Varietal wheat responsiveness to the use of pesticides and fertilizers

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Abstract. The article considers the reaction of the variety «Novosibirskaya 15» to the use of insecticides, fungicides, herbicides, as well as nitrogen fertilizers. Maximum yield of modern spring wheat varieties can be expected only when they are cultivated with elements of intensive technology in crop production. These are the improvement of soil fertility, the system of fertilizers and crop rotations, the use of zoned varieties, the integrated system of plant protection, the improvement of the tillage system, complex mechanization, etc. The fulfillment of these conditions makes a huge contribution to obtaining a high grain yield of excellent quality. In this regard we have studied individual elements of intensive technology and their contribution to the yield of one of the most popular varieties in the Krasnoyarsk Territory. The influence degree of pesticides and fertilizers usage on the elements of the crop structure and its quantity in the spring soft wheat variety «Novosibirskaya 15» was determined by the methods of mathematical statistics. It was established that in order to obtain the maximum productivity of this variety in the Krasnoyarsk Territory it is recommended to use both previous fallow and grain with maximum intensification and fertilization.

1. Introduction
In modern agriculture the variety is the basis of intensive and energy-saving technologies for the production of crop products. In recent years the methods used for the creation of varieties have been significantly enriched [1]. New varieties receive official recognition due to their advantages in comparison with the corresponding standards in terms of the quantity or quality of the obtained products, or in terms of agronomic plants indicators, including immunity to diseases, pests, and other leading characteristics and properties that ensure the improvement of the technological quality of the variety [2, 3].

The variety remains the main and most effective means of increasing productivity, yield increasing, quality, sustainability and, ultimately, the competitiveness of production. In our time there is a very urgent need to study the influence of various previous crops, plant protection products, as well as mineral nutrition on the quality and yield of grain [4, 5]. Because the poorly studied uncontrolled use of chemical plant protection products leads to a significant change in the environment and its pollution currently. But it is also obvious that it is impossible to abandon the means of intensifying agricultural production. There is an urgent need to develop optimal systems for the integrated usage of chemicalization agents and to search for biological products that will reduce the rates of introduced products and preserve their biological effectiveness [5, 6].
The purpose of this study was to determine the effect of various previous crops, mineral fertilizers and modern plant protection products on the yield and elements of its structure in spring wheat variety «Novosibirskaya 15».

2. Materials and methods

The experimental part of the work was carried out based on the results of field studies of the Department for Crop Production, Selection and Seed Production of the Krasnoyarsk State Agrarian University in the educational farm "Minderlinskoe" from the Sukhobuzimskiy district of the Krasnoyarsk Territory in 2018-2019 [7, 8]. The land-use area is located at the 56.40 of northern latitude in the central part of the Krasnoyarsk forest-steppe, at the junction of the south-eastern and eastern outskirts of the West Siberian Lowland and the foothill plain of the Eastern Sayans. Soil is luvis chernozem. The results of the soil analysis: the reaction of the pH medium from the salt extract is 6.7, the supply of nitrate nitrogen is low (10.2 mg/kg), of mobile phosphorus is high (254.0 mg/kg) and of exchange potassium is high (288 mg/kg).

The early-maturing soft spring wheat variety «Novosibirskaya 15», included in the State Register of Selection Achievements in the Russian Federation and allowed for cultivation in the Krasnoyarsk Territory, was used as the object of research.

The variety «Novosibirskaya 15» was included in the State Register in 2003. The patent holder is the Siberian Research Institute of Crop Production and Selection of the Siberian Branch in the Russian Academy of Agricultural Sciences. Variety is lutescens. The stem is erect. The straw is made weakly with a strong pubescence of the upper node. The last leaf has a strong waxy coating. The ear is cylindrical, medium density, white. The prong is short and straight. The grain is ovoid, colored, the tuft is short. The variety is early-maturing, the growing season is 75-83 days, resistant to lodging. Medium-dry resistant. The baking qualities are excellent. Strong wheat. The variety is moderately susceptible to hard smut and highly susceptible to brown and stem rust and powdery mildew. Weight of 1000 grains is 34-36 g.

Sowing was carried out in the second decade of May, after harrowing, fertilizing and pre-sowing cultivation. Before sowing the seeds were treated with protectant «Oplot», water-suspension concentrate (0.5 l/t). The previous crops were fallow and cereals (spring wheat). Fallow, fertilized fallow, grain and fertilized grain crops were selected as the backgrounds, where a full range of plant protection products was used.

Ammonium nitrate NH₄NO₃ (34.4% of the active substance) was used as a nitrogen fertilizer. Seeding rate was 5.0 million germinating grains per hectare. The size of the plot was 50 m², the size of the sites for recording the harvest was 12 m², the repetition was four-fold, the method of sowing was ordinary, the depth was 4 cm, the method of placing the plots was systematic. Phenological observations, evaluation and accounting were carried out in accordance with the «Methodology for the state variety testing of agricultural crops» [9]. During the growing season the crops were treated with modern means of protection: «Puna Super 100», suspension concentrate 0.6 l/ha; «Prozaro Quantum», emulsion concentrate 0.6 l/ha; «Detsis Expert», emulsion concentrate 0.125 l/ha; «Ultromag Profi» 2 l/ha. After determining the indicators of the yield structure for soft spring wheat «Novosibirskaya 15» the obtained materials were processed by the method of mathematical statistics (EXCEL) [10].

3. Results and discussion

We determined the following statistical indicators after performing mathematical data processing for both research years (table 1). The most stable elements of the crop structure were the weight of 1000 grains and the number of spikelets per ear, the variation of both indicators was 15 %. However, the values of these signs in fact have a positive response to the intensification, the variability range for the mass of 1000 grains was 16 grams in our studies. The difference between the number of spikelets in the ear is also able to vary by backgrounds and previous crops twice, from 7 spikelets to 14. The remaining elements were subject to even greater variability: from 33% varied the weight of grain per ear and up to 36% the number of plants surviving to harvest per m². All this is reflected in the variability of crop yield
by year, previous crops and background, Cv is 43%. In physical weight the difference between the most productive option and the extensive background of cultivation was 3.5 t/ha. At the same time, in general, the variation in the yield value for the previous grain with intensification is 34% greater than for fallow. In this connection, we concluded that the most predicted yield is for fallow than for the previous grain.

Table 1. The role of plant protection products and fertilizers in the formation of the crop structure and variety productivity.

| Statistical indicators | number of plants, m² | number of productive stems, m² | number of spikelets per ear, pcs | number of grains per ear, pcs | weight of ear grains, g | weight of 1000 grains, g | yield t/ha |
|------------------------|----------------------|-------------------------------|---------------------------------|-------------------------------|------------------------|--------------------------|------------|
| **Previous grain**     |                      |                               |                                 |                               |                        |                          |            |
| x                      | 192                  | 282                           | 10.7                            | 22                            | 0.7                    | 30                       | 1.8        |
| lim                    | 88-259               | 96-392                        | 7-14                            | 12-29                         | 0.3-1.1                | 22-38                    | 0.5-2.9    |
| V, %                   | 28                   | 34                            | 22                              | 28                            | 43                     | 19                       | 54         |
| **Previous fallow**    |                      |                               |                                 |                               |                        |                          |            |
| x                      | 327                  | 403                           | 11                              | 24.3                          | 0.8                    | 35                       | 3.3        |
| lim                    | 199-429              | 218-525                       | 10-12                           | 19-32                         | 0.6-1.2                | 32-39                    | 2.1-4.0    |
| V, %                   | 23                   | 28                            | 5                               | 16                            | 23                     | 6                        | 20         |
| **Both previous crops**|                      |                               |                                 |                               |                        |                          |            |
| x                      | 260                  | 342                           | 11                              | 23                            | 0.8                    | 32                       | 2.6        |
| lim                    | 88-429               | 96-525                        | 7-14                            | 12-32                         | 0.3-1.2                | 23-39                    | 0.5-4.0    |
| V, %                   | 36                   | 35                            | 15                              | 22                            | 33                     | 15                       | 43         |

**Figure 1.** Indicator’s analysis of the factors influence strength on productive bushiness, %.
According to the analysis of variance, the differences between the productive stem and the control for the previous crop are not statistically significant (p > 0.05). The situation is the opposite for the background variants - the differences are statistically significant (P=0.0004), and when the background and the previous crop interact, P= 0.00001. The background contribution to the variability of productive bushiness is 14 %, and the background-previous crop interaction is 19 % (figure 1).

![Figure 2](image)

**Figure 2.** Indicator’s analysis of the factors influence strength on the number of spikelets in the ear, %.

The analysis of the influence strength indicators (the ratio of the factorial variance to the total, expressed as a percentage) showed that the number of spikelets in an ear was determined by the previous crop by 5%, by intensification by 8%, by the interaction of the «Background» and «Previous crop» factors by 37 %, by other (random, not taken into account) factors by 58 % (figure 2). The significance of the differences is confirmed by the value of P = 2.34E-13.

Statistically significant (p<1.24E-07) differences in the number of grains in the ear of spring soft wheat «Novosibirskaya 15» were found between the studied previous crop, the indicator of the influence strength was 17 %. The interaction of the «Previous crop x Background» factors is 13 % with P-Value of 0.0008.

**Table 2.** Dispersion analysis of the influence «Previous crop» and «Background» factors on the grain mass in the ear.

| Source of variation | SS            | MS            | P-Value        | F critical          |
|---------------------|---------------|---------------|----------------|---------------------|
| Previous crop       | 2.117076114   | 2.117076114   | 4.83246E-08    | 3.916324541        |
| Background          | 1.2295959     | 0.20493265    | 0.005096357    | 2.171308818        |
| Interaction         | 3.581492186   | 0.596915364   | 1.29363E-08    | 2.171308818        |
| Inside              | 7.9050654     | 0.062738614   | -              | -                   |
| Total               | 14.8332296    | -             | -              | -                   |

The indicators analysis of the influence strength in the studied intensification elements showed that the grain weight of one ear was determined by the previous crop by 14%, by the intensification by 8%, by the interaction of the factors «Background» and «Previous crop» by 23%. Other, unaccounted factors are involved in the formation of this value by 55%.
4. Conclusions
Based on the conducted studies, the following conclusions were made that the yield of the zoned soft spring wheat variety «Novosibirskaya 15» on the previous grain was 1.8 t/ha on average. It was more variable depending on the background (Cv 54 %): the range of its variability was from 0.5 to 3.0 t/ha. The productivity of the studied variety on the previous fallow was 3.0 t/ha, with a range of trait variability from 2.0 to 4.0 t/ha (Cv 20 %). The most stable indicators for the research years were the number of spikelets per ear and the mass of 1000 grains with a variation of 15 %. The average value of the first was 11 pieces, and the second was 33 grams.

The influence analysis of the studied intensification elements on productivity showed that the grain weight of one ear was determined by the previous crop by 14%, by the intensification by 8 %, and by the interaction of the «Background» and «Previous crop» factors by 23%. Other, unaccounted factors are involved in the formation of this value by 55%. The number of spikelets in an ear was determined by the previous crop by 5%, by intensification by 8%, by the interaction of the «Background» and «Previous crop» factors by 37 %, and by other (random) factors by 58 %. The significance of the differences is confirmed by the value of P = 2.34E-13.

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