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Organic fertilizer from restored plant raw material

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The purpose. To study influence of application of processing barley straw by microbiological specimens and humate of potassium before composting with dung and peat on microbiological and agrochemical content of organic fertilizer. **Methods.** Model, analytical, statistical. They use fresh poultry dung with a moisture content 68%, peat (32%), and barley straw (14%). Straw of barley was treated before mixing together by solutions of microbiological specimens and humate of potassium (200 l of working solution for 1 t of straw). Duration of process of composting — 6 months **Results.** It is established that pretreatment of straw with microbiological and humate-containing specimens speeds up process of its decomposition. That, in turn, promotes martempering of quality of organic fertilizer. Microbiological and agrochemical characteristics of the gained organic fertilizers are brought. Regular application of organic fertilizer on the basis of straw will enrich soil with organic substance, components of mineral nutrition, useful microflora. That will raise its biological activity and will promote lowering of acidity. **Conclusions.** Treatment of barley straw before composting with microbiological specimen containing lactic acid bacteria, barm, purple not sulfuric bacteria or microbiological specimen, which basic component are cells of Azotobacter chroococcum, or humate of potassium promotes intense decomposition of nitrogen-free organic joints of straw, as well as heightening of a pool of microorganisms and quantity of fungi. As a result of composting of plant raw material for 6 months it is possible to get organic fertilizer with the content of organic substance not less than 70%, content of nitrogen on dry matter — not less than 2.8%, phosphorus — not less than 2.3, potassium — not less than 1,6%.

Key words: *straw, organic fertilizer, macronutrient elements, microorganisms.*
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Formulation of the problem. Agricultural sector of economy, in particular crop production sector, generates a big amount of wastes annually. Crop production by-products are an important sources of soil enrichment with organic matter.

According to N.M. Kolesnik, B.V. Timofiychuk, V.M. Sendetsky [1], an application of straw and other crop residues will make it possible to add (in terms of litter manure) 150-200 million tons of organic fertilizers. However, to make a straw more valuable as organic fertilizer, it should be degraded faster in a soil.

It was established [2-4] that crop residues, after applying into a soil, decomposes with different intensities. Thus, in the first year, crop residues of oilseed radish and mustard are most intensively decomposed (about 82 – 85 %), sunflower –slower (about 45 %), barley – 26 % and winter wheat – 25 %.

To accelerate decomposition of crop residues, destructors with different origin should be used, fungal origin, bacterial origin, and others (humates, nutrient media, biologically active substances, etc.). Fungal preparations mostly contain Trichoderma. Bacterial straw destructors consist of nitrogen-fixing bacteria, phosphorus and potassium mobilizers, Bacillus bacteria. Bacterial destructors contribute to reproduction of all types of microorganisms in a soil which involved in crop residues destruction into soil.

Application of straw-based composts improves physical and agrochemical properties of soils [5].

The purpose of the research – determination of the effect of pretreatment of barley straw with microbiological preparations and potassium humate before composting with litter and peat on microbiological and agrochemical composition of organic fertilizer.

Materials and methods. Organic fertilizer was obtained by mixing straw with litter and peat in accordance with the guidelines for composts production from crop residues [6]. Composting of organic raw materials with different genesis (barley straw, newly formed chicken litter and peat in a ratio 2:1:1) was carried out in plastic vessels with a lid and a perforated tube with an external outlet to provide aeration.

Characteristics of the materials which were used in the experiment are following. Newly formed chicken litter with humidity – 68 %, pH 7.5, total carbon content – 25.7 %, nitrogen content – 4.53 %, phosphorus – 3.88 %, potassium – 5.73 %. Peat moisture content – 32 %, pH 3.3, total carbon content – 46,4%, nitrogen content – 2.06 %, phosphorus – 0.10 %, potassium – 0.04 %. Barley straw has a moisture content – 14 %, total carbon content – 35 %, nitrogen content – 0.50 %, phosphorus – 0.18 %, potassium – 0.94 %. Barley straw before mixing was pretreated by microbiological preparations (Emochka Fertility, Azotofit) and potassium humate (200 l of solution per 1 ton of straw). The duration of the composting process – 6 months. The repetition of the experiment – 6. Humidity of mixtures was maintained at level 50-70 %, temperature – at least 20 °C.

The model experiment scheme:

1. Compost with untreated straw (control);
2. Compost with straw treated by Emochka Fertility (1 % solution);
3. Compost with straw treated by potassium humate (1 % solution);

4. Compost with straw treated by Azotofit (1 % solution);

5. Compost with straw treated by potassium humate (1 % solution) and Azotofit (1 % solution).

The microbiological preparation Emochka Fertility, the main component of which is Probio Balance Plus 3.9–4.1%, contains lactic acid bacteria - more than 3,0 × 105 CFU/cm^3; yeast – less than 1,0 × 106 CFU/ml; purple nonsulfur bacteria – more than 1.0 × 104 CFU/cm^3. The microbiological preparation Azotofit, the main component of which is Azotobacter chroococcum, contains macro- and microelements, biologically active waste products of bacteria: enzymes, amino acids, vitamins, phytohormones, fungicides. Potassium humate contains humic acids – 3.96 %, fulvic acids – 6.22 %, pH 11.6.

The analysis of organic fertilizer samples was carried out according to the current regulatory and methodological documents in certified laboratories (certificate of measurement system compliance with the requirements of State Standard ISO 10012: 2005 № 01-0104/2017 and № 01-0105/2017). Determination of the number of main microflora groups in colony-forming units (CFU) was carried out by microbiological seeding suspension of the corresponding dilution on solid nutrient media: microorganisms that assimilate nitrogen of mineral compounds and actinomycetes – on ammonium starch ammonia (KAA), microscopes opic mushrooms – on Richter's environment; oligotrophic microorganisms – on starvation agar (GA), associative nitrogen fixers – on Dobereiner and Ashby Wednesday [7]; moisture of samples – according to DSTU EN 13040 [8]; ash content – according to DSTU EN 13039 [9]; pH – according to DSTU EN 13037 [10]; total mass fraction of nitrogen and ammonium nitrogen – according to DSTU 7911 [11]; total phosphorus – according to DSTU ISO 5316 [12]; total potassium – according to DSTU 7949 [13]; total carbon – according to DSTU 4289 [14]; organic matter content – according to DSTU 8454 [15].

Results and discussion. As a result of the model experiment, it was found that destruction of barley straw is more intensive after treatment with a solution of potassium humate and microbiological preparation Azotofit, as evidenced by color changes from yellow to brown and black. Under the effect of a microbiological preparation, which includes lactic acid bacteria and yeast (Emochka Fertility), the destruction of straw proceeded more slowly.

Compost maturity was determined visually by the following features: blackening of crop residues, disappearance of the unpleasant odor of litter, the appearance of the smell of forest mold, soft texture of compost particles.

The content of microscopic fungi in the control organic fertilizer with untreated straw is 3.5 thousand CFU/g, with the straw treated by Emochka Fertility the content of fungi increased to 3,9 thousand CFU/g. For the variants with straw treatment by potassium humate and Azotofit – up to 26-26.4 thousand CFU/g. The presence in organic fertilizer of a large number of fungi indicates intensive decomposition of straw, because fungi are able to decompose sufficiently stable organic compounds (cellulose, hemicell Dhu, lignin).

Composting is a dynamic microbial process that occurs due to activity of various groups of microorganisms. Compost mixture should be adjusted so as to optimize the activity of microorganisms. Studies show that organic fertilizers did not differ significantly in the content of microorganisms. At the last stage of composting, the following regularities of microbial succession were observed: the growth of microorganisms assimilating organic nitrogen forms> nitrogen fixers> microorganisms assimilating mineral nitrogen forms> oligonitrophils (Fig. 1).

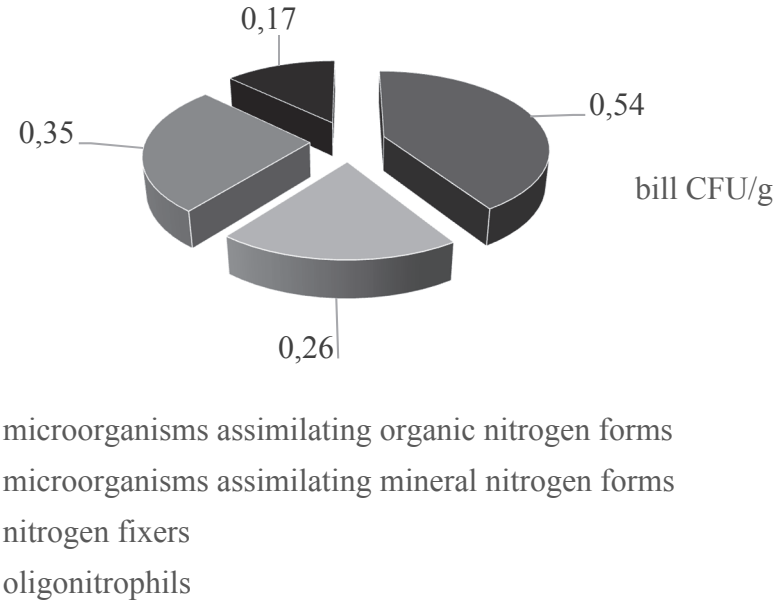

Fig. 1. The content of microorganisms in composts on the fifth month of composting, colony forming units per gram

Obtained organic fertilizers have a different agrochemical composition, pH and total carbon content (table 1).

1. Agrochemical characteristics of organic fertilizer based on barley straw

Compost type	pH	Moisture content,%	Content,% of dry matter				
			organic matter	Ctot	N	P_2O_5	K_2O
Compost with untreated straw (control)	7,9	63,2	79,0	31,0	1,98	2,24	1,42
Compost with straw treated by Emochka Fertility	8,5	61,7	72,5	32,2	3,35	2,38	1,69
Compost with straw treated by potassium	7,9	66,6	80,0	36,1	4,31	2,35	1,75
Compost with straw treated by Azotofit	8,4	65,2	76,0	32,7	3,14	2,87	1,81
Compost with straw treated by potassium humate and Azotofit	7,9	65,7	74,0	30,5	2,88	2,47	1,94
SSD_{05}	-	-	5,42	2,06	0,71	0,22	0,34

Thus, the control organic fertilizer (without treatment of straw) is characterized by moisture content – 63 % and ash – 21% and contains 1,98 % nitrogen, 2,24 % phosphorus and 1,42 % potassium.

For nitrogen fixation in composts the presence of a certain amount of nitrogen in the organic form is necessary to enhance decomposition of organic matter, as well as to activate bacteria that decompose cellulose, whose metabolic products are the energetic material for nitrogen fixators. During production of compost with high carbon content (straw, peat), the content of nitrogen is compensated by introducing litter and processing the raw material with a 1% Azotofit solution containing Azotobacter chroococcum cells. During composting, firstly, cellulose decomposes intensively, which makes up the bulk of crop residues. Processing of barley straw with the microbiological preparation Emochka Fertility significantly increases nitrogen content. The use of potassium humate for processing straw before composting increases content of nitrogen and phosphorus in the compost. Treatment of straw with Azotofit contributed to an increase in the content of all macronutrients in organic fertilizer.

Thus, as a result of composting barley straw treated with microbiological preparations or potassium humate with litter and peat, organic fertilizer is obtained, which contain an increased amount of organic matter, a certain amount of macronutrients and characterized by high microbiological activity. The systematic application of straw-based organic fertilizer will support to enrich soils with organic matter, mineral nutrition components, beneficial microflora, increase biological activity and will reduce acidity of soil.

Conclusions

Barley straw pretreatment by microbiological preparation containing lactic acid bacteria, yeast, purple non-sulfur bacteria, potassium humate or microbiological preparation based on Azotobacter chroococcum, before composting promotes intensification nitrogen-free organic compounds straw decomposition, increasing a pool of microorganisms and number of fungi in composts. As a result of composting during six months, organic fertilizers with organic matter content at least 70 %, a nitrogen content – at least 2.8 %, phosphorus – at least 2.3 %, potassium – at least 1.6 % are obtained.

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