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# THE IMPACT OF ORGANIC FERTILIZER WITH EFFICIENT MICROORGANISMS ON SOIL QUALITY AND MAIZE PRODUCTIVITY

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***Abstract***

*The paper presents the results of research on the impact of organic fertilizers, obtained from poultry manure with and without pro prebiotic PoultryStar$^{R}$me$^{EU}$, on the microbiological and biochemical quality of soil and corn productivity. For this purpose, initially, an experiment was organized in the practical conditions of the individual poultry enterprise "GT Nicolaescu V." from village Fagureni, district Straseni, in which material for the study was used the probiotic PoultryStar$^{R}$me$^{EU}$, and the object of research were broiler chickens ROSS 308. Subsequently, the manure obtained was subjected to traditional composting, and after 9 months, it was were injected into the soil. As a result of research, it was found that organic fertilizers have improved the microbiological and biochemical quality of the soil by increasing 10 times the amount of beneficial microorganisms, the content of organic matter - by 48.02% - 114.81% and humus - by 15.14% - 10.56%, thus stimulating the physiological development (height) of the plants by 7.69% - 10.53% and increasing the corn grain harvest by 5.98% and by 17.45% the amount of straw (organic matter) compared to the control group.*

***Key words***: *compost, manure, humus, maize, organic matter*

## INTRODUCTION

Obtaining organic agricultural production is a matter of global impotance for sosiety. The global environmental situation, including the regional, has worsened in the last century due to the industrialization and chemicalization of agriculture, the storage, preservation and unreasonable use of organic waste [3].

The implementation of the technology for regenerating of soil fertility and increasing the productivity of agricultural crops using organic fertilizers, obtained as a result of the use of different bioconversion technologies of organic waste, aims at towards the development of organic agriculture (ecological), which is a modern technique of plant cultivation, of the fattening of animals and to produce food using methods and technologies that are close to nature's laws - does not use synthetic fertilizers and pesticides, stimulators and growth regulators, hormones, antibiotics and intensive breeding systems of plants and animals [3; 5].

Organic farming assumes a return to the values of traditional agriculture, but not and to these methods. The process and procedures for obtaining ecological products are regulated by strict production rules and principles, which start from the quality the soil needs to have till to achieving the final product. This system of agricultural development can be adopted by own convictions or being influenced by growing demands on food security, maintaining unpolluted environment and not least for economic reasons. Whatever would be the reasons of transition to organic agriculture (ecological), greening resources and final production is important for minimizing the harmful effects of farming practices on the environment and consumer health [3; 11].

Fertility and biological activity of the soil must be maintained and improved by:

a) cultivation of legumes, green manure plants or deep-rooting plants in an appropriate crop rotation;

b) the incorporation of ecological substances in the soil in the form of compost (fertilizer) from manufacturing units, in accordance with the rules of production.

It can also be used derivative products originating from the livestock farms or domestic animals (manure), whether they come from units of breeding of animals, complying with the existing national regulations or, in their absence, recognized international practices referring to agricultural ecological production [4].
Compost from bird manure is one of the most affordable organic fertilizers [2].
Poultry manure is the most concentrated organic fertilizer, containing on average 1.46% nitrogen, 2.39% phosphorus ($P_2O_5$) and 1.16% potassium ($K_2O$). The organic matter in the composition of bird droppings has an average weight of 26%, but the coefficient of variation exceeds 64%. Therefore, in different batches of manure the content of organic matter can vary between 8% and 60% [10].
Most of the time bird droppings contain pathogens that can have a negative impact on human health, aquatic life and wildlife. For this purpose it is necessary to use new methods in the technological process of bioconversion of organic waste for the decontamination of pathogenic microflora from bird droppings with subsequent reduction of their composting time [1; 7].
Currently, effective microflora (EM) preparations are widely used for this purpose [6; 9].
One of the beneficial mycoflora preparations marketed in Republic of Moldova is the pro/prebiotic PoultryStar$^{R}$me$^{EU}$, a symbiotic product for birds, which stimulates the beneficial intestinal microflora through the combined action of carefully selected probiotic microorganisms and prebiotic fructooligosaccharides. The probiotic strains, from the preparation, Bifidobacterium animalis spp., Lactobacillus salivarius spp., Enteroccocus faecium were isolated from the intestines of healthy birds [2; 7].
In this context, the aim of the work was to determine the impact of organic fertilizers, obtained from poultry manure with and without pro/prebiotic PoultryStar$^{R}$me$^{EU}$, on the microbiological and biochemical quality of the soil and the productivity of corn.

## MATERIALS AND METHODS

In the practical conditions of the individual poultry enterprise "GT Nicolaescu V." from the village of Fagureni, distrct Straseni, an experiment was organized in which 2 batches of chickens were included (including one - control and one - experimental). The chickens from the control group consumed age-specific combined fodder, and those from the experimental group consumed the same fodder combined with the addition of pro/prebiotic PoultryStar$^{R}$me$^{EU}$ (produced by the Austrian company "Biomin"), in a proportion of 1.0 kg/t of feed. The duration of the experiment was 45 days. At the end of the research, the manure was collected from the room and transported to places specially designed for traditional air fermentation for a period of 9 months.
Experimental compost I was obtained as a result of traditional fermentation of broiler manure that consumed age-specific combined forage.
Experimental compost II was obtained as a result of traditional fermentation of broiler manure that consumed the same fodder combined with the addition of pro/prebiotic PoultryStar$^{R}$me$^{EU}$.
Both types of compost were evenly distributed, on the experimental lots, from the consideration of 10 t/ha. Maize was sown 3 weeks after incorporation of compost into the soil.
The determination of the microbiological composition of the soil and compost was performed using culture media, according to the usual methods [8].
The biochemical indicators of the soil, the compost were determined according to the usual methods [12; 13].

## RESULTS AND DISCUSSIONS

Initially, the biochemical composition of experimental compost I and II and soil was studied at the initial stage (Table 1) and 3 weeks after compost incorporation (Table 2).
The value of the humus content of experimental compost II exceeded that of experimental compost I by 15.23%. The

content of total nitrogen and organic matter in experimental compost II was lower by 26.76% and 51.95%, respectively, compared to that of experimental compost I.

Table 1. Biochemical composition of compost and soil at the initial stage

| Indicators | Compost experimental I | Compost experimental II | The original soil, sampling depth, cm 0-10 | The original soil, sampling depth, cm 10-20 |
|---|---|---|---|---|
| Total nitrogen % | 3.25±0.17 | 3.21±0.28 | 0.29±0.05 | 0.26±0.05 |
| Organic substance,% | 3.25±0.17 | 24.15±0.22 | 4.61±0.94 | 6.06± 0.11 |
| Humus content, % | 41.37±4.62 | 47.67±2.69 | 3.10±0.28 | 3.73±0.11 |

Source: Own calculation.

As a result of the research of soil samples collected from a depth of 0-10 cm of lot II and III, after 3 weeks from the incorporation of experimental compost I and II, the organic matter and humus increased by 40.50% and 48.02%; 3.43 and 15.14% respectively compared to their content in the soil of the control group (Table 2).

Table 2. Soil biochemical composition

| Lots | Sampling depth, cm | Total nitrogen, % | Organic substance,% | Humus content, % |
|---|---|---|---|---|
| Lot I | 0-10 | 0.35±0.03 | 4.79±2.03 | 3.50±0.13 |
| | 10-20 | 0.20±0.02 | 7.11±0.04 | 3.41± 0.14 |
| Lot II | 0-10 | 0.33±0.12 | 6.73±0.05 | 3.62±0.20 |
| | 10-20 | 0.20±0.13 | 7.12±0.08 | 3.67±0.08 |
| Lot III | 0-10 | 0.40±0.15 | 7.09±0.40 | 4.03±0.00 |
| | 10-20 | 0.28±0.09 | 7.16±0.03 | 3.77±0.24 |

Source: Own calculation.

In the soil samples collected from a depth of 10-20 cm, essential changes took place in the humus content of the soil of lot II and III, which exceeded that of the samples collected from the control group, respectively by 7.62 % and 10.56%, and the content of the organic matter has not changed significantly.

The results of the microbiological research of the hi soil samples, after 3 weeks from the incorporation of the compost (table 3, 4), showed quantitative changes of the microorganisms.

Thus, in soil samples collected from soil depth 0-10 cm, the maximum amount of NTG (total number of germs) $8.0\times10^6$ CFU/g was found in the lot III sample, and the minimum $6.0\times10^5$ CFU/g in the one in the control lot I.

Table 3. Microbiological content of soil samples collected from experimental batches, collected from a depth of 0-10 cm, CFU/g

| Indicators | Lot I | Lot II | Lot III |
|---|---|---|---|
| NTG | $6.0\times10^5$ | $1.1\times10^6$ | $8.0\times10^6$ |
| Lactobacillus spp. | $7.0\times10^4$ | $3.0\times10^4$ | $6.0\times10^4$ |
| Bifidobacterium spp. | $5.4\times10^5$ | $4.2\times10^5$ | $3.5\times10^5$ |
| Clostridium spp. | $2.1\times10^3$ | $9.0\times10^5$ | $2.0\times10^5$ |
| Bacillus spp. | $7.0\times10^5$ | $7.0\times10^5$ | $2.0\times10^5$ |
| Fungi | $1.5\times10^5$ | $6.7\times10^4$ | $1.1\times10^5$ |

Source: Own calculation.

In the sample taken from a depth of 10-20 cm of lot III was found a 10 times higher amount of effective microorganisms Lactobacillus spp., Bifidobacterium spp. and Bacillus spp., compared to lot II and control lot I.

In all soil samples the amount of fungi varied insignificantly, in the range of $10^4$-$10^5$ CFU/g, with levumiform fungi predominating.

Table 4. Microbiological content of soil samples collected from experimental batches, collected from a depth of 10-20 cm, CFU/g

| Indicators | Lot I | Lot II | Lot III |
|---|---|---|---|
| NTG | $1.5\times10^6$ | $3.3\times10^6$ | $9.0\times10^5$ |
| Lactobacillus spp. | $4.5\times10^4$ | $5.0\times10^4$ | $2.0\times10^5$ |
| Bifidobacterium spp. | $6.0\times10^5$ | $7.0\times10^5$ | $7.6\times10^6$ |
| Clostridium spp. | $2.0\times10^2$ | $6.0\times10^5$ | $3.0\times10^5$ |
| Bacillus spp. | $5.1\times10^5$ | $9.8\times10^5$ | $1.9\times10^6$ |
| Fungi | $4.0\times10^5$ | $3.5\times10^5$ | $1.1\times10^5$ |

Source: Own calculation.

As a result of the biochemical analyzes of the soil samples collected at the end of the experiment, after 5 months from the beginning of the experiment (Table 5), at a depth of 0-10 cm of lot III, compared to the control, a higher amount of total nitrogen, organic matter and humus respectively by 6.45%, 27.15%, 13.37%. The content of total nitrogen and humus, at a depth of 10-20 cm in lot III, exceeded that of the respective control lot by 8.33% and 12.22%, and the content of organic matter was decreased by 2.03%.

Table 5. Biochemical composition of the soil at the end of the experiment

| Lots | sampling depth, cm | Total nitrogen, % | Organic substance,% | Humus content, % |
|---|---|---|---|---|
| Lot I | 0-10 | 0.31±0.03 | 5.12±0.54 | 3.44±0.13 |
| | 10-20 | 0.24±0.02 | 7.40±0.53 | 3.52±0.07 |
| Lot II | 0-10 | 0.28±0.00 | 6.42±1.80 | 3.67±0.05 |
| | 10-20 | 0.24±0.02 | 7.88±0.03 | 3.73±0.08 |
| Lot III | 0-10 | 0.33±0.03 | 6.51±0.02 | 3.90±0.13 |
| | 10-20 | 0.26±0.02 | 7.25±0.18 | 3.95±0.10 |

Source: Own calculation.

At the end of the experiment, in the soil samples collected from the control and experimental lots, NTG, Bifidobacterium spp., Clostridium spp. and Bacillus species varied in the limit $10^5$ CFU/g (Table 6 and 7), and the amount of Lactobacillus spp. and fungi ranged from $10^4$-$10^5$ CFU/g.

Table 6. Microbiological content of soil samples at the end of the experiment, collected from a depth of 0-10 cm, CFU/g

| Indicators | Lot I | Lot II | Lot III |
|---|---|---|---|
| NTG | $2.6\times10^5$ | $3.9\times10^5$ | $4.6\times10^5$ |
| Lactobacillus spp. | $7.9\times10^4$ | $1.3\times10^5$ | $1.2\times10^5$ |
| Bifidobacterium spp. | $1.8\times10^5$ | $4.7\times10^5$ | $3.2\times10^5$ |
| Clostridium spp. | $2.5\times10^5$ | $2.7\times10^5$ | $3.6\times10^5$ |
| Bacillus spp. | $3.1\times10^5$ | $4.8\times10^5$ | $3.5\times10^5$ |
| Fungi | $5.1\times10^4$ | $2.2\times10^5$ | $8.2\times10^4$ |

Source: Own calculation.

Table 7. Microbiological content of soil samples at the end of the experiment, collected from a depth of 10-20 cm, CFU/g

| Indicators | Lot I | Lot II | Lot III |
|---|---|---|---|
| NTG | $1.8\times10^5$ | $4.9\times10^5$ | $4.5\times10^5$ |
| Lactobacillus spp. | $1.1\times10^4$ | $1.9\times10^5$ | $9.0\times10^4$ |
| Bifidobacterium spp. | $4.5\times10^5$ | $3.7\times10^5$ | $8.7\times10^5$ |
| Clostridium spp. | $1.7\times10^5$ | $3.5\times10^5$ | $8.6\times10^5$ |
| Bacillus spp. | $2,5\times10^5$ | $3.0\times10^5$ | $8.6\times10^5$ |
| Fungi | $7.6\times10^4$ | $1.2\times10^5$ | $1.1\times10^4$ |

Source: Own calculation.

During the experiment (from emergence to harvest), observations were made on the physiological development of corn in various phenological phases.
According to the maize growing technology, 3 maize plants per linear meter were left on all lots. As a result, 96 plants were left on each of the lots. In order to determine the influence of experimental compost I and II on the physiological development of maize, during the development of the experimental period, 8 measurements of the height of maize plants were performed. Four of the measurement results are shown in Table 8, because the difference in plant height in the other measurements was 1-2 cm.

Table 8. Average height of maize plants during the experimental period

| Lot | Measurement times and plant height, meters | | | |
|---|---|---|---|---|
| | Round I | Round II | Round III | Round IV |
| | 13.06. 18 | 28.06.18 | 27.07.18 | 19.09.2018 |
| Lot I | 0.26± 0.01 | 0.76± 0.05 | 1.90 ± 0.04 | 2.03± 0.01 |
| Lot II | 0.26± 0.01 | 0.76± 0.02 | 1.95± 0.06 | 2.11± 0.04 |
| Lot III | 0.28± 0.02 | 0.84± 0.07 | 2.09 ± 0.06 | 2.22± 0.04 |

Source: Own calculation.

Analyzing the results presented in Table 8, it was found that the height of the plants from lot III exceeded that of the plants from lot I control by 7.69%, 10.53%, 8.38%, 9.36%. In the last two rounds of measuring the height of maize plants, it was found that the height of the plants in the lot II exceeded by 1.56% and 3.94% respectively that of the plants in the control lot. The results of the study of maize development depending on the phenological phases (ear and cob formation) are presented in Table 9.

Table 9. Study of the phases of formation of ears and cobs in the field experiment

| Counting day | Lot, number of plants with ears and cobs | | | | | |
|---|---|---|---|---|---|---|
| | Lot I | | Lot II | | Lot III | |
| | ears | cobs | ears | cobs | ears | cobs |
| 30 | - | - | - | - | 2 | - |
| 40 | 13 | - | 12 | - | 23 | 4 |
| 50 | 18 | 2 | 17 | 3 | 29 | 8 |
| 60 | 90 | 64 | 91 | 65 | 96 | 89 |
| 70 | 96 | 72 | 96 | 75 | | 96 |
| 80 | | 96 | | 96 | | |

Source: Own calculation.

Maize in the beginning phase of the formation of cobs is represented in Photos 1, 2 and 3.
The physiological development of the maize the milk phase of the cobs is represented in Photos 4, 5 and 6.

Photo 1. Lot I (No fertilizer)
Source: Own determination.

Photo 2. Lot II (Fertilizer without EM)
Source: Own determination.

Photo 3. Lot III (Fertilizer with EM)
Source: Own determination.

Photo 4. Lot I
Source: Own determination.


Photo 5. Lot II
Source: Own determination.


Photo 6. Lot III
Source: Own determination.

As a result of the observations, it was found that the formation of ears and cobs in corn on lot III began, respectively after 50 and 54 days, and the total formation of ears and cobs was found 62 and 64 days after the emergence of corn. On the control group and the experimental group II, both the ear formation phase and the cob formation phase started later, respectively 4 days and 7 days, then those on the lot III. The total number of cobs in these groups formed 5 days later than in lot III.

Table 10. Grain/cob and corn straw harvest

| Lot | Harvest t/ha | | Maize straw harvest, t/ha |
|---|---|---|---|
| | cobs | corn grains | |
| Lot I | 12.550 | 9.036 | 5.845 |
| Lot II | 12.950 | 9.324 | 6.050 |
| Lot III | 13.300 | 9.576 | 6.865 |

Source: Own calculation.

After a period of five months, at the end of the experiment, the harvest of cobs and corn straw collected from the lots included in the experiment was determined by weighing. The results of the crop evaluation are presented in Table 10 and Fig. 1.

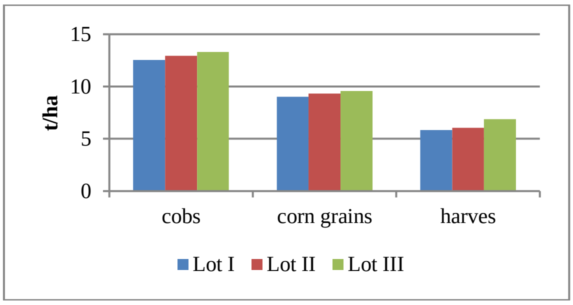

Fig. 1. Grain/cob and corn straw harvest
Source: Own calculation.

It is obvious that experimental compost I and II had a more effective influence on the harvest of cobs and corn straw. The yield of cobs and grains (calculated from the consideration t/ha) of maize cultivated with experimental compost fund I, exceeded it by 3.19%, and that of maize cobs cultivated with experimental compost fund II exceeded it by 5.98% that of the control group.

Analyzing the corn straw harvest obtained, it was found that from the lots II and III fertilized with compost, a harvest was obtained that exceeded the one collected from the control lot I, respectively by 3.51% and 17.45 %.

The production obtained can be used for:

- feeding animals (cattle, sheep, goats, etc.)
- use as bedding for animals;
- pellet production (solid biofuel);
- the return of a significant part of the organic matter in the soil.

So, as a result of research, it was found that experimental composts I and II used for soil fertilization had a beneficial influence, improving soil quality and increasing the yield of cobs and corn straw per unit area.

## CONCLUSIONS

Fertilization of the soil with compost obtained from bird droppings with and without pro/prebiotic PoultryStar$^{R}$me$^{EU}$ contributed to:

• improvement of the microbiological quality of the soil by quantitatively increasing, 10 times, the efficient microorganisms Lactobacillus spp., Bifidobacterium spp. and Bacillus spp. at a depth of 10-20 cm of the soil compared to the first control and lot II;

• increasing the amount of organic matter and humus, at a depth of 0-10 cm of the soil, corresponding to 48.02% and 15.14%, and to 10-20 cm respectively by 114.81% and 10.56%, in comparison with their content in the soil of lot I;

• stimulating the physiological development (height) of the plants, in the four phenological phases, by 7.69%, 10.53%, 8.38%, 9.36% compared to the lot I;

• increase of the corn grain and straw biomass harvest, respectively by 5.98% and 17.45%, compared to that of the lot I.

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