Application of tillage methods and seed disinfection techniques for the development and spread of diseases in spring wheat crops

N S Kozulina and A V Vasilenko

Federal Research Center Krasnoyarsk Scientific Center Siberian Branch of the Russian Academy of Sciences - a separate subdivision Krasnoyarsk Research Institute of Agriculture, 66 Svobodny Ave., Krasnoyarsk, 660041 Russia

E-mail: wasilenkoav@yandex.ru

Abstract. Improving the tillage system will stabilize the agricultural sector of the Krasnoyarsk Region and meet the growing demand for agricultural products. The principles of minimizing mechanical tillage and preserving plant residues on its surface are the basis of the technology of conservation agriculture. Among the new agro-ecological advantages of the technology is the reduction of dependence on weather conditions thanks to effective moisture conservation. Improvement of the soil structure by reducing the pressure on it, partial replenishment of natural fertility by reducing (by 25-30%) the rate of humus mineralization. It is based on soil fertility management, minimum and combined tillage; differentiated fertilizer system. Zero sowing on the predecessor stubble - an element of technology - contributes to the accumulation of moisture, disruption of the plough-pan, an increase in the microbiological activity of the soil, etc. Presowing seed preparation is a technological technique that can increase the yield of wheat. Seed disinfection techniques significantly affect the development and spread of diseases in spring wheat crops. A systematic, scientifically grounded approach to phytosanitary rehabilitation of agrocenoses will ensure the prevention of chemical contamination of soil and agricultural products, an increase in yield (by 15-20%), a decrease in production costs per unit of produced products (by 10-15%), and an increase in production profitability.

1. Introduction
The Krasnoyarsk Region, in terms of soil and climatic indicators, belongs to the zone of risky farming. The plant growing industry in the region is developing dynamically and consistently; annually there is an increase in the area of sowing cereals, the level of their yield, gross grain harvest, as well as an increase in its quality [1].

An important role in solving the main tasks in the agricultural industry of the region is played by the factor of scientific support aimed at managing soil fertility, improving the soil cultivation system, scientifically substantiated use of fertilizers, plant protection products from a complex of harmful organisms, reducing production costs, increasing labor productivity and efficiency of the plant production in general [2, 3].

Significant importance in this direction is given to the continuation of research aimed at improving the phytosanitary state of food and seed grains, as well as soils and vegetative plants.

The most important conditions for the use of resource-saving technology are a high level of agricultural technology, carrying out mechanized work in optimal terms, etc. [4].
Traditional technology of cereals cultivation with fall-plowing and spring harrowing is characterized by high labor intensity and high energy consumption. Therefore, one of the ways to improve technologies is to minimize tillage both in the number of operations and in depth [5].

The options of energy-saving technologies used in modern practice differ in many respects depending on the system of basic and pre-sowing tillage.

The technology with surface tillage, in comparison with the traditional one, makes it possible to reduce the mechanical effects of tillage machines on the soil and the compacting effect of their running systems on it, and to reduce the number of machines passes over the field.

In modern conditions, resource conservation should objectively become the basic technology for stopping destructive trends in agriculture.

For certain soil and climatic conditions of the Krasnoyarsk Region, a scientifically grounded and differentiated approach to the use of methods and means of plant protection is required [6, 7]. The disinfection techniques of food seed grain of spring wheat ensure a decrease in the development and spread of diseases by 15-17%. The methods of tillage and seeds disinfection techniques affect the infection with diseases, pests and the yield of the studied crop [8].

2. Research methodology and methods

The climate of the Krasnoyarsk Region is sharply continental, characterized by extreme unpredictability, complexity and diversity. One of its features is a rapid rise in air temperature in spring and a rapid decrease in autumn.

In terms of the degree of continentality (61-63%), the region differs from other regions of Siberia; the difference is manifested in the peculiarities of fluctuations in annual and daily temperatures, the amount of precipitation, and their distribution. The climate is largely determined by the meridional and latitudinal atmospheric circulation; the first ensures the arrival of warm air from the south, and the second - cold air from the north. Latitudinal circulation brings moist air from the west and dry air from the east.

In most of the agricultural territory of the region, the average January temperature varies from -17 to -22°C. Krasnoyarsk forest-steppe - a place of research is located in the valley of the Yenisei River, at an altitude of 160 meters. The average July temperature in the agricultural part of the region is 17-19°C.

The period with above-zero temperatures lasts on average 177-195 days, the growing season (temperatures above + 5 °C) is 140-153 days and, depending on the zone, covers the period from the first decade of May to the end of September.

The average long-term sum of active temperatures in the agricultural part of the region increases from the northern to the central regions from 1400 °C to 1750 °C; the duration of the frost-free period in this case increases from 80 to 118 days, and the period with the sum of temperatures above 10 °C - from 90 to 125 days.

The latest frosts are observed in late May - early June; their intensity is from 0.5 to -3°C. They are not dangerous for early cereals, as the seedlings tolerate a short-term drop in temperatures down to -10 °C. The first autumn frosts are observed at the beginning of September, rarely at the end of August; at their intensity -2…- 4°C negative influence on vegetative plants is possible. Frequently repeated early-autumn frosts direct towards the cultivation of varieties with a short growing season.

The production experiment was established according to the generally accepted methodology in the forest-steppe zone of the Krasnoyarsk Region [10]. The soil is leached chernozem, the total area of the site is 6 hectares. The predecessor is spring wheat; the placement of the plots is not complete and randomized. Sowing time - 2nd decade of May; seeding rate - 4.5 million germinating grains per hectare.

The experiment was placed by moldboard plowing, minimal tillage, zero seeding on the stubble of the previous crop, using resource-saving technology.

The experiment scheme includes 6 variants in four replications.

In the course of experiment were studied:
• methods of tillage (plowing to a depth of 20-22 cm, minimal tillage, zero sowing);
• varieties of spring wheat included in the State Register;
• integrated protection of cereals from soil and leaf-stem diseases;
• agrotechnical methods aimed at improving the soil, seeds, vegetative plants;
• agricultural technology for disinfection and biostimulation of cereals.

All protective measures were planned and implemented on the basis of the survey results, thresholds of harmfulness and "Scheme for the short-term forecast of decision-making on the conduct or cancellation of chemical protective measures", developed for the conditions of the forest-steppe zone of the Krasnoyarsk Territory.

The records and observations were carried out during the entire growing season:

• the planting density of wheat plants was determined at the emergence stage - the third leaf. On the diagonal of the plot, special plots with a size of 1 / 3m were detected; for drill sowing, 2 rows of 1.11 m in length were taken and the plants were counted;
• the spread and development of diseases were taken into account within the time frame established by standard methods, the assessment was carried out in accordance with the scales (in points) recommended by the All-Russian Research Institute of Plant Development of the Ministry of Agriculture of the Russian Federation;
• during the research, phytopathological and microbiological methods were used;
• the population of the soil with B. sorokiniana was determined by the flotation method;
• phytoexamination of seeds - using the method of wet chambers in accordance with State Standards (GOST) 12044-93. Sampling for analysis - in accordance with GOST 12047-66;
• the length of the coleoptile - using phytoexamination of seeds in rolls;
• microbiological studies of rhizosphere soil and quantitative registration of microflora - on diagnostic nutrient media;
• biometric indicators were taken into account at the same time as diseases of wheat plants;
• for the analysis of the structure of the harvest, the plants were selected by the method of test plots, which were selected along the diagonal of the plot, at regular intervals, in all variants and non-adjacent replications of the experiment;
• the actual harvest in bunker weight was taken into account for each variant in 4-fold repetition, resulting in a standard 14% moisture content and 100% purity;
• yield data processed by methods of mathematical statistics using DataFit and SNEDECOR packages. The indicator for assessing the reliability of the results was the least significant difference (LSD), which was determined with a 90–95% probability level.

3. Research results

Grain production is the main link in the plant production industry; spring wheat occupies the largest sown area in the Krasnoyarsk Territory. The development and deployment of resource-saving technology for the cultivation of spring wheat, taking into account the soil and climatic conditions of the zone, provide a high and stable yield [11]. In the conditions of the forest-steppe zone of the Krasnoyarsk Territory, agrotechnology was developed for the application of the most effective agrotechnical methods (crop rotation, soil cultivation methods, variety, sowing time, seed disinfection, chemical means of protection, etc.), for the improvement of soil, seeds and vegetative plants based on the results of laboratory and field research. ...

In a multifactorial production experiment, an assessment was made of the phytosanitary role of the traditional fall-plowing in the research zone to a depth of 20-22 cm, minimal tillage and direct sowing of wheat on the stubble of the previous crop in the development and distribution of a complex of harmful objects.
In the process of assessing agrochemical indicators, it was found that there were no significant changes in the humus content depending on the method of tillage. The reserves of humus in the soil layer of 0-20 cm. were fixed. They are 121-169 t / ha in the variant with moldboard processing and 122-147 t / ha, with direct sowing. In both cases they are rated as average.

By the end of the growing season, in conditions of sufficient moisture, moldboard and zero tillage of chernozem formed similar reserves of soil moisture in the 0-20 cm layer.

It was found that zero tillage, increasing the density of the arable layer to the optimal value (1.00 - 1.03 g / cm³), reduces the content of agronomically valuable aggregates to a satisfactory and good level of structure (50-60%), while maintaining their good and excellent water resistance (77 -83%).

In the conditions of moldboard plowing, the best agrophysical state of the arable layer of chernozem is formed on the variants of the experiment with the use of herbicides and fertilizers at a dose of N₆₀P₃₀K₃₀. With a loose constitution (0.91-0.94g / cm³), an excellent soil structure (78-82%) and water resistance of aggregates (83%) are formed.

It was revealed that zero treatment, combined with the application of herbicides and fertilizers at a dose of N₆₀P₃₀K₃₀, determines the normal composition of the arable layer (1.00 g / cm₃), its excellent (71%) and aggregate state (83%) throughout the growing season. Such a technological method significantly reduces production costs for soil cultivation, creates and maintains an optimal agrophysical state of chernozem.

The use of seed material disinfection technique of was accompanied by an increase in field germination and the density of standing of wheat plants in sowing. Field germination was 71.3% compared to control (70.5%). The effect of the reception of seed disinfection with a fungicide hampers the growth of the infectious potential of the root rot.

Root rot by the beginning of tillering of wheat against the background of direct sowing - 86%. By the stage of milky-wax ripeness on both backgrounds of treatment, each plant was more or less damaged (distribution - 100%). The intensity of the development of the disease also increased (up to 42.5 - 55.5). Seed disinfection contributed to the later manifestation of the disease and hampered, until a certain time, its further development.

The results obtained indicate that the main tillage significantly influences the density and state of the B. sorokiniana population in the soil, and on infected plant residues, as well as on the biometric parameters of growing wheat plants, the level of their infection with root rot and leaf-stem diseases.

4. Conclusion

As a result of the research carried out, the following conclusions can be drawn:

Against the background of moldboard tillage, the number of conidia in the 20-centimeter layer is by 1.5 times lower than that in direct sowing (253 k / 1 g of soil versus 373). The excess of EPV is from 6.0 to 9 times, respectively. In the tillering phase, the soil population of the experimental plot was many times higher than the EPV:

- By the autumn count (the stage of full ripeness of wheat) on the moldboard plowing, the population density decreased in the 0-20 layer by 90 conidia / 1 g of air-dry soil, which corresponds to 35.5%.
- Against the background of direct sowing, the decrease in the population level was 27.1%. By autumn, in conditions favorable for the growth of the infectious potential of pathogens, there was a decrease in the indicator by 35.5 and 27%, respectively. Due to the change in the infection reserve, its level on the moldboard treatment corresponds to an excess of EPV by 2.3 times - on direct sowing - by 6 times;
- The significant influence of the method of tillage on the growth and development of plants has been noted; the height of plants from the booting stage to milky ripeness against the soil-protective background (zero tillage) increased by 5.4%, during plowing - 2.8. The tendency to exceed the number of stems per plant, the length of the ear and the number of spikelets in the ear was observed against the zero sowing background but it was insignificant.
• The influence of the reception of seed disinfection with a highly effective fungicide adapted in the research area hampers the growth of the infectious potential of root rot, and partly of some leaf-stem diseases;

• It was found that root rot had a high distribution, higher - against the background of direct sowing (86%); the intensity of development did not differ.

• By the stage of milky-wax ripeness on both backgrounds of treatment, each plant was more or less damaged (distribution - 100%). The intensity of the development of the disease also increased (up to 42.5 - 55.5) according the background, respectively.

• Reception of seed disinfection contributed to the later manifestation of the disease and hampered, until a certain period, its further development.

• Leaf-stem diseases in conditions of a significant excess of moisture supply relative to the average long-term level were widespread and significant, especially against the background of direct sowing. In particular, if on average 59.7% of plants were damaged by Septoria blight during plowing, then on a stubble background - 71.8%, which is 20% higher. The intensity of the development of the disease is (14.9 and 46.3%), respectively.

• Brown leaf blight - being one of the manifestations of root rot, had similar indicators of distribution and development, which is quite corresponds to the level of development of common root rot and the influence of soil preparation technology on the population density of B. sorokiniana pathogens.

• With regard to the mutual influence of two factors, the disease - the method of tillage; the moldboard tillage continues to positively influence the spot disease infestation.

Various methods of the tillage have a significant impact on the development and distribution of diseases. Their conservation and distribution are directly connected with the soil.

The biological effectiveness of the use of fungicides against leaf-stem diseases, according to long-term data and the experiment, was on average 42.6%. Wheat plants suffered more from leaf-stem diseases against the background with zero tillage.

The method of the tillage, especially against the background of unfavorable weather conditions of the Krasnoyarsk Region and seed disinfection techniques, has a significant impact on the quality of products and the level of yield of spring wheat.

The materials were received within the framework of the grant "Development of the project for varietal agricultural technology and certification of adaptive varietal complexes of cereals for the territory of the Krasnoyarsk Region, allowing more fully realize the potential yield of cereals, maintaining high technological qualities of grain."

References
[1] Surin N A 2011 Adaptive potential of varieties of grain crops of Siberian selection and ways of improving it (wheat, barley, oats) (Novosibirsk: Krasnoyar. scientific research in-t sat. households)
[2] Akimenko A S 2020 Formation of crop rotations and the structure of sown areas for obtaining a given amount of products taking into account the natural resource potential Zemledelie 4 19-22 Doi: 10.24411 / 0044 - 3913 - 2020 - 10405.
[3] Kalichkin V K, Koryakin R A, Maksimovich K Yu, Sigitov A A and Galimov R R 2020 Conceptual model of agroecological properties of lands Siberian Bulletin of Agricultural Science 50 72-80 Doi: 10.26898 / 0370 - 8799-2020 - 1-9
[4] Brylev S V 2015 The system of agriculture of the Krasnoyarsk Territory on a landscape basis (Krasnoyarsk)
[5] Kozhevnikov N V 2016 Influence of basic tillage methods on the content and reserves of humus in ordinary chernozem of Krasnoyarsk forest-steppe Reflection of bio-, geo-, anthropospheric interactions in soils and soil cover. Materials of the VI All-Russian Scientific and Practical Conference (Tomsk, 2016) pp 288-91
[6] Alekhin V T, Mikhailova V V and Mikhina N G 2016 *Economic thresholds of harmfulness of pests, diseases and weeds in crops* (M.: FGBNU Rosinformagrotech)

[7] Demidenko G A and Romanov V N 2016 The influence of herbicides on the productivity of spring wheat in the forest-steppe zone of the Krasnoyarsk Territory *Bulletin of OmGAU* **2(22)** 11-5

[8] Kozulina N S, Vasilenko A V, Vasilenko A A and Shmeleva Zh N 2020 Substantiation of the ecological method application for disinfection and biostimulation of spring wheat seeds in the Krasnoyarsk territory forest-steppe zone *IOP Conf. Ser.: Earth Environ. Sci.* **548** 052034

[9] Belash M Yu, Veprikova E V, Sobolev A A, Romanov V N, Kozulina N S, Snitkova T A, Vasilenko A V, Mikhailits M A, Lipshin A G and Taran O P 2020 Development of nitrogen-containing fertilizer based on pine bark and study of its effectiveness in wheat growing in the agricultural zone of the krasnoyarsk territory *J. Sib. Fed. Univ. Chem.* **13(4)** 578-92 DOI: 10.17516 / 1998-2836-0207

[10] Dospekhov B A 1985 *Field experiment technique* (M.: Agropromizdat)

[11] Saveliev V A 2015 *Spring wheat* (Kurtamysly: Kurtamysly printing house)