Technology of the application of microbial preparations on ordinary chernozem soil in the zone of unstable moistening of the Central Ciscaucasia

V I Faizova¹, S V Tskhovrebov, V Y Lysenko and A A Novikov
Stavropol State Agrarian University, lane Zootechnichesky, 12, Stavropol, 355017, Russia

¹E-mail: verafaizova@gmail.com

Abstract. Studies were conducted in the zone of unstable moistening of the Central Ciscaucasia in the ordinary chernozem carbonate according to the scheme: 1. control 2. KBP-standard; 3. KBP – innovative; 4. PCM; 5. KMP-92. According to the traditional technology was carried out treatment of seeds before sowing and maize plants in the phase of 3-4 leaves and flowering, and on the proposed produce and processing of the soil. Revealed that the number of aerobic nitrogen-fixing bacteria on control in phase 3-4 sheet amounted to 21.1 thousand CFU/1 g, and in the flowering stage 76.3 thousand CFU/1 g and increased with the application of KBP-standard respectively 2.2 and 1.7 times, KBP – innovative 1.9 and 1.6 times, PCM 2.1 and 1.4 times and the PCM-92 – 1.7 and 1.4 times. The lowest values have on the phase of wax ripeness. The number of ammonifying control in the phase of 3-4 leaves was 55 million CFU/1 g. and has increased as a result of the application of biopreparations in 1,4-1,6 times. In the flowering stage, the number of ammonifying control increased to 259 million CFU/1 g and increased by different versions from 1.6 to 1.7 times. Similar changes can be traced in the number of nitrifying microorganisms. The yield of corn for grain was lowest on control (of 4.07 t/ha), increased more than conventional technology, the embodiment with the use of KBP-S 24.1 %, and the proposed technology with the use of KMP-92 - 31.4%.

In the socio-economic development of the Central Caucasus specific importance is the increase in grain production of maize and improve its quality. [1, 2]. So far, however, these indicators remain unstable, not fully revealed the potential of varieties insufficiently developed agricultural practices that apply to the cultivation of this crop. The implementation of the proposed chemical fertilizer industry and drugs are not always safe for the environment and human health [9, 10]. From this point of view, no doubt, biological drugs and their metabolites in biological and natural origin have enormous benefits [3, 4]. With the help of the microbiota are natural processes of biological nitrogen fixation, phosphatability, growth-stimulation, bioprotectiveness, and humus-formation. Bacterization of seeds with microbial drugs contributes to the introduction in the agroecoses of agronomically useful microorganisms and is a part of organic farming [5, 6].

In recent years, an increasing importance of an integrated approach to the use of multifunctional drugs that have astragulus, anti-stress and protective action. There are new drugs that represent a complex of organic compounds that includes both macro and trace minerals and amino acids, polysaccharides and directly biologically active substances [7,8]. In Stavropol region, some of these
drugs are already applied in agricultural production, but, unfortunately, no evidence-based recommendations. The purpose of the research is the development and testing of new application technology of multifunctional microbial preparations on corn.

The object of research are the following multifunctional microbial preparations: KBP-KBP standard and innovative complex biological drugs RMB - polystrain complex of microorganisms; KMP-92 - complex microbial preparations. The observations were carried out in 2017-2019 year on the ordinary chernozem powerful humus, loam on loess-like loam. Maize for hybrid Mashuk 355 has been sown. According to the traditional technology was carried out treatment of seeds before sowing and maize plants in the phase of 3-4 leaves and flowering. The proposed technology included in addition to seed treatment and vegetative plants, pre-sowing soil treatment. The selection of soil samples was conducted in the phase of 3-4 leaves, flowering, and wax ripeness from the rhizosphere of plants in maize from the layer 0-20 cm.

The number of nitrogen-transforming microorganisms was studied by sowing soil suspension on solid nutrient media. For nitrogen-fixing aerobic microorganisms, Ashby medium was used, for ammonium nutrient medium fiers - meat-peptone agar (MPA), nitrifying agents - starch-ammonia agar (KAA).

A complex of microbial preparations (KBP), both standard and innovative, as well as KMP-92, is obtained by mechanical mixing of the finished preparations Diazofit, Phosphoenterin, Biopolitsid in different proportions.

The dominant functions of bioagents: Agrobacterium radiobacter 204 (nitrogen fixer), biosnow of the microbial preparation Diazofit; Enterobacterium ipressuralis 32-3 (phosphate mobilizer, phytohormone producer), a bioagent of the drug Phosphoenterin; Paenibacillus polymyxa P (an antagonist of phytopathogenic microfungi) is able to fix atmospheric nitrogen, a very weak phosphate mobilizer) - a bioagent of the drug biopolicide (BSP).

The multi-strain complex of drugs (KPM) was created on the basis of bacteria - antagonists of phytopathogens with growth-promoting effect - Paenibacillus polymyxa P + Bacillus sp.10 + Bacillus subtilis 01-1.

It was found that in the 3-4 phase of the sheet the number of nitrogen fixers in the control was 10 thousand CFU / g (figure 1). The use of KBP-S and KBP-I using traditional technology increased the number of the studied group of microorganisms in comparison with the control by 2.5 and 2.1 times, respectively. The introduction of KMP-92 did not significantly affect the number of nitrogen fixers, the difference being 1.5 times. When using the PCM preparation, the difference in the number of microorganisms was the most significant and amounted to 3.8 times. As a result of soil and seed treatment using the proposed technology, the number of nitrogen-fixing microorganisms significantly increased in all cases, and especially when using KMP-92 (6.8 times).

Table 1. The number of nitrogen fixers in the soil, depending on the use of biological products, thousand CFU / 1g.
In the flowering phase, the number of nitrogen fixers in the control was 50 thousand CFU / g. The increase in the number of microorganisms of this physiological group when applying traditional technology compared to the control amounted to 1.3 to 2.1 times for KMP-92 and KBP-S, and with the proposed technology from 1.9 times when processing the drug KMP-I and 2.4 times when using KMP-92.

By the wax ripeness phase in the control, the number of nitrogen fixers was 14 thousand CFU / g. Treatment with microbial preparations provided an increase in the number of Azotobacter chroococcum from 1.1 times with PCM and up to 1.8 times when exposed to KMP-92. With the proposed technology, the number of microorganisms increased from 1.6 times with the use of PCM and up to 3.2 times with the use of KMP-92.

It was revealed that in the phase of 3-4 leaves the number of ammonifiers on the control was the lowest and amounted to 56 million CFU / 1g. (Figure 2) When using KMP-I and PCM using traditional technology, the number of studied microorganisms increased in relation to the control by 1.2 and 1.3 times, respectively. The use of KMP-92 did not significantly affect the number of ammonifiers. The introduction of KBP-S preparations gave the best result, and the difference was 1.4 times. According to the proposed technology, the number of ammonifiers increased significantly in all variants of the experiment, especially when using the KMP-92 preparation, where the difference with the control was 2.1 times.

**Table 2. The number of ammonifiers in the soil, depending on the use of biological products, million CFU / 1g.**

| № | experience options                          | 3-4 leaves | Flowering | Wax ripeness |
|---|---------------------------------------------|------------|-----------|--------------|
|   | Traditio ny | Proposed technology | Traditio ny | Proposed technology | Traditio ny | Proposed technology |
| 1 | Control (without treatment) | 56 | 56 | 196 | 196 | 37 | 37 |
| 2 | KBP - standard (complex of biological preparations) | 78 | 89 | 371 | 435 | 55 | 65 |
| 3 | KBP - innovative (complex of biological preparations) | 67 | 77 | 324 | 443 | 48 | 58 |
| 4 | PCM (multi-strain complex of microorganisms) | 71 | 86 | 331 | 470 | 44 | 57 |
| 5 | KMP-92 (complex of microbial preparations-92) | 63 | 120 | 301 | 480 | 39 | 90 |

In the flowering phase, the number of ammonifiers in the control was 196 million CFU / 1g. When applying traditional technology, there was an increase in the number of microorganisms of the studied physiological group in relation to the control in the variant using KMP-92 by 1.5 times, and when using KBP-S by 1.9 times. In the variants with the proposed technology, the smallest increase in the number of ammonifiers in relation to control (2.2 times) was observed with KBP-S, and the largest (2.4 times) when treated with KMP-92.

In the phase of wax ripeness, the number of ammonifiers was the highest when using the preparation KBP-S, and according to the proposed technology when using the drug KMP-92.

When studying the number of nitrifying agents, it was found that in the 3-4-phase phase, their amount in the control was 52 million CFU / 1g. (table 3) When using KBP-I and PCM using traditional technology, the number of microorganisms increased 1.2 and 1.3 times compared with the control, respectively. The use of the drug KMP-92 least affected the studied parameter. When making KBP-S, the difference was the largest and amounted to 1.5 times. As a result of the use of biological products according to the proposed technology, the number of microorganisms increased in all cases, especially when using KMP-92 where the difference is 1.6 times.
Table 3. Number of nitrifying microorganisms in soil depending on the application of biopreparations, million CFU/1G.

| №   | experience options                          | 3-4 leaves | Flowering | Wax ripeness |
|-----|---------------------------------------------|------------|-----------|--------------|
|     | Traditio
tag technology                  | Proposed technology | Tradition technology | Proposed technology | Proposed technology |
| 1   | Control (without treatment)                 | 52         | 52        | 168          | 168          | 35          | 35          |
| 2   | KBP - standard (complex of biological preparations) | 74         | 68        | 365          | 365          | 50          | 41          |
| 3   | KBP - innovative (complex of biological preparations) | 62         | 75        | 352          | 388          | 42          | 55          |
| 4   | PCM (multi-strain complex of microorganisms) | 70         | 71        | 360          | 412          | 47          | 52          |
| 5   | KMP-92 (complex of microbial preparations-92) | 61         | 80        | 314          | 419          | 28          | 59          |

In the flowering stage, the number of nitrifying microorganisms in the control was 168 млн CFU/1G. The increase in the number of microorganisms of this physiological group in the application of traditional technology increased relative to the control and ranged from 1.8 times for the ILC-92 to 2.1 times when using the drug KBP, and when the proposed technology from 2.1 times in the treatment of KBP-S to 2.4 when using KMP-92.

To the phase of wax ripeness the number of this group of microorganisms in traditional technology was the highest when using the drug KBP, and on the proposed technology with the use of KMP-92.

Table 4. Yield hybrid corn Mashuk 355, depending on the application of biological products and method of making.

| №   | Option                                      | Traditional technology | Proposed technology |
|-----|---------------------------------------------|------------------------|---------------------|
|     | Yield t/ha | Increase t/ha | % | Yield t/ha | Increase t/ha | % |
| 1   | Control (without treatment)                 | 4.07                  | - | -         | 4.07          | - |
| 2   | KBP - standard (complex of biological preparations) | 5.05                 | 0.98 | 24.1 | 5.23     | 1.16 | 28.5 |
| 3   | KBP - innovative (complex of biological preparations) | 4.65                 | 0.58 | 14.2 | 4.90     | 0.83 | 20.4 |
| 4   | PCM (multi-strain complex of microorganisms) | 4.73                 | 0.66 | 16.2 | 4.95     | 0.88 | 21.6 |
| 5   | KMP-92 (complex of microbial preparations-92) | 4.50                 | 0.43 | 10.6 | 5.35     | 1.28 | 31.4 |
| 6   | HCP0.5 t/ha                                  | 0.19                 | - | - | 0.25 | - |

In the study of the yield of grain maize revealed that the least she was in control and made up 4.07 t/ha. In traditional technology application of the PCM - Standard gave the greatest increase at 24.1 %. The smallest increase of 10.6% was observed in variant with application of ILC-92. According to the
proposed technology the situation is quite different. On the variant with application of ILC-92 corn yield was the highest and amounted to 5.35 tons/ha. It is above the control of 31.4%.

As a result of the studies, it was revealed that when using multifunctional microbial preparations KBP-standard, KBP-innovative PKM - and KMP-92 - the number of nitrogen-converting microorganisms changed. The number of aerobic nitrogen fixers in the control in the 3-4 leaf phase with 21.1 thousand CFU / 1g, and in the flowering phase with 76.3 thousand CFU / 1g increased with the use of KBP-standard 2.2 and 1.7 times, respectively, KBP - innovative 1.9 and 1.6 times, RMB - 2.1 and 1.4 times and KPM-92 - 1.7 and 1.4 times. The smallest values are in the phase of wax ripeness. The number of ammonifiers in the control in the phase of 3-4 leaves was 55 million CFU / 1 g, and increased as a result of the use of biological products by 1.4-1.6 times. In the flowering phase, the number of ammonifiers in the control increased to 259 million CFU / 1 g and increased in various variants from 1.7 to 1.6 times. Similar changes can be seen in the number of nitrifying agents. The yield of maize on the smallest grain was on the control (4.07 t / ha), it increased on the traditional technology most of all in the variant using KBP-S by 24.1%, and according to the proposed technology on the variant using KMP-92 - by 31.4%. Thus, the introduction of biological preparations into the soil gives an additional effect.

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