Exposure of maize bioagrocenoses to diseases at no-till

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Abstract. The yield and quality of corn grain is significantly affected by the infection of plants with diseases of agricultural crops. The susceptibility of corn bioagrocenoses of hybrids ROSS 145 MV, ROSS 140 SV, Povolzhsky 107 SV, Katerina SV, NC Falcon, NC Gitago and Delitop to diseases during their cultivation for grain according to traditional, minimal and no-till technology in the agro-climatic conditions of the Volga-Vyatka region was studied. In the course of research, it was found that the most common diseases of corn due to excessive moisture in the soil and high humidity during the harvest period are mildew on the cob, fusarium on the cob, root and stem rot, dust and blister smut. Under unfavorable harvesting conditions, the incidence can reach 40%. Under favorable weather conditions, there are isolated cases of plant diseases, regardless of the cultivation technology. To protect the bioagrocenoses of corn, it is necessary to grow disease-resistant hybrids, monitor the rotation of crops in the crop rotation, apply full doses of mineral fertilizers and micronutrients, sow at the optimum time with an appropriate seeding depth, maintain a complex chemical plant protection system, starting with seed dressing. The closest to the requirements are zoned maize hybrids with a short growing season ROSS 145 MV, ROSS 140 SV, Povolzhsky 107 SV and Katerina SV.

1. Introduction
The peculiarity of scientific research in agriculture is their interrelation with agro-climatic conditions. However, it does not matter whether the justification of the system of farming, the clarification of individual methods of soil cultivation or cultivation technology, the choice of variety or hybrid, the use of organic and mineral fertilizers or chemical protection plants. It is always necessary to link them with the degree of heat and water availability of the region, the duration of the frost-free period, the possibility of frost, drought, etc. [1–5].

Cultivation of corn for grain in the zone of risky farming justifies the invested funds due to the high potential yield and biological characteristics of the crop itself. At the same time, in order to obtain high grain yields, a proper selection of early maturing hybrids and a well-developed cultivation technology are necessary.

Chuvashia is located in a temperate continental climate zone. Winters are cold and frosty here, and summers are hot. The average annual air temperature in most of the republic does not exceed 2.9–3.0 °C. The hottest month is July with an average monthly temperature of 18.2–19.4 °C, the coldest is January with a temperature of 12.3–13.4 °C below zero. The duration of the warm period with an average daily temperature above 0 °C is 200–210 days, the cold period is 155–165 days [6–8].

Despite the fact that the Chuvash Republic is in an area with unstable moisture, sufficient spring charging by the moisture of the root layer is a distinctive feature of its climatic conditions. For the year in the republic falls from 450 to 550 mm of precipitation. In very wet years, the amount of precipitation...
reaches 600-700 mm, in arid - does not exceed 270-380 mm. In the period from April to October, about 70% of all precipitation falls. But their size for the same month in different years is not the same and in recent years the amount of precipitation by years and periods varies greatly. Deviations from the average multi-year rate in 2016-2020 reached 50-60%. Often, they are too few in the first half of the summer, in the most critical phases of plant development, and too much in the second, during harvesting. It is these reasons that have remained the limiting factors for the spread of this culture in the Volga-Vyatka region until recently.

Based on this, the aim of the study was to study the susceptibility of maize bioagrogenoses to diseases when they are cultivated for grain according to the traditional, minimum and no-till technology in the agro-climatic conditions of the Volga-Vyatka region.

2. Experimental

The research subjects were maize hybrids: ROSS 145 MV, ROSS 140 SV, Povolzhsky 107 SV, Katerina SV, NC Falcon, NC Gitago and Delitop.

ROSS 145 MV – FAO 150. The vegetation period from shoots to maturation is 95–96 days. The height of plants is 210–215 cm, the cob is formed at a height of 75–77 cm in cylindrical form, has 14 rows of grains. The grain is yellow semiliquid. Well adapted to mechanized harvesting.

ROSS 140 SV – FAO 150. Plant of medium height. The cob is weakly conical, of medium length, the stem is colored, the color intensity is medium. Grain intermediate, yellow.

Povolzhsky 107 SV – FAO 170. The plant is high. Cob from short to medium. The grain is siliceous. The color of the upper part of the grain is yellow-orange. There is no anthocyanin color of the core.

Katerina SV – FAO 170. Period from shoots to flowering cob 50–52 days, plant height 220–235 cm, cob attachment – 75–80 cm. Plants are light green in color. The cob is white and red. Number of rows of grains 12–14. The grain is siliceous-dentate to semi-siliceous. Grain color from yellow to yellow-orange.

NC Falcon – FAO 190. Has a high yield potential. Characterized by a very rapid start and early development of plants. It has good drought resistance and heat resistance. When ripening, the grain quickly gives off moisture.

NC Gitago – FAO 200. Grain of intermediate type, closer to siliceous. The plant is high. The cob is slightly sloping, of medium length, of medium thickness. It has resistance to lodging and stressful situations, is super-drought-resistant, suitable for cultivation on various types of soils.

Delitop – FAO 210. Characterized by high field germination, rapid start and early development of plants, good drought resistance and heat resistance. Has an excellent grain-to-green ratio, low fiber content - nutritious food with excellent digestibility, high starch content in the grain. It is characterized by high adaptability.

For sowing, pickled seeds were used, supplied through the shopping and purchasing centers of ZAO «Shchelyolkovo Agrokhim» and the company «Syngenta».

Traditional technology for cultivating maize for grain included disking stubble of spring wheat to a depth of 4–6 cm with a harrow disk heavy BDT-6, peeling plowshare PLL–10–25, plowing PLN–4–35 at 20–22 cm, presowing cultivation of KPS–4 for 4–6 cm with simultaneous harrowing of BZSS-1.0, seeding with SZ-3.6 and packing of 3KKSH–6.

When testing the technology of maize cultivation with minimal soil cultivation, autumn disking and stubble plowing were carried out to a depth of 6–10 cm of BDM–6 and PLL–10–25, spring pre-sowing cultivation for 8–10 cm with block-modular cultivator KBM-10.8 and seeding the Amazone seed drill.

In an option with no-till processing in the fall period, the Zero continuous herbicide was sprayed and the maize sown with the Amazone complex in the second decade of May. Regardless of the technology, the sowing was carried out according to the scheme of 70x30 cm with the consumption of conditional seeds of 25 kg/ha and the introduction of mineral fertilizers in a dose of N9P60K60.

The integrated system of crop protection from weed vegetation included 3–5-leaf spraying with a tank mix of Kalisto herbicides (0.2 l/ha) and Milagro (1.2 l/ha). Harvesting was carried out in the phase
of full ripeness of maize in late September – early October. In conducting research, analyzing and discussing results, we adhered to the generally accepted methodology of field research.

3. Results and Considerations
The most common diseases of corn due to excessive soil moisture and high air humidity during harvesting are corn mold on the cob, fusarium on the cob, root and stem rot, dust and blister smut (table 1).

Table 1. Susceptibility of maize bioagrocenoses to diseases under different cultivation technologies, %.

| Hybrids           | mold on the cob | fusarium on the cob | root and stem rot | dusty and blistering smut |
|-------------------|-----------------|---------------------|-------------------|---------------------------|
|                   | Traditional technology |                       |                   |                           |
| ROSS 145 MV       | 26              | 18                  | 10                | -                         |
| ROSS 140 SV       | 30              | 19                  | 11                | -                         |
| Povolzhsky 107 SV | 38              | 22                  | 10                | -                         |
| Katerina SV       | 35              | 24                  | 11                | -                         |
| NC Falcon         | 40              | 24                  | 12                | 2                         |
| NC Gitago         | 36              | 22                  | 15                | 3                         |
| Delitop           | 40              | 24                  | 13                | 3                         |
|                   | Mini-till technology |                       |                   |                           |
| ROSS 145 MV       | 27              | 19                  | 11                | -                         |
| ROSS 140 SV       | 29              | 19                  | 11                | -                         |
| Povolzhsky 107 SV | 36              | 20                  | 12                | -                         |
| Katerina SV       | 38              | 22                  | 12                | -                         |
| NC Falcon         | 39              | 23                  | 12                | 2                         |
| NC Gitago         | 38              | 24                  | 14                | 2                         |
| Delitop           | 40              | 25                  | 12                | 3                         |
|                   | No-till technology |                       |                   |                           |
| ROSS 145 MV       | 26              | 18                  | 10                | -                         |
| ROSS 140 SV       | 31              | 19                  | 11                | -                         |
| Povolzhsky 107 SV | 37              | 23                  | 11                | -                         |
| Katerina SV       | 35              | 23                  | 11                | -                         |
| NC Falcon         | 40              | 24                  | 13                | 2                         |
| NC Gitago         | 37              | 24                  | 15                | 3                         |
| Delitop           | 40              | 25                  | 14                | 3                         |

Moldy corn seeds are considered by some scientists not so much as a disease, but as a reaction of grain to adverse conditions. This attack significantly degrades the condition of the plants. The germination and germination energy of moldy seeds is sharply reduced, as a result of which the seeds become unsuitable for their subsequent sowing. Mold develops especially actively with waterlogged soil and excess rainfall.

The main signs of mold are considered to be the formation of dense bluish, greenish, dirty black, grayish, brown or white on the grains. In our practice, we have found three main varieties of corn seed mold on the cob: pink, dark, and gray-green. Pink bloom most often developed on damaged grains, and after a while covered the entire ear. Dark mildew was characterized by the formation of dark olive or black mildew, located predominantly in the upper part of the ear. Moreover, the most common was gray-green mold, in which the shape had a corresponding gray-green tint.

Seed mold is caused by a complex of pathogens, such as Penicillium, Mucor, Aspergillus, Trichothecium, Cephalosporium, Cladosporium and some others caused molding of corn seeds. On our crops, these pathogens acted together. Since all the fungi possessed saprotrophic properties, they became more active when they established acceptable temperatures and increased humidity. Infect corn kernels, they did not even catch up with a drop in temperature to seven degrees. In addition to the fact that these
fungi used nutrients in the grains, they are able to poison the embryos with their toxic secretions. When some of the above mushrooms are affected, corn grain becomes unsuitable even for its use in animal feed.

Fusarium disease or dry rot of corn cobs appeared on the cob in the form of several foci of cobwebby, sometimes dense pinkish or white plaque. Each hearth covered not less than 25 grains. In the center of the focus, where the disease arose, the grains were highly amazed and could be completely destroyed. These corn kernels were dirty-brown, easily broken and crumbled. On the pre-ferrum part of the Fusarium foci of infection, the grains were less affected, severely undiagnosed and covered with a pink bloom.

At the initial stage of the disease, the grains located on the periphery of the focus had a normal appearance, and there were no external signs of damage, including a characteristic plaque for the disease. In the presence of several foci or with the growth of foci, the entire cob was affected.

The causative agent of Fusarium disease is the fungus of the imperfect class Fusarium moniliforme Scheld. This parasite develops mainly in the conidial stage, manifested as pink pads. When infecting the cob, the fungus penetrates into the tissue through the injuries inflicted by insects (caterpillars of the stem moth, cotton scoops), birds. Often we noticed that the fusariosis developed on the cob, stricken, with linen.

This disease developed very strongly in wet weather, causing significant crop losses. Dry rot of corn grain did not stop even during storage due to high humidity of the ears (27 % and higher). Infection can persist in seeds and in post-harvest residues, especially in cob cover wrappers.

The stem and root rot of maize were manifested in the second half of the vegetation in the form of decay of stalks and roots. Depending on the nature of the manifestation and causative agent of the disease, we installed Fusarium and coal rot on the experimental plots.

The causative agents of Fusarium rot are various imperfect fungi of the genus Fusarium Link. They are distributed by conidia, which are of two types: macroconidia – spindle-shaped or sickle-shaped with 3–5 septa and microconidia – one- or two-celled. The latter are often formed when budding macroconidia.

Fusarium rot was manifested at the second and third lower nodes and interstitial sites in the form of brown and yellow spots of various shapes that were covered with a red-white or white-pink bloom in wet weather. The stalk of the affected plants inside became hollow and often razmochalas. Underground interstitial and rootlets acquired red color, and the parenchyma of the core disintegrated. The disease developed more strongly at elevated temperatures and in small precipitations.

The causative agent of coal rot is the imperfect fungus Sclerotium bataticola Taub. In the cycle of its development, it forms sclerotia in the size of 50–152 x 22–32 microns and mycelium, which infects plants.

Carbon decay caused discoloration or discoloration of the lower part of the stem and root. Under the epidermis, small black sclerotia scattered along the stalk in the form of dots were found. The parenchyma of the core was almost completely destroyed, the stem shriveled or mashed, becoming easily broken. The development of the disease was intensified with a small amount of precipitation and elevated temperatures.

The causative agent of the bladder is the fungus Ustilago zeae Ung. All the young tissues of the plant were affected by a bubbling gland, most often the cobs, stems and reproductive kidneys (rudimentary cobs) located in the axils of the leaves beneath the fertile cob. The causative agent affects only the vegetative cells; the outer shell of the pericarp is affected in the ear of the ovary, the mycelium does not penetrate the embryo, the nucellus, and the endosperm; with the defeat of young ovaries these cells atrophy.

The fungus produced on the affected parts of the corn plant the formation of nodules, tumors, blisters at first a whitish-pink color, then they became dark, filled with a mass of brownish-brown spores. Gums were 12 cm in diameter. Inflations of the largest size were found on the cobs and stems. In the panicles, individual flowers or branches were affected, resulting in irregular small saccular bulging, often hanging down in the form of brushes. On leaves there were small swellings in the form of a group of rough
wrinkles. Similar symptoms were also characteristic for affected corn seedlings. In the latter case, the complete death of young plants was noted.

The greatest (8%) morbidity in establishing a week-long excess humidification was detected in the NC Falcon hybrid, which was higher by 0.5 and 0.9 % than in hybrids of the NC Gitago and Delitop; on 1.2 and 1.5 % – hybrids ROSS 145 MV and ROSS 140 SV; by 1.9 % – the Katerina SV hybrid, respectively, and the smallest (5.2 %) in the Povolzhsky 107 SV hybrid.

With a two-week duration of unfavorable conditions for harvesting corn grain, the morbidity rates increase by another 3.6; 3.3; 3.2; 2.6; 2.4; 2.1 and 2.0 % for the test hybrids, respectively. With a three-week duration of bad weather, signs of the disease appear in 40 % of corn plants, regardless of the type of hybrid.

In addition to the deterioration of the quality of grain due to the damage caused by diseases and pests, losses occur because of the impossibility of timely harvesting of the grain by the combine. At the same time, direct combining can be carried out with the moisture content of corn grain not more than 30 %.

The losses due to the delay of harvesting on the 5th day are for hybrids with a high starch content of NC Falcon, NC Gitago, Delitop 4.0–6.0 %, for hybrids with relatively low starch content 2.0–4.5 %, respectively. On the 15th day, grain losses are 8.0–10.0 % and 5.0–7.5 %; on the 25th day – 12.5–14.0 % and 9.0–10.0 %; and on the 30th day – 15.5–18.5 % and 12.0–14.5 % and higher for the hybrids under analysis, respectively.

The mathematical analysis of the data obtained showed that the technology of cultivation of corn for grain did not have a significant effect on the damage to plants by diseases.

4. Conclusion
To protect corn from diseases, it is necessary to cultivate disease-resistant hybrids, follow the alternation of crops in crop rotation, make full doses of mineral fertilizers and microfertilizers, sow at the appropriate time for the appropriate depth of seeding, maintain an integrated chemical plant protection system, starting with seed dressing.

To date, a necessary list of such qualities does not have any of the hybrid we investigated. The closest to the requirements are zoned maize hybrids with a short growing season ROSS 145 MV, ROSS 140 SV, Povolzhsky 107 SV and Katerina SV.

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