The role of granular organic fertilizers in improving the micromycete composition of the soil

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Abstract. It is necessary to have microorganisms in the rhizosphere for normal growth and development of higher plants. Fungi play an important role in the functioning of ecosystems. Soil fertility is created in the process of vital activity of plants and microorganisms under certain environmental conditions. The size and quality of the crop of cultivated plants depends on the activity of soil microorganisms. Therefore, in the first place, it is necessary to study in detail its micro population in the search for ways to improve soil fertility. They actively participate in the decomposition of organic residues, the synthesis and mineralization of humus, provide elements of the root nutrition of plants, in the nitrogen cycle, form soil structures, stimulate or inhibit plant growth, the synthesis of enzymes, amino acids and other biologically active compounds. Metabolites of soil fungi can cause soil fatigue. Some representatives of micromycetes are the causative agents of plant diseases. Plants and micromycetes form certain cenoses, the components of which are closely related to each other by functional connections. The vital activity of soil microorganisms is inseparably linked with the fertility of the soil and the content of organic matter in it. The investigations carried out by us showed that the application of granular organic fertilizers based on bird droppings increases the number of soil microorganisms. Under the influence of fertilizers there are changes in the number and composition of the rhizosphere microflora. The number of antagonist fungi increases in the rhizosphere of spring wheat, the number of pathogens decreases. The number of pathogens was from 0.5 to 2.0 thousand.

1. Introduction

Higher plants can not exist without relationships with microorganisms. Plants are provided with mineral nutrition, protection against pathogens, and also regulation of development in phytocenoses due to symbiosis with microorganisms [1]. It is necessary to have microorganisms in the rhizosphere for normal growth and development of plants. The possibility of simultaneous tracking of the development of various fungi on plant roots differing in pathogenicity due to studies on the evaluation of root colonization by fungi has been shown [2-10].

Fungi, as an integral component of the biocenosis, play an important role in the functioning of ecosystems. They participate in the circulation of substances and are the main destructors, decomposers of organic substances. In addition to increasing the fertility of soils, the destruction of organic residues helps purify it from pathogenic organisms. All higher plants enter into symbiosis with fungi, which form mycorrhizas on the roots.

The level of species diversity of the microbial community of soil can be considered as one of the...
most important criteria for the stability of the basic ecological functions of the soil [11].

Technological methods of cultivation of agricultural crops are used to create favorable conditions for the growth and development of plants, culture in agroecosystem. They affect soil microorganisms; they are of no small importance in their use for regulating the abundance in the soil of infectious diseases. The importance of technological methods in the formation of the phytosanitary state of the arable layer of the soil increases with the growth of the level of anthropogenic impact. The degree of cultivation of sod-podzolic soils is characterized by such biological indices as the humus organic matter, the structure of the complex of soil microorganisms and the number of some of their groups, the biological activity of the soil, the presence of toxic substances, the contamination of the soil by pathogens.

In general, typical sod-podzolic soils are characterized by poor microflora and have low biological activity with an increased potential in them, which causes toxicosis of soils in their natural state. This is due to the high acidity of the soil, poverty of organic matter, nitrogen, mobile forms of phosphorus and exchangeable potassium, weak base saturation [12].

Soil cultivation entails a decrease in phytotoxic potential. To a large extent, the specific features of their biology are lost in the process of cultivation of podzolic soils, which is associated with a fundamental change in the conditions for the existence of microorganisms. Ultimately, in anthropogenesis, soil is a kind of laboratory in which innumerable populations of organisms that determine both the origin, development of the soil, and the quality of the human impact on it are born and are continuously born and die [13].

The introduction of fertilizers, by intensifying microbiological processes in soils, to certain limits can be considered as a positive phenomenon. According to V. G. Mineev excessive activation of soil microorganisms can be harmful, as the processes aimed at restoring the disturbed equilibrium, leading to losses of mineral fertilizers, worsen the physico-chemical and biological properties of the soil, lead to other serious environmental consequences.

The phytosanitary situation of the soil is unsatisfactory in the conditions of the Republic of Mari El. Recently, the occurrence of saprophyte micromycetes - antagonists is decreasing and the occurrence of pathogenic fungi, especially those causing root rot of cultivated plants in agriculture, is increasing. Previously, this problem in the region was solved by the introduction of organic fertilizers. However, the intensification of production intensification at the end of the last century, the introduction of increased doses of mineral fertilizers, an increase in the load of pesticides and a reduction in the application of organic matter led to an imbalance in energy exchange in agroecosystems.

In the fresh form it should be used with caution, as instead of good it can harm the soil and plants. The high cost of mineral fertilizers and a decrease in the fertility and phytosanitary condition of the soil led to the need to develop and study biofermented organic fertilizers based on bird droppings. Granules, obtained after fermentation of poultry manure by microorganisms, are environmentally acceptable and economically effective for the cultivation of various agricultural crops.

The purpose of our research is to study the change in the micromycete composition of the soil from the use of granulated organic fertilizers based on bird droppings and to reveal its effect on root rot damage and the yield of spring wheat.

2. Experimental
Studies were carried out on the experimental field of the Mari State University on the sowings of spring wheat of the "Lada" variety. Biofermented granulated organic fertilizers (GOF) were introduced as top dressing in the tillering phase in doses of 100 kg / ha, 200 and 300 kg / ha. For comparison, mineral fertilizer Azofosk with an active substance of nitrogen, phosphorus and potassium was used at 15%. Biofermented GOF is a 10-17 mm pellet made from compost. Compost is prepared from bird droppings with the addition of microorganisms, which recycle litter for several days. The result is an organic fertilizer that does not contain pathogenic infection, weed seeds, without the unpleasant odor.

The soil of the experimental section is sod-podzolic, medium loamy with the following
agrochemical indicators: humus content 1.6%, pH 5.6, easily hydrolyzable nitrogen 1.7 mg. eq. per 100 g of soil, P2O5 - 26 and K2O - 11 mg / 100 g of soil. The nitrogen content was 3.0%, phosphorus - 4.2%, potassium - 9.8% in the biofermented GOF, which we used

Soil fungi were studied by seeding on a solid nutrient medium Czapek. Mushrooms isolated from the rhizosphere of spring wheat. Samples were taken three times during vegetation: in the phase of tillering, earing and milk stage.

Soil micromycetes were identified to the species using determinants.

3. Results and Considerations

A certain number and groups of microorganisms develop and establish a biological equilibrium, characteristic of these conditions and the season in each type of soil, which has specific physicochemical properties. The number and composition of the microflora vary considerably, especially in the basal zone in the presence of plants in the soil. Rhizosphere microorganisms feed on root secretions and, in turn, secrete metabolites or synthesize nutrients available to plants.

Under the influence of fertilizers there are changes in the number and composition of the rhizosphere microflora. We isolated 20 microorganisms as a result of the analyzes.

Fungi of the genus Fusarium spp., Alternaria spp from pathogenic fungi have been found. Of these, the following species can be considered typical for this agrocenosis: Fuzarium culmorum Sacc., Fuzarium oxysporum Schl., and Alternaria alternata Fr. These fungi are the causative agents of root rot of cereals, in particular spring wheat.

Among the saprotrophs, typical species include Penicillium frequentans Westl., Penicillium viridicatum Westl., Penicillium funiculosum Thom, Aspergillus niger van Tiegh, Aspergillus clavatus Desm. Rhizopus nigricans Ehr. A fungus of Mucor piriformis Fisch was very common.

A typical representative of the antagonistic microflora, the fungal antagonist Trichoderma lignorum (Tode) Haz, was also isolated from the saprotrophic fungi. Antagonist fungi play an important role in suppressing the development of phytopathogens and improving the phytosanitary state of the soil. This fungus feeds on dead, half-decomposed plant remains in the natural habitat, in the soil.

It concentrates more in the vicinity of the root system of plants. Actively exhibits antagonistic activity upon contact with phytopathogens.

The introduction of mineral and organic fertilizers in the soil improves the nutrition of plants, alters the conditions for the existence of soil microorganisms. They contribute to a change in the micromycete composition of the soil. The total number of fungi and the number of causative agents of root rot varies with the application of granulated organic fertilizers in the plowing soil layer.

The total number of fungi was 26.0 thousand CFU per 1 g of soil, of which 1.5 thousand CFUs were pathogenic fungi on the control variant at the beginning of the growing season. They were 1.5 times smaller (17.5 thousand CFU per 1 g of soil) in the second variant. But there were more pathogens than in control in this variant. The introduction of granular organic fertilizers contributed to an increase in the total number of fungi in the soil. This increase was mainly due to saprotrophs and fungal antagonists (Trichoderma lignorum Tode.). The number of pathogens was 0.5; 1.0 and 2.0 thousand CFU per 1 g of soil, and antagonists - 0.5; 10.5 and 10 thousand CFU in these variants. The total number of fungi increased in comparison with the control in 1.6-2.3 times.

Further analysis of the micromycete composition of the soil showed that the amount of saprotrophic and antagonistic fungi in variants with GOF increases. So, the greatest number of antagonists was in the fifth variant (43.0 thousand CFU per 1 g of soil). The antagonists were 20.5 thousand CFU per 1 g of soil in the fourth variant, 10.5 thousand CFU per 1 g of soil in the third. The tendency of increase in antagonist fungi is observed with an increase in the rate of application of granular organic fertilizers. The number of pathogens in variants with GOF was 2 times less in comparison with the control and variant with mineral fertilizers in the phase of earing. The total number of fungi increases with increasing doses of organic fertilizers.

The maximum number of fungi was in the fifth variant (176.6 thousand CFU per 1 g of soil) in the milk stage. The number of pathogens is less in variants with organic fertilizers than in the control and
in the second variant. The number of saprotrophic fungi, on the contrary, increases.

The number of fungi increases with increasing dose of granulated organic fertilizers in the rhizosphere of spring wheat.

Table 1. Micromycete composition of soil, thousand pieces. CFU per 1 g of soil.

| Options                  | Total Mushroom (CFU per 1 g of soil) | Number of pathogens | Number of saprotrophs | Number of antagonists |
|--------------------------|-------------------------------------|---------------------|-----------------------|-----------------------|
| phase of tillering of spring wheat |                                    |                     |                       |                       |
| 1. Control               | 26.0                                | 1.5                 | 24.5                  | 0                     |
| 2. Azophoska             | 17.5                                | 2.5                 | 15.0                  | 0                     |
| 3. GOF (100 kg / ha)     | 41.6                                | 0.5                 | 40.6                  | 0.5                   |
| 4. GOF (200 kg / ha)     | 49.8                                | 1.0                 | 38.3                  | 10.5                  |
| 5. GOF (300 kg / ha)     | 59.0                                | 2.0                 | 47.0                  | 10.0                  |
| earing phase             |                                    |                     |                       |                       |
| 1. Control               | 28.0                                | 2.0                 | 16.0                  | 10.0                  |
| 2. Azophoska             | 41.5                                | 2.0                 | 26.0                  | 2.5                   |
| 3. GOF (100 kg / ha)     | 60.2                                | 1.5                 | 48.2                  | 10.5                  |
| 4. GOF (200 kg / ha)     | 77.5                                | 1.0                 | 56.0                  | 20.5                  |
| 5. GOF (300 kg / ha)     | 136.0                               | 1.0                 | 92.0                  | 43.0                  |
| milk stage               |                                    |                     |                       |                       |
| 1. Control               | 30.4                                | 6.2                 | 20.2                  | 4.0                   |
| 2. Azophoska             | 24.0                                | 2.2                 | 21.7                  | 0.7                   |
| 3. GOF (100 kg / ha)     | 66.5                                | 2.0                 | 52.0                  | 12.5                  |
| 4. GOF (200 kg / ha)     | 110.5                               | 1.5                 | 89.0                  | 20.0                  |
| 5. GOF (300 kg / ha)     | 176.6                               | 1.7                 | 148.2                 | 29.7                  |

The level and ratio of the basic elements of nutrition differentially affect the change in the reaction of the plant to the introduction and spread of the pathogen, as well as the phytocenotic relationships of cultivated plants.

Analysis of spring wheat plants to identify root rot at the beginning of vegetation prior to application of fertilizers showed that the prevalence of the disease was 16.4%, and development - 8.5%. We found that the introduction of organic granular fertilizers based on bird droppings helps to reduce the damage to wheat by root rot.

The prevalence of the disease is reduced when applying mineral fertilizers and GOF at a dose of 100 kg/ha in the earing phase, but the development was higher than the control variant. The least damage to plants was in the version with the use of GOF 300 kg/ha. The prevalence of root rot of spring wheat decreased 1.6 times, and development - 1.4 times. The decrease was 2.6 times in the milk stage. The development of root rot was only less when applying 300 kg/ha of GOF in the earing phase.

Improvement of the phytosanitary state of the soil leads to a decrease in the damage to spring wheat by root rot. This, in turn, affects the increase in yield. The introduction of organic fertilizers significantly increased the yield of spring wheat. Thus, the increase in yield was 0.42 t/ha with application of 100 kg/ha. The increment was lower by 0.21 t/ha compared with mineral fertilizer. The yield increased by 0.54 t/ha when 200 kg of organic granulated fertilizers were applied per 1 ha. The yield of spring wheat was 3.48 t/ha, which is 1.08 t/ha more than control with an increase in organic matter to 300 kg/ha.

4. Conclusion
The introduction of granular organic fertilizers contributes to the increase of saprotrophic and antagonistic fungi in the soil and reduces the number of pathogens. Species diversity of fungi increases with the introduction of GOF in the soil. The best results were in the version with the introduction of
GOF 300 kg/ha. The total number of fungi is 2.3 times greater than the control. The number of pathogens in the phases does not increase, and the antagonist fungi becomes larger.

The introduction of biofumigated granular organic fertilizers on the basis of bird droppings helps to reduce the damage to spring wheat by root rot.

Top-dressing of spring wheat with organic fertilizer on the basis of bird droppings contributes to an increase in yield by 44-45% compared to the control. Compared with mineral fertilizer, the yield of spring wheat on the experimental version increased by 11-14%.

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