Responsiveness of spring wheat to the use of chemicals

V V Keler, O V Martynova, A A Demeneva and N V Shram
Krasnoyarsk State Agrarian University, 90, Mira Avenue, Krasnoyarsk, Russia

E-mail: vica_kel@mail.ru

Abstract. Increase in grain production in the Krasnoyarsk Territory is possible with the use of three intensification factors in wheat cultivation technology – intensive varieties, increased doses of fertilizers and intensive protection. The fulfillment of these conditions makes a huge contribution to obtaining a high grain yield of excellent quality. In the conditions of agricultural intensification, with the increase in the chemical’s usage prospects for more complete potential realization of spring wheat for the formation of high yields and improving the quality of grain are opening up. The article considers the reaction of the varieties «Novosibirskaya 15», «Novosibirskaya 29», «Novosibirskaya 41» and «Altayskaya 75» to the intensification of cultivation technology. The response of the most popular spring wheat varieties to the use of nitrogen fertilizer, as well as to the introduction of herbicide, fungicide and insecticide in its crops was studied. Methods of mathematical statistics determine the degree of variation in the crop structure, as well as its amount in the above varieties of spring soft wheat after the use of pesticides and fertilizers. It is established that with financial tension in the farms of this zone, it is possible to make a choice in favor of the use of pesticides to control the number of pathogens and weeds in the phytocenosis.

1. Introduction
The variety remains the main and most effective means of productivity and yield increasing, quality, sustainability and, ultimately, the competitiveness of production [1]. New varieties are able to use moisture, elements of mineral nutrition and other factors of plant life in comparison with previously zoned ones fully. However, there are no universal varieties that are equally suitable for all backgrounds and conditions [2]. Therefore, the identification of the productivity potential, the reaction norms of new varieties to the factors of intensification in modern conditions of climate change is the most important condition for the development of varietal technologies, improving methods of managing the productivity of grain crops [3].

In our time there is a very urgent need to study the influence of various previous crops [4], plant protection products, as well as mineral nutrition on the quality and yield of grain [5]. Therefore, the purpose of this study was as well as the study of previous crops intensification in the formation of productivity and crop structure in spring wheat varieties «Novosibirskaya 29», «Novosibirskaya 41», «Novosibirskaya 15» and «Altayskaya 75» in the sub-taiga zone of the Krasnoyarsk Territory.

2. Materials and methods
The experimental part of the work was carried out on the basis of LLC ”Mokriy Elnik” of the Dzerzhinsk district in the Krasnoyarsk Territory in 2018-2019. Soft spring wheat varieties «Novosibirskaya 29», «Novosibirskaya 41», «Novosibirskaya 15» and «Altayskaya 75», included in State Register of
Selection Achievements in the Russian Federation and allowed for cultivation in the Krasnoyarsk Territory, were considered as objects of research.

LLC "Mokriy Elnik" where the experience was laid is located in the subtaiga zone of the Krasnoyarsk Territory. The seeds were sown on the 20th of May with a rate of 6.0 million germinating grains per hectare after mandatory pre-sowing treatment with protectant «Oplot» at working fluid consumption of 10 l/t. The soil was gray forest, the total area of the plot was 12 m², the accounting area was 10 m², and the repetition was fourfold. The results of the soil analysis: the reaction of the pH medium of the salt extract was 6.0, the supply of nitrate nitrogen was low (7.2 mg/kg), of mobile phosphorus was high (244.0 mg/kg) and of exchange potassium was high (266 mg/kg). As a fertilizer, based on the results of agrochemical analysis ammonium nitrate (34.4%) 70 kg of the active substance per hectare was used.

During the growing season the crops were treated with modern means of protection: «Puma Super 100», suspensions 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.

Phenological observations, evaluation and accounting were carried out in accordance with the «Methodology for the state variety testing of agricultural crops». To solve the tasks set for the study the materials of field experiments and laboratory analyses were processed using mathematical statistics with the standard Excel package [6].

3. Results and discussion
After mathematical processing of the data for both research years, we determined the following statistical indicators (tables 1-4).

**Table 1.** Variability of crop structure elements of the spring wheat «Novosibirskaya 15» under the influence of different cultivation backgrounds.

| Previous fallow | productive bushiness | length of the main plant, cm | length of the main ear, cm | Number of spikelets per ear, pcs | number of grains per ear, pcs |
|-----------------|-----------------------|-------------------------------|--------------------------|---------------------------------|-------------------------------|
| control         | 1.0                   | 86.7                          | 5.8                      | 10.1                            | 15.6                          |
| plant protection products | 2.2                   | 95.9                          | 8.1                      | 11.7                            | 21.8                          |
| ammonium nitrate | 1.1                   | 96.6                          | 6.4                      | 11.4                            | 21.7                          |
| ammonium nitrate + plant protection products | 1.4                   | 86.8                          | 6.2                      | 11.4                            | 21.4                          |
| $\bar{x}$       | 1.4±0.9               | 91.5±8.7                      | 6.6±1.6                  | 11.2±1.1                        | 20.1±4.8                      |
| lim             | 1.0-2.2                | 86.7-96.6                     | 5.8-8.1                  | 10.1-11.7                       | 15.6-21.8                     |
| $V$, %          | 38                    | 6                             | 16                       | 6                               | 15                            |
Assessing the indicators variability in the harvest structure of spring soft wheat variety «Novosibirskaya 15» (table 1), we can conclude the following: the length of the main plant and the number of spikelets in the ear are the most stable (Cv 6%). These elements were not affected by the use of plant protection products and fertilizers. This is probably due to the genetic stability of this variety [7]. The length of the main ear and the number of grains in the ear are subject to greater variation (15-16%). The greatest variability was observed in productive bushiness, it was at the level of 38% with an average value of 1.4. The use of a full range of plant protection products increases the productive bushiness of variety «Novosibirskaya 15» twice.

Table 2 shows that the variety «Altayskaya 75» has the greatest stability (Cv 2-6%) in such indicators as the length of the main plant and the length of the main ear, these elements were not affected by the use of plant protection products and fertilizers. The number of spikelets per ear and productive bushiness are characterized by high variation (17-21%). The intensification of the previous crop can increase the number of spikelets by 6 pieces on average. This is also confirmed by scientific data [8]. High variability was observed in the number of grains in the ear, it was at the level of 28%, with an average value of 29.8.

**Table 2.** Variability of crop structure elements of the spring wheat «Altayskaya 75» under the influence of different cultivation backgrounds.

| Previous fallow                              | productive bushiness | length of the main plant, cm | length of the main ear, cm | number of spikelets per ear, pcs | number of grains per ear, pcs |
|----------------------------------------------|----------------------|-------------------------------|---------------------------|----------------------------------|-------------------------------|
| control                                      | 1.2                  | 102.9                         | 8.3                       | 10.5                             | 17.1                          |
| plant protection products                    | 1.8                  | 100.8                         | 9.4                       | 16.2                             | 33.8                          |
| ammonium nitrate                            | 1.2                  | 99.2                          | 8.5                       | 13.7                             | 34.8                          |
| ammonium nitrate + plant protection products | 1.6                  | 102.7                         | 8.9                       | 14.6                             | 33.4                          |
| \( \bar{x} \)                               | 1.5±0.5              | 101.4±2.8                     | 8.8±0.8                   | 13.8±3.8                         | 29.8±13.5                     |
| lim                                          | 1.2-1.8              | 99.2-102.9                    | 8.3-9.4                   | 10.5-16.2                        | 17.1-34.8                     |
| V, %                                         | 21                   | 2                             | 6                         | 17                               | 28                            |

It should be noted that the introduction of plant protection products and ammonium nitrate, both individually and in combination, increases the value of this indicator twice, and accordingly, the productivity of this variety. Such conclusions are confirmed in scientific sources [9, 10]. Also, the productive bushiness is subject to high variability in «Altayskaya 75», this element can be increased by applying plant protection products in 0.6 units.

The variety «Novosibirskaya 29» showed the following results (table 3): the number of spikelets in the ear and the length of the main plant have the greatest stability (Cv 3-4%). The length of the main ear and the number of grains in the ear (8-11%) are also relatively stable. The variability of the productive
bushiness in this variety was at the level of 27%, with an average value of 1.7. Using a complex of insecticides, fungicides and herbicides on crops of spring wheat variety «Novosibirskay 29», you can increase the productive bushiness by one and get two inflorescences on the plant instead of one.

**Table 3.** Variability of crop structure elements of the spring wheat «Novosibirskaya 29» under the influence of different cultivation backgrounds.

| Previous fallow                  | productive bushiness | length of the main plant, cm | length of the main ear, cm | number of spikelets per ear, pcs. | number of grains per ear, pcs |
|----------------------------------|-----------------------|------------------------------|-----------------------------|----------------------------------|-----------------------------|
| control                          | 1.2                   | 92.5                         | 6.9                         | 12.4                             | 19.4                        |
| plant protection products        | 2.2                   | 100.2                        | 8.2                         | 12.7                             | 25.1                        |
| ammonium nitrate                 | 1.4                   | 95.1                         | 8.2                         | 11.9                             | 22.1                        |
| ammonium nitrate + plant protection products | 1.8                   | 98.1                         | 8.1                         | 12.7                             | 23.2                        |
| **x̄**                           | 1.7±0.7               | 96.5±5.4                     | 7.9±1.0                     | 12.4±0.6                         | 22.5±3.8                    |
| **lim**                          | 1.2-2.2               | 92.5-100.2                   | 6.9-8.2                     | 11.9-12.7                        | 19.4-25.1                   |
| **V, %**                         | 27                    | 4                            | 8                           | 3                                | 11                          |

Analyzing the indicators variability in the yield structure of spring soft wheat variety «Novosibirskay 41» (table 4), we can draw conclusions about the similarity of their variation with the previous varieties taken for research. The most constant elements were the length of the main plant and the length of the main ear; these parameters were not affected by the use of plant protection products and fertilizers (Cv 5-7%). The business was characterized by greater variation (14%) (increase from plant protection products is 0.5). The variability of the number of grains in the ear was at the level of 19%, with the value in the control of 21 pieces. The use of intensification can increase the number of grains in the ear by 10 pieces in this case.

**Table 4.** Variability of crop structure elements of the spring wheat «Novosibirskaya 41» under the influence of different cultivation backgrounds.

| Previous fallow                  | productive bushiness | length of the main plant, cm | length of the main ear, cm | number of spikelets per ear, pcs. | number of grains per ear, pcs |
|----------------------------------|-----------------------|------------------------------|-----------------------------|----------------------------------|-----------------------------|
| control                          | 1.2                   | 95.1                         | 7.9                         | 12.8                             | 21.2                        |
| plant protection products        | 1.7                   | 104.5                        | 9.2                         | 14.3                             | 30.2                        |
| ammonium nitrate                 | 1.4                   | 93.1                         | 8.1                         | 12.9                             | 23.5                        |
| ammonium nitrate + plant protection products | 1.4                   | 100.8                        | 8.8                         | 15.3                             | 31.7                        |
4. Conclusions
The use of a complex of modern protection means with the simultaneous use of nitrogen fertilizers in the sub-taiga zone of the Krasnoyarsk Territory shows almost the same results in productivity in the studied varieties of soft spring wheat, as well as the use of plant protection products without fertilizers. Therefore, with financial tension in the farms of this zone, it is possible to make a choice in favor of using only pesticides to control the number of pathogens and weed vegetation in the phytocenosis.

References
[1] Khizhnyak S V and Keler V V 2019 IOP Conf. Ser.: Earth Environ. Sci. 315 052001
[2] Keler V V 2013 The role of environmental conditions in the yield formation of spring barley in the Kansk forest-steppe Bulletin of KSAU 7 86-8
[3] Zulfiqar U, Hussain S and Ishfaq M 2021 Manganese supply improves bread wheat productivity, economic returns and grain biofortification under conventional and no tillage systems Agriculture 11 142
[4] Keler V V 2007 Ecological and Varietal Features of Technological Qualities Formation of Spring Wheat in Forest-steppe of the Krasnoyarsk Territory (Krasnoyarsk: Krasnoyarsk state agrarian university) p 123
[5] Keler V V and Martynova O V 2019 IOP Conf. Ser.: Earth Environ. Sci. 421 062029
[6] Khizhnyak S V and Puchkova E P 2019 Mathematical Methods in Agroecology and Biology: Training Manual (Krasnoyarsk: Krasnoyarsk state agrarian university) p 244
[7] Ghosh D et al. 2021 Conservational tillage and weed management practices enhance farmers income and system productivity of rice–wheat cropping system in Central India Agric. Res.
[8] Nawaz M, Anjum S A, Ashraf U, Khan I, Hussain S, Zohaib A, Hubiao Y and Zhiyong W 2020 Assessment of cropping system productivity, profitability and economic efficiency of wheat Journal of animal and plant sciences 30(2) 467-74
[9] Russell B, Guzman C and Mohammadi M 2020 Cultivar, trait and management system selection to improve soft-red winter wheat productivity in the Eastern United States Frontiers in plant science 11
[10] Sharma N, Kumar A, Sharma B, Chand L, Sharma V and Kumar M 2020 Effects of sowing dates and weed management on productivity of irrigated wheat (Triticum aestivum) Indian journal of agricultural sciences 90(3) 556-9