Variability of productivity elements in spring wheat as a result of farming intensification

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Abstract: The article describes the influence of different cultivation backgrounds on the yield structure and productivity in soft spring wheat of the zoned variety «Svirel» in the steppe of the Krasnoyarsk territory. It was found that the productive tillering and grains number in the ear from the crop structure elements in spring wheat variety «Svirel» had the best reaction to the using of fertilizers and chemical protection. The maximum average yield increase was observed when wheat was sown on a fertilized background with using of a full range of plant protection products, the minimum after previous grain without using of intensification agents.

1. Introduction
Grain production in many countries of the world, including the Russian Federation, plays a strategic and system-forming role and is the largest sphere of agricultural production. It acts as the main factor for ensuring national and food security of Russia and is a strategically reproducible product of self-sufficiency and trade, the main condition for sustainable development of agriculture and agro-industrial production in general [1].

With fairly high wheat production for food purposes there is shortage of high-quality grain in Russia. The decrease in the commercial grain quality is expressed in the share decreasing of the upper classes and in the share increasing of the 3rd and 4th classes. The increasing in yield and gross grain production depends on the availability with seeds of high reproductions along with the improvement of cultivation technologies.

Existing technologies for agricultural crops cultivation are calculated on the average indicators of natural conditions and technical and resource support. Going beyond these conditions puts the farmer in difficulty with the alternative choice in specific production situations [2]. Therefore, improving cultivation technology of spring wheat with the use of new recommended and promising varieties, the latest means of chemization and optimal doses of fertilizers for the planned yield is certainly necessary. To realize the productivity potential of spring wheat varieties fully and improve the quality of seeds scientific research is needed about seeds using of the first reproductions, rational use of mineral fertilizers, optimization in plant protection, etc. [3].

In connection with the above, the complex impact analysis of the previous crops, fertilizers and pesticides on the yield of spring wheat variety «Svirel» recommended to producers in the steppe of the Krasnoyarsk territory is certainly relevant.
The research was aimed at the following: to establish the most cost-effective technology elements in cultivation of soft spring wheat «Svirel» providing high yields in the steppe zone of the Krasnoyarsk territory.

For achieving this aim we need to solve the following tasks:

- to study the resulting crop structure of spring wheat variety «Svirel» depending on nutrition, previous crops and pesticides backgrounds;
- to establish previous crops, mineral nutrition and modern plant protection products role in the yield formation of spring wheat variety «Svirel»;
- to identify and recommend more effective background for maximum yield in the cultivation of spring wheat variety «Svirel» for production in the steppe zone of the region.

2. Methods and results

For implementing these tasks experience was set at state variety testing site «Minusinskoe» on the territory of the base enterprise "Rus +" in the Minusinsk district of the Krasnoyarsk territory in 2017. As a previous crop grain was chosen as one of the most commonly used by agricultural producers. The soil of the experimental site was southern medium-humus chernozem. After the preliminary soil analysis for nutrient availability sowing was carried out in the first decade of May with a selection seeder SS-11 "Alpha", seeding rate was 4.5 million grains/ha, method of sowing was ordinary, seeding depth was 4 cm. Before sowing all seeds were treated with protectant «Lomador» 0.15 l/t. The total area of the plot was 12 m², accounting area was 10 m², repeat seeding was fourfold, and the method of plots placing was randomized. NPK soil analysis showed very high and high content of P and K and low content of N, in this regard, ammonium nitrate (34.4 %) was used as a fertilizer in the physical weight of 250 kg/ha for programmable yield of 50 c/ha.

Fungicides, herbicides and insecticides were used as means of protection during the growing season: Puma Super 100 0.6 l/ha; Prozaro Quantum 0.6 l/ha; Detsis 0.125 l/ha, as well as Ultromag Profi 2 l/ha was added to the tank mixture to reduce stress in plants during pesticide treatment. Harvesting was carried out in the third decade of August.

In 2017 the meteorological conditions of May, June and August were similar to the average annual data in terms of their hydrodynamic characteristics. June was not much warmer than usual, so the hydrothermal coefficient exceeded the average slightly. These hydrothermal coefficient dimensions are characteristic for the arid steppe. In July precipitation fell twice as much as the average annual value and the heat and moisture conditions were 2.0 of hydrothermal coefficient which is typical for an excessively wet zone. The value of the hydrothermal coefficient in August 2017 was typical for a moderately humid zone (table. 1).

| Indicators                          | May   | June  | July  | August |
|------------------------------------|-------|-------|-------|--------|
| Average daily temperature, °C (2017) | 12.4  | 20.5  | 19.6  | 16.8   |
| Temperature, °C - long-term average | 11.4  | 17.5  | 19.8  | 17.3   |
| The amount of precipitation, mm (2017) | 44    | 54    | 125   | 77     |
| Precipitation, mm-annual average   | 39    | 54    | 69    | 65     |
| The hydrothermal coefficient (2017) | 1.0   | 0.8   | 2.0   | 1.5    |
| The hydrothermal coefficient long-term average | 1.1  | 1.0   | 1.3   | 1.2    |

After the experiments we obtained the following results (table 2).

The analysis of the obtained results showed that almost all crop structure elements had a tendency to grow when using intensification means. Especially productive tillering distinguished in this with increasing by more than 35 % and the grains number in the ear with progress of 25 %.
**Table 2.** The role of cultivation backgrounds in the yield structure formation of the variety «Svirel» in the steppe of the Krasnoyarsk territory.

| Previous grain | The number of plants, thousand pieces/ha | Productive Tillering | The number of spikelets per spike, piece. | The number of grains Per spike, number | Weight of grains in spikelet, g | Weight of 1000 grains, g | Yield, t/ha |
|----------------|-----------------------------------------|-----------------------|------------------------------------------|--------------------------------------|-------------------------------|---------------------|------------|
| Control        | 2.3                                     | 1.2                   | 12                                       | 22                                   | 0.75                          | 34                  | 20.4       |
| Pesticides     | 2.4                                     | 1.4                   | 12                                       | 23                                   | 0.89                          | 39                  | 29.8       |
| NH₄NO₃         | 1.6                                     | 1.8                   | 14                                       | 29                                   | 1.05                          | 36                  | 29.6       |
| NH₄NO₃ + Pesticides | 2.2                                     | 1.9                   | 14                                       | 27                                   | 1.05                          | 39                  | 44.3       |
| The scope of the trait variability | 1.6-2.4                                | 1.2-1.9               | 12-14                                    | 22-29                                | 0.75-1.05                    | 34-39               | 20.4-44.3  |
| Average        | 2.1±0.6                                 | 1.6±0.5               | 13±1.8                                   | 25±5.3                               | 0.94±0.2                     | 37±3.9              | 31±15.7    |

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Considering this zoned variety yield it was noted that applied separately intensification elements played a role in productivity increasing equally: with the introduction of ammonium nitrate the crop yield was 29.6 c/ha, and with the use of pesticides 29.8 c/ha. The complex application of fertilizers and pesticides was the most productive, the yield compared to the control increased by more than 2 times (figure 1).

![Figure 1. Yield variation of soft spring wheat on cultivation backgrounds, c/ha.](image)

Applying for statistical processing pairwise two-sample t-test method for mean values we found significant differences between the number of plants million piece/ha and yield at P=0.01, between grain yield and productive tillering at P=0.008, and significant differences between productivity, number of spikelets per spike and grain weight of spike at P of 0.02 and 0.008 respectively (table 3).
Statistically significant (p<0.05) differences were found between the studied backgrounds in the average yield of spring soft wheat «Svirel» (at 7.9644 E-12), the index of influence strength was 78.1 
\%. The maximum average yield increase was observed when sowing wheat on a fertilized background with the use of a full range of plant protection products (44.3 c/ha), the minimum (20.4 c/ha) - on previous grain without intensification.

**Table 3.** Dispersion analysis results in intensification influence of cultivation background on spring wheat productivity in the steppe of the Krasnoyarsk territory.

| Source of variation | SS     | df | MS      | F          | P-Value | F critical |
|---------------------|--------|----|---------|------------|---------|------------|
| Among backgrounds   | 4611.694 | 6  | 925,7959143 | 55,83888284 | 7.9644E-12 | 2,5727     |
| Inside backgrounds  | 745,7304 | 21 | 16,57977143 | -         | -        | -          |
| Total               | 5902,951 | 27 | -       | -         | -        | -          |

From the data of table 4 it can be seen that the variety yield with a grain background is 20.4 c/ha and it is lower than twice after previous grain with the use of a full complex of intensification-44.3 c/ha. At the same sale price of 850 rubles per hundredweight income was received, which varied from 17340 rubles per hectare to 37655 rubles.

**Table 4.** Estimation of economic efficiency of wheat variety «Svirel» at different cultivation backgrounds.

| Indicators               | Background                  | grain | grain + NH₄NO₃+ plant protection products |
|-------------------------|-----------------------------|-------|------------------------------------------|
| Yield, c/ha             | 20,4                        | 44,3  |
| Sale price of 1 centner, RUB. | 850,0                      | 850,0 |
| Proceeds from sale, RUB. | 17340,0                    | 37655,0 |
| Costs per 1 ha, RUB.    | 12593,6                     | 25527,8 |
| Cost price of 1 centner, RUB. | 617,3                      | 576,2 |
| Profit per 1 centner, RUB. | 232,7                      | 273,8 |
| Level of profitability, % | 37,7                       | 47,5  |

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The level of grain background profitability is high and is 37.7 
\%, but when applying a full complex of intensification on the grain background, the level of profitability increases even more and becomes equal to 47.5 
\%.

Thus, based on the obtained data, it can be said that in the production of soft spring wheat of variety «Svirel» in the conditions of the Minusinsk forest-steppe pesticides and fertilizers should be used since the grain yield and the level of production profitability with their introduction increases.

3. **Conclusions**

On the basis of the conducted research it was established that:

1. The productive tillering and grains number in the ear from the crop structure elements in spring wheat variety «Svirel» had the best reaction to the using of fertilizers and chemical protection, their value varied from 1.2 to 1.9 and from 22 to 29 grains respectively
2. Statistically significant (p<0.05) differences were found between the studied backgrounds in the average yield of spring soft wheat «Svirel» (at 7.9644 E-12), the index of influence strength was 78.1 %.

3. The maximum average yield increase was observed when sowing wheat on a fertilized background with the use of a full range of plant protection products (44.3 c/ha), the minimum (20.4 c/ha) - on previous grain without intensification (control).

References
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