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A New Method of Biological Disposal of Poultry Droppings

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Abstract*: *The article shows the methods of biological processing of poultry droppings, and their advantages and disadvantages. A new method of disposing of quail's droppings has been suggested, which helps reduce the costs and improve their quality for use as a fertilizer. The technical result is achieved by placing quail's litter in layers, mixing it with the Tereklit zeolite-containing clay from the lower and the upper layers, and the soil from the 0 – 20 cm layer under legumes 2 – 3 years of age, and moisturizing each layer with a 0.3 – 0.4 % aqueous solution from the roots of common licorice plants. The fertilizers were tested on the crops of potato and winter wheat. The efficiency of the proposed variant allowed increasing the yield of crops at no additional cost.

Keywords*: *Quail's Droppings, Biological Treatment, New Method, Tereklit Clay.

I. INTRODUCTION

In the recent decades, issues of agriculture ecologization have been addressed by scientists around the world, since the increase in the world's population is accompanied by the increased livestock and poultry production [1-3]. This increases the amount of wastes in much larger quantities than the products made. All this increases the environmental load; therefore, this problem becomes more and more relevant every year [4-6].

Ecologization of agriculture is understood as the development of the methods of agricultural production, including the introduction of the systems of agriculture based on the principles of rational environmentally safe nature management, which can increase the volume of agricultural production [7-9]. The main problem addressed by the humankind in ecologization of agricultural production is ensuring the reproduction of soil fertility, creating the conditions for land preservation, and production of environmentally friendly products [10-12].

Along with the issues of food security, ecologization of crop and livestock production is one of the priority issues of the state policy of the country [13-15].

Daily accumulation of the litter at poultry farms of large agricultural enterprises creates challenges associated with disposal, and given the significant financial costs of solving them, as well as the need for the space for storing droppings and pastures for the introduction of the obtained fertilizer, the problem becomes exacerbated, and is sometimes beyond the capacities of a farm [16-18].

As a raw material, droppings from poultry farms themselves are not particularly valuable. Moreover, they present a real danger of environmental pollution. However, after processing, they turn into a fertilizer that is in demand, and can increase the efficiency of the poultry industry [19-22]. The long-used method of direct (without processing) introduction of droppings into the soil, being the simplest and the most cost-saving one, was not widely used due to the cost of transportation, infestation with invasive, infectious, and toxic elements, and accumulation of nitrates, copper, and zinc in the grains, the grass, and the water sources [23, 24].

Along with the above-mentioned method, there are over ten ideas about recycling droppings [25-27], which have certain advantages and disadvantages. The opinion of respected scientists from the All-Russian Poultry Breeding Research Institute (VNITIP) should be noted here, who stated that of all the many methods proposed for large and medium poultry farms in Russia, only one method was acceptable, namely, the production of organic fertilizers based on droppings.

There are various ways of processing droppings: vermicomposting; composting of poultry droppings with fillers; biothermal disinfection; biofermentation (accelerated fermentation); microbiological processing; granulation of droppings; anaerobic processing (biogas production); biological processing; and processing of components for preparation of fertilizers based on poultry droppings with desired properties [28, 29].

Based on these methods, poultry droppings are processed with the addition of cattle droppings and biological wastes with the mandatory introduction of biological preparations [30, 31].

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It should be noted that the used technological solutions are not sufficiently efficient since the biological preparations are quite costly, and the process of their introduction into the compost at certain humidity is long and inefficient due to the insufficient amount of macro- and micronutrients.

A more reasonable technical solution is the method when the droppings and the moisture-absorbing organic material are laid layer-by-layer with the introduction of the strains of microorganisms [32, 33]. Despite several advantages, this method of processing droppings has the following disadvantages: the need for systematic mixing the pit with the mixture of organic substances, which is quite time consuming; the use of various types of strains, which are not always available; rapid volatilization of nitrogen compounds from the droppings, which are required for initial growth and development of plants; and performing aerobic fermentation. All of these disadvantages increase the costs of implementing the method and obtaining fertilizers for the crops.

Greater efficiency in obtaining droppings with desired characteristics, balanced by various nutrients, can be achieved by introducing mineral supplements and "microbial starters" [34-36]. Quail's droppings contain three to four times more organic matter than cattle droppings and are characterized by the presence of many mineral substances required for plants.

This work was aimed at determining the efficiency of the new method of biological processing of quail's droppings for obtaining the fertilizer, and the possibility of using it for cultivating crops.

II. MATERIALS AND METHODS

The proposed method of processing quail's droppings helps reduce the costs and improve the quality of processed quail's droppings to be used as fertilizer.

The technical result is achieved by placing quail's litter in layers, mixing it with the Tereklit zeolite-containing clay from the lower and the upper layers, and the soil from the 0 – 20 cm layer under legumes 2 – 3 years of age, and moisturizing each layer with a 0.3 – 0.4 % aqueous solution from the roots of common licorice plants.

The Tereklit clay contains 19.4 % of aluminum, 2.75 % of calcium + magnesium, 5.54 % of iron, up to 1.87 % of organics; losses during calcination are 9.75 %.

The mineralogical composition by fraction is the following: kaolinite — 5 %, montmorillonite — 10 – 15 %, chlorite — 5 – 10 %, pyrite — 1 %, quartz — 15 – 20 %, feldspar — 0.3 – 15.3 %, and mica — not more than 1.7 %.

The valuable properties of Tereklit are high heat capacity, low thermal conductivity, and high adsorption and catalytic ability. Unlike other clay deposits, Tereklit contains considerable amounts of water-soluble salts (sodium, magnesium, calcium, phosphorus, potassium, etc.). The Tereklit clay is dense dark-gray rock with a homogeneous structure without extraneous inclusions. The clay is dense, odorless, and makes up the lower part of the left bank of the Terek River. For processing the droppings, a 30 – 35 cm thick layer of clay, which had good absorption capacity and prolonged effect, was laid first. The next 10 cm thick layer was laid on the quail's droppings and covered with a 20 cm thick layer of the soil taken from the area with growing leguminous herbs. At the depth of 0 – 20 cm, the soil contained a significant amount of nodule bacteria (Azotobacter), which were also covered with a 20 cm thick layer of the Tereklit clay. Each layer was poured with an aqueous 0.3 – 0.4 % solution of the root system of common licorice plants (Glycyrrhiza glabra L.)

Common licorice is a perennial herbaceous plant of the legume (Fabaceae) family with a strong root system. The rootstalk of common licorice contains 7.88 % of ash; macronutrients (mg/g): potassium — 14.5; calcium — 11.50; manganese — 2.40; iron — 0.7; microelements: magnesium, copper, chromium, aluminum, barium, vanadium, nickel — within 0.2 – 0.7 %. It also contains a significant amount of selenium — 12.2 %. Licorice grows like a weed at forest edges, in ravines, on slopes, on the banks of small rivers. The roots and the rootstalk contain up to 23 % of saponin: glycyrrhizin (potassium and calcium salt of glycyrrhizic acid), which gives it a sickly-sweet taste, and numerous derivatives from glycyrrhizic acid: about 30 % of flavonoids (liquiritin, licurazide, glabroside, uranozide, quercetine, apigenin, ononin, etc.), mono- and disaccharides (20 %), starch (up to 34 %), pectins (6 %), resins (40 %), bitter substances (up to 4 %), phenol carbonic acids (salicylic, sinapic, ferulic) and their derivatives (salicylic acid acetate), coumarins (14 %), alkaloids, essential oils (0.03 %), and organic acids – up to 4.6 % (tartaric, citric, malic, fumaric).

Such a complex of micro- and macro elements of licorice ensures feeding of the nitrogen-fixing nodule bacteria located in the soil layer, taken from the root system of the legumes (clover, alfalfa, sainfoin, sweet clover, crown vetch, astragalus, deervetch, and other perennial legumes) located at farms during the preparation of fertilizers from poultry droppings.

III. RESULTS AND DISCUSSION

The Tereklit clay was laid in a 30 cm thick layer on an elevated plot with a length of 20 m and a width of 10 m. A 15 cm thick layer of quail's droppings was laid over, and covered with a 20 cm thick layer of the soil taken from under the crops of red clover at the depth of 15 cm. The fourth layer was covered with a 20 cm thick layer of clay. Each layer was wetted with an aqueous 0.3 % solution of common licorice roots at the rate of 30 g per 10 liters of water. The prepared compost was covered with foil and stored for three to four weeks, after which briquettes were made and used for potatoes and vegetable crops by placing them in the furrows before planting. Due to the adsorption properties of the upper and the lower layers, the compost was stirred, dried and briquetted after storage.

On a prepared 20×15 cm plot, a 35 cm thick layer of clay was laid. The second layer was quail's droppings with the thickness of 20 cm, which was covered with another 20 cm thick layer of the same soil; finally, a 25 cm thick layer of clay was placed on top. Each layer was wetted with an aqueous 0.4 % solution of common licorice. From the dug-out licorice plants, parts of the main and the branch roots were taken in the amount of 40 g per 10 liters of water, steamed in hot water for 20 – 30 minutes, and after cooling used for wetting each layer.

The compost was covered with tape for three weeks, after which the whole mass was stirred, dried and briquettes were made, which were subsequently placed into the soil for winter wheat.

The variants shown in the table were used on leached black soil with the humus content of 4.2 %. The selected parameters of the method by the thickness of the Tereklit layer were substantiated by its high capacity to absorb chemical compounds from quail's droppings, which contain significant amounts of nitrogen in the form of uric acid. The amount of droppings placed on the layer of Tereklit in a 15 – 20 cm thick layer and on the surface of the soil is completely absorbed by the clay and partially by the soil, ensuring the prolonged action of the nutrient solution on winter wheat (cultivar Tanya) and potato (cultivar Bars).

The used fertilizer was tested on the crops of potato and winter wheat (examples 1 and 2). The results of the experiments are summarized in the Table.

Table 1: Efficiency of using variants of the fertilizers on the crops yield rate

Variants of the experiment	Winter wheat yield, hw/ha	Potato yield, hw/ha	Introduction rate, t/ha (for winter wheat)	Introduction rate, t/ha (for potato)	Humus content in the soil, %
Reference (without fertilizers)	16.8	185.6	-	-	4.2
Tereklit+droppings	21.4	196.2	1.5	2.0	4.8
Soil under leguminous herbs+Tereklit	19.8	186.6	2.0	2.0	4.7
Tereklit+soil from legumes +droppings	23.5	217.3	2.5	3.0	4.9
Proposed variant	35.1	232.0	2.5	3.5	5.1
LSD	1.8	12.7	-	-	-

IV. CONCLUSION

Using natural sources of raw materials (the Tereklit clay and the soil from under legumes containing nitrogen-fixing nodule bacteria), the yield of crops may be increased at no additional cost.

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