The duration of the growing season for samples of spring soft wheat of Siberian selection

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Abstract. The results of field experiments on the study of the duration of the growing season and its main phases in 33 samples of Siberian selection under the conditions of the Krasnoyarsk forest-steppe showed that the variability of the interphase periods of shoots - earing and earing - waxy ripeness is largely determined by the growing conditions (31.1 and 37.4% respectively) in relation to the growing season (0.9%). The duration of the growing season is primarily determined by the genotypic characteristics of wheat samples (88.3%). The contribution to the phenotypic variability of the studied traits depends on the ripeness group. We identified wheat samples of interest for hybridization, with a longer interphase period - sprouting - earing and shortened - earing - waxy ripeness.

1. Introduction
In the forest-steppe zone of the Krasnoyarsk Territory, the duration of the growing season for spring soft wheat is a decisive indicator when recommending varieties to production, selecting a starting material for hybridization.

Varieties will not turn out to be valuable if their growing season as a whole, as well as individual growth phases, do not correspond to local natural conditions [1].

The total duration of the growing season of wheat under the conditions of the Krasnoyarsk forest-steppe reliably correlates with the duration of the germination - earing period [2]. For Eastern Siberia, wheat varieties with a longer period from germination to earing, “going away” from the spring-summer drought, and a shorter period from earing to maturation, capable of assimilating late summer precipitation, maturing at low temperatures are of interest [3, 4]. The relationship between the growing season and the yield and quantitative characteristics, as well as the definition of the ripeness group of the variety, is regional in nature [5].

To create varieties adapted to the conditions of the Krasnoyarsk forest-steppe with high yields, it is necessary to constantly replenish the source material. The purpose of our research in this work is to assess modern varieties and breeding lines of spring soft wheat of Siberian selection according to the variability of the growing season and its phases and their relationship with the yield.
2. Initial material and research methodology

Field studies were carried out in the fields of the Krasnoyarsk Research Institute of Agriculture, located on the territory of the Minino experimental production farm, 4 km. away from the city of Krasnoyarsk in 2017-2019.

The objects of the research were 33 samples of spring soft wheat of four ripeness groups: quickly ripening; mid - early; mid-ripening; mid- late. The collection includes modern varieties of Siberian breeding, promising breeding numbers created on the basis of the Krasnoyarsk Research Institute of Agriculture collection, as well as old varieties and varieties not included in the register, approved for use in production, but used by breeders in hybridization.

Sowing was carried out at the optimal time for the Krasnoyarsk forest-steppe: the second - the third decade of May, with an SSFK-7 seeder, in four repetitions with a seeding rate of 500 germinating seeds per 1m2. Plot area - 3.26 m2, registration area - 3 m2.

Experiments, records and observations were carried out in accordance with the methodology of state variety testing [6, 7].

3. Research results

During the year of the research, the average duration of the growing season for wheat samples varied from 70 to 85 days. Due to the dry conditions in the first half of the growing season, in all the years of the experiments, the difference between quickly ripening and mid-early samples was insignificant (0-3 days), which made it possible to combine them into one conditional group (figure 1).

![Figure 1. Duration of interphase periods of the quickly-ripening - mid-early group of wheat samples (2017-2019), days.](image)

The duration of the growing season for quickly ripening samples was mainly determined by the sprouting - earing interphase period ($r = 0.742 \pm 0.193$). The period of germination - tillering for all varieties of the quickly -ripening group was 18-19 days, and the period of tillering - earing - 16 - 20 days. The shortest interphase period of sprouting - earing was 33 days (Novosibirskaya 15), the longest - 37 days (Altayskaya 70, Omskaya 32). The duration of the interphase period heading - waxy ripeness is 35-37 days.

For the group of mid-ripening and mid-late samples, the amplitude of variability was 11 days: Novosibirskaya 18 (74 days) - K-626-1 (85 days) (figure 2).
Figure 2. Duration of interphase periods of the mid-ripening - mid-late group of wheat samples (2017-2019), days.

The duration of the growing season in them is in close correlation with the interphase period of seedlings - earing ($r = 0.923 \pm 0.093$) and earing - waxy ripeness ($r = 0.907 \pm 0.102$).

A longer period of sprouting - earing had breeding numbers: K-626-1, K-592-5, K-613-2 (43 days), the smallest - Omskaya 33, Omsk beauty, Novosibirskaya 18, Krasnoyarskaya 12, Veltuzhanka, Sigma 2 (38 days). The longest interphase period of earing - waxy ripeness was observed in K-626-1 (42 days), the short one - Novosibirskaya 18, K-543-2, K-524-2 (36 days).

The samples were selected that combine high productivity, a longer interphase period, sprouts - earing and shortened - earing - waxy ripeness (Table 1).

Table 1. Wheat samples of interest for selection by the ratio of interphase periods.

| Samples                  | Average yield, g/m² | Seedlings-earing days | Earing-waxy ripeness days | V.%  | V.%  |
|--------------------------|---------------------|------------------------|---------------------------|------|------|
|                          |                     | Quickly – ripening - mid-early group |                       |      |      |
| Zoryana                  | 229                 | 36                     | 35                        | 6.4  | 8.8  |
| Kanskaya                 | 229                 | 36                     | 35                        | 6.5  | 8.6  |
| Tulunskaya 12            | 272                 | 36                     | 36                        | 9.6  | 10.0 |
| Novosibirskaya 29        | 282                 | 36                     | 36                        | 9.0  | 8.3  |
| Uyarochka                | 292                 | 36                     | 36                        | 7.1  | 8.4  |
| Omskaya 32               | 301                 | 37                     | 37                        | 6.9  | 8.3  |
| Altaiskaya 70, standard (st.) | 308               | 36                     | 36                        | 8.8  | 10.0 |
| The smallest significant difference (SSD)_{st} | 13.8              | 1.4                    | 1.3                       |      |      |

| Mid-ripening group       |                     |                        |                           |      |      |
|--------------------------|---------------------|------------------------|---------------------------|------|------|
| Altaïskaya 75, st.       | 297                 | 40                     | 37                        | 6.3  | 6.7  |
| K-524-2                  | 330                 | 41                     | 36                        | 4.2  | 4.2  |
| Novosbiorskaya 18        | 336                 | 38                     | 36                        | 6.7  | 9.7  |
| K-518-4                  | 344                 | 39                     | 37                        | 6.0  | 8.1  |
The yield of wheat samples in the years under the study was largely determined by the duration of the sprouting – earing interphase period ($r = 0.814 \pm 0.079$), less earing - waxy ripeness ($r = 0.581 \pm 0.113$).

Assessment of the influence of the studied factors (genotype, growing conditions and their interaction) on the variability of the duration of the growing season made it possible to identify the greatest contribution of genetic differences between the samples (88.3%). The interaction of factors "years x genotype" accounts for 10.0%. The influence of vegetation conditions and random factors is insignificant: 0.9 and 0.8%, respectively (figure 3).

The genotypic characteristics of wheat samples (62.8%) also have a significant effect on the variability of the interphase period, seedlings - earing, the growing conditions contribute 31.1% to its variation.

Growing conditions (37.4%) and genotype (35.8%) bring approximately the same contribution into the variability of the duration of the interphase period earing - waxy ripeness. A significant proportion falls on the interaction of factors "years x genotype": 23.0%.

Significantly, by changing the duration of individual interphase periods, spring wheat samples slightly change the growing season as a whole.

![Figure 3. The share of the influence of the studied factors on the variability of the duration of the growing season and its phases,%.](image-url)

When analyzing the contribution of the studied factors to phenotypic variability according to ripeness groups, completely different results are obtained. In mid-early specimens, the main influence on the variability of the duration of the growing season is exerted by growing conditions (51.5%), especially in its interphase periods: earing - waxy ripeness (89.8%) and seedlings - earing (84.3%). The share of
the influence of the genotype on the variability is significant and decreases from the duration of the growing season (10.1%) to the interphase period, earing - waxy ripeness (2.6%).

In the formation of the duration of the growing season of mid-season samples, the most significant contribution belongs to their genotypic characteristics (72.9%). Growing conditions and the interaction of factors "years x genotype" play a much smaller role: 10.3 and 4.1%, respectively. In the variability of the duration of interphase periods, the share of the genotype decreases from the germination - earing phase (21.6%) to earing - waxy ripeness (9.9%), while the contribution of growing conditions increases significantly: 72.1 and 74.1%, respectively.

In the phenotypic variability of the duration of the growing and interphase periods of mid-late wheat samples, the main share of the influence belongs to the growing conditions (48.4 - 83.3%), primarily on the period of germination - earing (83.3%), in relation to earing - waxy ripeness (48.4%).

4. Conclusion
As a result of studying the duration of the growing and interphase periods and their correlations with productivity, the following conclusions have been drawn.

1. The share of the contribution of the studied characters (growing conditions, genotype and their interaction) to the variability of the duration of the growing and interphase periods was different for the entire group of samples and groups of ripeness. In general, the formation of the growing season is determined by the genotype (88.3%) and, to a lesser extent, by the conditions of the growing season (0.9%). In the phenotypic variability of the interphase periods, seedlings – earing and earing - waxy ripeness, the share of the influence of the genotype decreases and increases - according to the growing conditions. The interfacial period of earing - wax ripeness (37.4%) especially depends on the growing conditions.

In mid-ripening specimens, the variability of the duration of the growing season is largely determined by the genotype (72.9%), earing - waxy ripeness - by the growing conditions (74.1%). For mid-early and mid-late samples, the growing conditions are the main factor determining the duration of the growing season and its phases. But in the middle late samples, in comparison with the middle early ones, the share of the contribution of growing conditions to the variability of the interfacial period earing- waxy ripeness is much less (by 34.9%) than the seedlings - earing.

2. The duration of the growing season of early ripening wheat samples is mainly determined by the duration of the interfase period sprouting - earing (r = 0.742 ± 0.193), mid-maturing and mid-late specimens as the interfacial period sprouting - earing (r = 0.923 ± 0.093), and earing - waxy ripeness ( r = 0.907 ± 0.102).

3. The formation of the yield of Siberian wheat samples occurs mainly in the interphase period of sprouting - earing (r = 0.814 ± 0.079), earing - wax ripeness (r = 0.581 ± 0.113) contributes to a lesser extent to the yield level, which depends on hydrothermal conditions, forming during the growing season.

References
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