Sowing time and seeding rate in the new wheat varieties cultivation for seeds

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Abstract. The most effective agricultural techniques in the production of high-quality and productive seeds of wheat varieties are the sowing time and seeding rate. The results of the study showed that the best time for new varieties of wheat in the conditions of 2019-2020 is sowing on May 25 with a seeding rate of 5.5 million viable grains per hectare. In terms of yield, the promising variety Beiskaya surpassed the zoned variety Krasnoyarskaya 12 in all variants by 0.1-0.3 t/ha. The response of varieties to seeding rates is more noticeable at a late sowing period: the difference in yield in thinned and thickened crops was 0.4 t/ha, while at an early date - 0.2 t/ha. Indicators of the parameters of the elements of the structure of yield (weight of 1000 grains, grain content of an ear, productive stalk) increased with a late sowing period. Analysis of variance of wheat varieties by yield revealed that this indicator significantly depended on the sowing time - 54%, seeding rates - 22%, as well as on the hereditary characteristics of the studied forms - 14%. The seed multiplication factor (the ratio of the mass of harvested seeds to the mass of sown seeds) was 20-22 at a seeding rate of 3.5 million germinating grains per hectare for both varieties and 12-14 at a seeding rate of 5.5 million germinating grains per hectare; the reduced seeding rate allows you to get an additional 4-6 tons of seeds.

1. Introduction
Among the many technological processes that affect the formation of yield and sowing qualities of seeds, the most significant and controlled methods are the sowing time and rates of seeding, which affect the entire complex of plant growth and development at all stages of organogenesis [1].

The early maturity of the variety, culture makes it possible to sow both early and late. Generalization of science and practice show that the choice of the optimal sowing time increases the yield, seed evenness, sowing quality and sometimes reduces the total duration of the growing season by 5-7 days [2,3].

Creation of favorable conditions (sowing time, seeding rates, fertilizer systems and chemical plant protection products) for varieties of grain crops allows to some extent to protect the dependence of plants from unfavorable factors and to form high-quality grain [4, 5].

With a decrease in the seeding rate of seeds, the multiplication factor increases (the ratio of the mass (number) of harvested seeds to the mass (number) of sown seeds). Due to the larger area sown with a reduced seeding rate, you can get an additional amount of seeds of scarce and promising varieties [6].

The aim of the research was to develop elements of seed technology (sowing time and seeding rates) for the cultivation of new varieties of spring wheat, providing an increase in the yield of high-quality seeds by 20-30%. 

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For the first time in the conditions of the Krasnoyarsk Territory, agrotechnical measures (sowing time, seeding rates) were studied, aimed at identifying the potential productivity of new and promising varieties of wheat.

The relevance of this problem is determined by the current state of agricultural production, science and the development of new varieties that require recommendations for cultivation for seeds.

2. Research methods

The experiments were carried out on the fields of a separate subdivision "Krasnoyarsk Agricultural Research Institute, village Minino ", according to the Methodological Recommendations for the production of seeds of the elite of grain, leguminous and cereal crops [7]. As objects of research, we used wheat varieties Krasnoyarskaya 12, entered in the State Register for cultivation in the Krasnoyarsk Territory, and a promising variety Beiskaya, which is undergoing state variety testing. Both varieties are mid-season.

Fallow is the predecessor. The soil of the test plot is represented by leached chernozem, thin, heavy loamy. The accounting area of the plots is 10 sq. m., threefold repetition [8]. The weather conditions for the growing season of 2019 in terms of the amount of heat and precipitation were established at the level of average annual, and this had a favorable effect on the growth and development of plants. The conditions of 2020 were characterized by sufficient moisture in all months. In June, July, August - their number was higher by 53.3, 83.6 mm and 36 mm in comparison with the long-term average values. The amount of heat was sufficient throughout the entire period of plant development.

Statistical data processing was carried out using the SNEDECOR software package.

The study of the influence of seeding rates and sowing dates on the yielding and sowing qualities of wheat seeds of varieties Krasnoyarskaya 12 and Beyskaya was carried out according to the following scheme:

- seeding rate of 3.5 million germinating grains per hectare, sowing on May 17 and 25;
- seeding rate of 4.5 million germinating grains per hectare, sowing on May 17 and 25;
- seeding rate of 5.5 million germinating grains per hectare, sowing on May 17 and 25.

3. Results and discussion

The yield of wheat varieties significantly depended on the sowing time - 54%, seeding rates - 22%, as well as on the hereditary characteristics of the studied forms - 14% (Table 1).

Table 1 Multifactorial variance analysis of wheat varieties by yield.

| Source of variation | Sum of squares | Variation share | Fisher criterion | Least Significant Difference (LSD) (5%) |
|---------------------|----------------|-----------------|-----------------|--------------------------------------|
| C*                  | 34.160         | 0.54            | 22.12           | 0.17                                 |
| B **                | 0.115          | 0.22            | 2.940           | 0.54                                 |
| BC                  | 0.399          | 0.008           | 1.224           | 0.48                                 |
| A***                | 6.812          | 0.14            | 41.84           | 0.27                                 |
| AC                  | 0.077          | 0.001           | 0.470           | 0.39                                 |
| AB                  | 0.195          | 0.004           | 0.598           | 0.48                                 |
| ABC                 | 0.098          | 0.002           | 0.302           | 0.67                                 |

* - sowing time; ** - seeding rate; *** - variety

The yield of both wheat varieties (table 2) increased in the second sowing period compared to the first: in Krasnoyarskaya 12 by 1.1-2.1 t / ha, in Beiskaya by 1.0-1.2 t / ha, respectively. At the same time, the new variety exceeded the zoned one in all variants by 0.2-0.3 tons.
Table 2 The influence of sowing dates and seeding rates on the yield of new varieties of wheat, 2019-2020.

| Variety          | Seeding rate, mln | Yield, t/ha | Reproduction factor |
|------------------|-------------------|-------------|---------------------|
|                  | I*     | II**    | I*     | II**    |
| Krasnoyarskaya 12| 3.5    | 3.27    | 4.37    | 20      | 21      |
|                  | 4.5    | 3.37    | 4.48    | 17      | 19      |
|                  | 5.5    | 3.57    | 4.43    | 12      | 14      |
|                  | 3.5    | 3.49    | 4.55    | 20      | 22      |
| Beiskaya         | 4.5    | 3.47    | 4.68    | 16      | 18      |
|                  | 5.5    | 3.67    | 4.75    | 12      | 14      |

LSD0.5 sowing time (A) – 0.3; LSD0.5 seeding rate (B) – 0.3; LSD0.5 variety(C) – 0.2

* sowing time May 15; ** sowing time May 25

The response of the varieties to the seeding rate depended on the sowing time as follows. With early sowing, the yield varied from 3.27 t / ha with 3.5 million germinating grains per hectare to 3.67 t / ha with 5.5 million germinating grains per hectare, with late sowing from 4.37 t / ha to 4.75 t / ha, respectively. Differences in yield in sparse and thickened crops, at an early date, are 0.2 t, while at a later date, they are more noticeable - 0.4 t / ha near Beiskaya and 4.43 t / ha near Krasnoyarskaya 12.

In addition to yield, an important characteristic is the seed multiplication factor (the ratio of the mass of harvested seeds to the mass of sown seeds). In our studies, this indicator depended on the seeding rate in both varieties and the highest value was at 3 million germinating grains per hectare - 20-22, while at 5 million germinating grains per hectare - 12-14. With a higher multiplication factor, an additional 4-6 tons of seeds can be obtained.

Sowing indicators of seed quality are the mass of 1000 grains and germination, which are subject to certain variability under the influence of growing conditions.

In research 2019-2020, under conditions of sufficient moisture supply at a late sowing period, the weight of 1000 grains increased in comparison with the early one by 1-2 grams in both varieties (table 3). In sparse crops, this indicator formed 0.8-1.3 grams higher than in thickened crops (within the NSR). The tillering period coincided with heavy rainfall, which caused the equalization of the mass of 1000 grains at different seeding rates.

Under the conditions of the year, the grain turned out to be full, large with the largest mass in the variant with a seeding rate of 3.5 million germinating grains per hectare in the second sowing period in both varieties. Beiskaya has 1000 grains more than Krasnoyarskaya 12 by 1.2-1.5 grams at a seeding rate of 3.5 million germinable grains per hectare.

Table 3. Sowing time and seeding rates per 1000 grain weight and germination of new wheat varieties, 2019-2020.

| Variety          | Seeding rate, mln. | Weight of 1000 grains, g | Germination rate, % |
|------------------|--------------------|--------------------------|---------------------|
|                  | I      | II     | I      | II     |
| Krasnoyarskaya 12| 3.5    | 38.3   | 39.1   | 92     | 90     |
|                  | 4.5    | 37.5   | 39.6   | 95     | 93     |
|                  | 5.5    | 37.1   | 39.1   | 98     | 98     |
| Beiskaya         | 3.5    | 39.5   | 40.6   | 90     | 90     |
|                  | 4.5    | 38.5   | 39.2   | 94     | 92     |
|                  | 5.5    | 38.5   | 39.3   | 95     | 92     |
Weight of 1000 grains: LSD$_{0.5}$ sowing time (A) – 1.2; LSD$_{0.5}$ seeding rates (B) – 1.3; LSD$_{0.5}$ variety (C) – 1.2

Germination rate LSD$_{0.5}$ sowing time (A) – 2.0; LSD$_{2.0}$ seeding rates (B) – 2.0; LSD$_{2.0}$ variety (C) – 2.0

* sowing time May 17; ** sowing time May 25

Seed germination of wheat varieties, in general, high, did not depend on the variety and sowing time, but in sparse crops it decreased by 3-5%.

In the conditions of the Krasnoyarsk forest-steppe, significant fluctuations in the indicators of the elements of the yield structure are possible, depending on the seeding rate, sowing time, weather conditions, and the predecessor.

An increase in productive stalk (table 4) was noted in the second sowing period in both wheat varieties at all seeding rates: from 285 to 354 pcs / m$^2$ at Krasnoyarskaya 12 and from 288 to 320 pcs / m$^2$ at Beiskaya and increased with an increase in seeding rates. In all variants, the number of productive stems is higher in the Beyskaya variety. Obviously, it was this indicator that influenced the yield of varieties.

The number of grains per ear can vary widely under the influence of environmental factors and is closely related to the biological characteristics of the variety. In the second sowing period, the number of grains per ear was 1–3 higher than in the first sowing period and varied from 40 to 43 units regardless of the seeding rate. The largest number of grains was observed in the variant with a seeding rate of 5.5 million germinating grains per hectare in the second sowing period in both varieties (43 pcs.).

Productive tillering is one of the important indicators of the density of productive stems. In our studies, this indicator did not depend on the sowing time, variety, but changed from the seeding rate, increasing in sparse crops. The highest productive tillering (1.4) in the variant in the second period with a seeding rate of 3.5 million germinating grains per hectare was in the Krasnoyarskaya 12 variety.

**Table 4** Influence of sowing time and seeding rates on the productive plant stand of new varieties of wheat, 2019-2020.

| Variety         | Seeding rate, mln | Productive plant stand, pcs./m$^2$ | The number of grains in an ear, pcs. | Productive bushiness |
|-----------------|-------------------|-------------------------------------|-------------------------------------|----------------------|
|                 |                   | I | II   | I   | II  | I   | II  |
| Krasnoyarskaya  |                   |   |      |     |     |     |     |
| 12              | 3.5               | 244| 285  | 40  | 42  | 1.35| 1.40|
|                 | 4.5               | 281| 319  | 39  | 40  | 1.23| 1.20|
|                 | 5.5               | 293| 354  | 40  | 43  | 1.12| 1.28|
|                 | 3.5               | 261| 288  | 41  | 42  | 1.31| 1.36|
| Beiskaya        | 4.5               | 286| 299  | 42  | 42  | 1.28| 1.25|
|                 | 5.5               | 290| 320  | 41  | 43  | 1.14| 1.22|

Productive plant stand: LSD$_{0.5}$ sowing time (A) – 15; LSD$_{0.5}$ seeding rates (B) – 17; LSD$_{0.5}$ variety (C) – 17

Number of grains in an ear: LSD$_{0.5}$ sowing time (A) – 1.0; LSD$_{0.5}$ seeding rates (B) – 2.0; LSD$_{0.5}$ variety(C) – 2.0

Productive bushiness: HCP$_{0.5}$ sowing time (A) – 0.1; LSD$_{0.5}$ seeding rates (B) – 0.1; LSD$_{0.5}$ variety (C) – 0.1

* sowing time May 17; ** sowing time May 25.

**4. Conclusions**

For wheat varieties, the optimal sowing time during the years of research was the late date (May 23) with a seeding rate of 5.5 million germinating grains per hectare.
In terms of yield, the promising variety Beiskaya exceeded Krasnoyarskaya 12 in all variants by 0.1-0.3 t/ha.

Differences in yield in sparse and thickened crops, at an early time are 0.2 t/ha, while at a later time they are more noticeable - 0.4 t/ha.

Parameters indicators of the structure elements of the yield increased with a late sowing time.

Multivariate analysis of variance of wheat varieties by yield showed that this indicator significantly depended on the sowing time - 54%, seeding rates - 22%, as well as on the characteristics of the variety - 14%.

With a decrease in seeding rates to 3.5 million viable grains per hectare, the multiplication factor increases to 20-22, while at a seeding rate of 5.5 million viable grains per hectare, it is 12-14. In this regard, it is advisable to use reduced seeding rates when multiplying new varieties in the primary links of seed production.

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