An innovative approach to the use of the granulated organic fertilizers based on bird droppings on crops of spring wheat

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Abstract. The production of the granulated organic fertilizers based on bird droppings is important in the disposal of poultry waste and of the improvement of the fertility and in improving the phytosanitary condition of soil. In agricultural landscapes the issues of a phytosanitary condition and environmental situation are important. The fertilizing of the spring wheat in the tillering by the stage granular organic fertilizers based on bird droppings helps to reduce destruction of the plants root rots (prevalence and development of disease is reduced in 2-3 times). There is an improvement of the phytosanitary state of soil. In soil increases the amount of fungi-antagonists, and also the number of pathogenic fungi decreases. The yield of spring wheat increases in 1.5-2 times from making granular fertilizers. In this activity such fertilizers do not yield in terms of nutrients expensive mineral fertilizers. The profit of grain production from the use of the granulated organic fertilizers based on bird droppings increases in 1.7 times. The economic indicators of production of the grain in comparison with application of compound fertilizers was higher.

1. Introduction

In agriculture, particularly in crop production, currently, the introduction of innovative technologies is of great importance. Without the use of the innovation is practically difficult to create competitive products. Innovations are an effective tool of competition, as they lead to the creation of new needs, to reduce production costs, investment flows, to improve the image of the manufacturer of new products, opening and capture of new markets, internal and external [1]. Modern agricultural production requires the development of ecologically safe technologies of cultivation of agricultural crops. [2, 3].

Modern poultry farms produce not only meat and eggs of poultry, but a large amount of waste. In one year from the one hen you can get 250-300 eggs and 55-73 kg litter humidity of 65-75%. For every pound received of chicken meat additionally obtained 3 pounds of droppings. On many poultry farms number of litters produced per year reaches tens of thousands of tons. Taking in account the increasing number of poultry farms in recent years the disposal of poultry litter has become a difficult problem for many poultry farms, because it is costly logistics and funds and the availability of large areas of farmland [4].

Organic fertilizers are a good tool in order to solve the General problem of soil fertility and to provide plant nutrients for a long time. However, any animal waste, especially poultry, should be used with caution, because any manure fresh may do more harm than good. Organic fertilizers are working in the soil for a long period providing aftereffect. They have a positive effect on the plant, allow to
obtain a good yield increase [5-6].

In agricultural landscapes, issues of the phytosanitary condition and environmental situation are important.

Organic fertilizers based on bird droppings are a good means to solve the common problem of soil fertility. They are having a low concentration of nutrients, a long time working in soil, providing aftereffect. This has a positive effect on the plant, allowing you to obtain good yield increase [7].

Granular poultry manure is a complex organic fertilizer with a full range of batteries for all agricultural and ornamental crops in open and protected grounds. All the nutrients in it are in the organic form, so it is better absorbed by plants, they are doing gradually. It provides a nutrient medium for a longer time. Raw chicken manure as fertilizer can "burn" the plant, so the use of the granules of the litter and still ensures the safety of the crop. Granular fertilizer from it easier to transport and store because it is devoid of unpleasant smell and acquires the simple form (requires 3-4 times less warehouse space). In addition, the fertilizer no viable weed seeds, eggs and larvae of worms and flies, and during prolonged storage it is able to retain all its useful properties [8].

The decline of fertility and the phytosanitary state of the soil has led to the need to develop the granular organic fertilizers based on bird droppings and studying its impact on the phytosanitary condition of the soil.

Despite the high content of macro - and microelements in fresh poultry manure may not be applied in its original form because of the high content of ammonium nitrogen, burning the soil, and pathogenic organisms. He has a number of disadvantages, for example, high toxicity, inability to use it directly after receiving an unpleasant odor [9]. A rational method of processing high moisture (70-75%) of chicken manure is producing granulated organic fertilizers.

The purpose of our research is the study of optimization of phytosanitary state of the soil and increase crop yields by making the granulated organic fertilizers.

2. Experimental part
Granulated organic fertilizers based on bird droppings were obtained by composting pure manure for several days. Compost is periodically mixed with a special tedder. During composting, the mass heated up strongly, this contributed to the destruction of pathogens and weed seeds. A crushed mass was obtained, which was passed through a granulator. The granules were then dried. Such granules can be stored for a long time, do not deteriorate, do not have an unpleasant odor. Granulated fertilizer from chicken manure is a concentrated fertilizer, because in the process of processing the volume of raw materials decreases more than 10 times due to the removal of water and increase in density during pressing. They can be used in autumn before plowing as the main fertilizer. When sowing, it is possible to load seeders instead of mineral fertilizers. For this, you can prepare small rounded granules. We used it as a top dressing for spring wheat.

| Components          | Amount, % | Micronutrients | Amount, mg/kg |
|---------------------|-----------|----------------|---------------|
| Organic substances  | 60.0-62.0 | Manganese      | 300-350       |
| Nitrogen (NH₄⁺+N₂O₃) | 1.5-5.0   | Sulfur         | 40.0-42.0     |
| Phosphorus (P₂O₅)   | 1.8-5.5   | Zinc           | 20.0-23.0     |
| Potassium (K₂O)     | 1.5-2.0   | Copper         | 2.7-3.3       |
| Iron (Fe₂O₃)        | 0.1-0.3   | Bor            | 4.2-4.8       |
| Calcium (CaO)       | 0.5-1.0   | Cobalt         | 3.0-3.5       |
| Magnesium (MgO)     | 0.2-0.3   | Molybdenum     | 0.05-0.07     |

The study was carried out at the experimental field of the Mari state University on spring wheat in 2015-2017. Granulated organic fertilizer (GOF) applied as a top dressing in the early phase of tillering. To compare we used mineral fertilizer azophoska with the content of NPK of 15% (in a dose of 100 kg/ha). On the control option the fertilizer was not applied. GOF was used in doses 100, 200
and 300 kg per 1 ha. The fertilizer was scattered on the soil surface by hand. For spreading in the farms you can use the spreaders of mineral fertilizers.

During the study we observed the growth and development of spring wheat, analyzed the micromycete of the composition of the soil by the method of soil inoculation of a nutrient medium of Czapeka-Doks, carried out accounting of root rot of spring wheat by the conventional method of All-Russian Research Institute of Phytopathology.

3. Results and Considerations

In its effect on plant productivity poultry manure is not inferior to expensive mineral fertilizers. In terms of the number of nutrients it even superior thanks to its organic form. These nutrients are much less washed out of the soil, well reach the roots and do not create a high concentration of salts around the root system.

Analysis of plants of spring wheat to identify the root rot showed that the prevalence and development of disease is reduced depending on the make of the granulated organic fertilizers based on bird droppings. We found that with increasing dose of the granules to 300 kg/ha of lose wheat root rots is reduced.

Table 2. The incidence and development of the root rot of spring wheat, %.

| Options          | Prevalence of the root rot, % | Development of the root rot, % | Yield, t/ha | Increase, t/ha |
|------------------|--------------------------------|--------------------------------|-------------|---------------|
| Control          | 44.3                           | 14.9                           | 2.24        | -             |
| Azophoska (100 kg/ha) | 35.0                        | 11.1                           | 3.30        | +1.06         |
| GOF (100 kg/ha)  | 31.7                           | 11.2                           | 3.09        | +0.84         |
| GOF (200 kg/ha)  | 30.8                           | 10.6                           | 3.41        | +1.17         |
| GOF (300 kg/ha)  | 27.6                           | 9.0                            | 3.66        | +1.42         |

Making the GOF in a dose of 100 kg/ha the prevalence of the disease decreases by 12.6% compared to the control, and the development of the disease decreases by 3.7%. In contrast to compound fertilizers these figures differed. The smallest lesion of the plant was in the variant with application of GOF 300 kg/ha. Prevalence and development of the root rot on spring wheat has decreased by 1.6 times. Reduce destruction of plants contributed to the improvement of phytosanitary condition of the soil due to insertion of the granulated organic fertilizers based on bird droppings.

According to the effect on the yield of crops, the nutrients of bird droppings are almost equal to an equal number of those in mineral fertilizers. But since the nutrients in the chicken litter are in organic form, they are less washed out of the soil, entering it gradually, over a long period, without creating a high concentration of salts. This increases not only the yield. Phosphorus in the litter is mainly represented by organic compounds, therefore it is practically not fixed in the soil in the form of phosphates of iron, aluminum or calcium, and as the mineralization of the organic matter is assimilated by plants. For this reason, the phosphorus of manure is used better than phosphorus of mineral fertilizers. A similar situation is with nitrogen. The amount of available nitrogen in the granulated chicken litter reaches 100%, phosphorus - 70%, potassium - 90%. In the fertilizer there is calcium, which contributes to the deoxidation of soils. Upon contact with water, granules from chicken manure swell, increasing in size several times. With a lack of water in the soil, they slowly give up this moisture, ensuring, with short droughts, plant roots and microorganisms the best conditions.

The soil application of the organic fertilizers not only improves nutrition but also modifies the conditions for the existence of soil microorganisms. The micromycetes analysis of the composition of the soil showed that the application of organic granular fertilizer increases microbial activity. This increases the total number of soil fungi. In control variant the total number of mushrooms amounted to 26 thousand colony forming units (CFU) per 1 g soil, of which 1.5 thousand of them were the pathogenic fungi. In the second and third options we had the same amount of mushrooms (17.5 million
CFU / 1 g soil). But the number of pathogens, these options differed. So in the variant with mineral fertilizers the number of pathogens was 2.5 thousand CFU, and in the version with GOF (100 kg/ha) – 0.5 thousand CFU / 1 g soil.

The application of granular organic fertilizers of 200 and 300 kg per 1 ha contributed to the increase in the total number of fungi in the soil. This increase was mainly due to the fungi-antagonists (*Trichoderma lignorum* Tode.). The number of the pathogens in these variants was, respectively, 1.0 and 2.0 thousand CFU / 1 g soil and the number of the antagonists was 10.5 and 10 thousand CFU. The total number of fungi increased compared to control in 1.6 times in the fourth embodiment, and 2.3 times in the fifth.

The further analysis of the micromycetes composition of the soil showed that the number of saprotrophic and antagonistic fungi in GOF increases. The greatest number of fungi-antagonists was in the fourth and fifth options (30 and 36 thousand CFU / 1 g soil).

**Figure 1.** The number of fungi of pathogens, saprotrophs and antagonists at the beginning of vegetation, thousand CFU per 1 g soil.

**Figure 2.** The number of fungi of pathogens, saprotrophs and antagonists at the end of vegetation, thousand CFU per 1 g soil.

At the heading stage the maximum number of fungi was in the fourth variant (110.5 thousand CFU
/ 1 g soil). Making the GOF the species composition of fungi in the soil increases.

The application of granular organic fertilizers contributes the yield of spring wheat. Making 100 kg/ha rise of the yield was 0.85 t/ha. Compared to mineral fertilizer the increase was below 0.22 t/ha. Making 200 kg per 1 ha of organic granulated fertilizers the yield is increased by 1.17 t/ha. By the growth of the rate of organic matter up to 300 kg/ha the yield of spring wheat composed 3.66 t/ha, 1.42 t/ha more control.

The use of the granulated organic fertilizers based on bird droppings is economically. The largest profit obtained in the fifth embodiment, compared with the control higher than 1.7 times. The profitability of grain production of spring wheat with the application of granulated organic fertilizer increases by 20%.

4. Summary

The application of granular organic fertilizers based on birds dropping improves the phytosanitary condition of the soil. In the rhizosphere of spring wheat, the number of pathogenic fungi decreases and the number of antagonists increases.

The fertilizing of spring wheat in the tillering stage by granular organic fertilizers helps to reduce the lesions of root rot in 1.6 times.

Organic fertilizers significantly increased the yield of spring wheat by 44% compared with control, in comparison with mineral fertilizer by 22%.

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