" of peat	Loader PKU-0.8 A	20,0 t/hour
Transportation of peat	Truck KamAZ	19,5 t/hour
Mixing of components and laying in a heap	Loader PKU-0.8 A	20,0 t/hour
Loading of the mixture	Loader PKU-0.8 A	16,0 t/hour
Transportation and unloading of the mixture in the fermentation chamber	MTZ-82 + ROU-6 (spreader of organic fertilizers)	18,0 t/hour
Aerobic fermentation of the mixture	Compressor 2АФ capacity of 2.5 kW	220 $м^3$/ hour
Loading, transportation and stacking of finished compost in the pile	Loader PKU-0.8 A; MTZ-82 + ROU-6 (spreader of organic fertilizers)	10,0 t/hour 15,0 t/hour

Table 2 – Technical and economic indicators of production of compost by the method of aerobic fermentation

The annual output of compost, t	80
Direct costs, $/t	12,0
including: salary	3,87
depreciation	2,58
deductions for repairs	1,48
Fuels and lubricants and electricity	3,34
overhead	0,77
Other costs, $/t	0,6
Total cost, $/t	12,6
Raw material costs, $/t	41,6
peat	32,2
dung	9,35
The cost of capital investments (the fermentation chamber, equipment), $/t	7,74
Total, $/t	61,9

The technological process is designed for the rapid production of peat-based compost by the method of aerobic fermentation by means of forcing of oxygen into the mixture until saturation.

The cycle of oxygen supply is repeated until the aerobic process in the fermentation chamber is competed. After the optimal temperature (57^oC) is reached, the mixture has to age for 4 days. During this period, the mixture is disinfected from pathogenic organisms, and weed seeds lose their germination

The duration of composting is 10 days. The process is accompanied by loss of weight from 1.8 to 4.7 % per day due to evaporation and decomposition of organic matter. The air flow rate from 2.5 to 4.5 m^3/t of mix per hour provides the conditions for acceleration of the biothermal process.

3. Results and discussions

Peat-based composts are classified as low-risk, non-hazardous substances (hazard class 4 according to GOST (State standard) 12.1.007), and must comply with regulatory requirements for Toxilogical, radiological characteristics. . Handling, transportation and storage of finished compost must meet the requirements of GOST (State standard) 12.3.009.

To prevent infiltration of excess moisture in the soil and groundwater contamination, the sites for the storage of litter, (manure) should have monolithic concrete pavement or a base of the clay cushion with a minimum thickness of 20-25 cm.

When used in recommended standards, peat-based compost should not pollute the soil and groundwater with toxic elements and radionuclides.

When composts was used in the field experiments, the productivity of grain-crops crop rotation has increased by 20-25% compared to control.

To reduce nitrogen loss in the compost production using

the method of aerobic fermentation, the study of effectiveness of sorbents as a covering material or fillers of compost (10% by volume) in the with peat, clay, and zeolite used as sorbents was conducted.

The largest production of ammonia (NH3↑) in mixtures placed in the aerator was noted in the control variant and in variants with the mixing of the sorbents in the composting mixture. The maximum temperature of 50°C was reached when using the sorbents as a filler and peat as a covering material. These variants had the smallest mass loss after bio fermentation compost mixture.

Table 3 shows data on the effect of methods of application of sorbents when using the method of aerobic fermentation, the loss of physical mass and total nitrogen in morphometry mixture during the period of composting.

Table 3 – The influence of methods of use of the sorbents during the period of composting on the change of mass and the content of total nitrogen in compost

Options	Weight loss,%	Loss N_{tot}·, %
Control (no sorbent)	22,5	10,2
Sorbent zeolite	22,8	7,0
Sorbent peat	16,5	8,0
Sorbent clay	26,7	12,0
Mix: peat+dung+clay	20,0	19,6
Mix: peat+dung+ zeolite	17,0	18,0

Composting is a dynamic process occurring through the activity of microbial community of different groups [3,4]. The main groups involved in composting are bacteria, actinomycetes, fungi, yeasts, etc. Microbiological analysis of finished compost from tartaportal mixture showed that in the aerobic composting significantly increases the number calculatorului and uses organic and mineral forms of nitrogen. The highest microbiological activity was observed in the finished compost when using clay as a sorbent.

4. Conclusions

The following results of the study of the compost production using the method of aerobic fermentation, were obtained

• period of composting is reduced to 7-10 days;

• final compost does not contain weed seeds and pathogenic microorganisms;

• when peat is used as a filler, the reduction in the loss of physical mass is 16.5% as compared to the control;

• method of compost production used in the study reduces the concentration of pathogens by increasing the temperature in the compost mass to 50-55 degrees;

• the use of compost in field crop rotation allows to increase the productivity of agricultural crops by 20-25%.

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