Variability of morphological features of spring soft wheat Moskovskaya 35

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Abstract. The variety of spring soft wheat Moskovskaya 35, zoned in 1971, is an outstanding breeding achievement. It is included in the State Register of approved varieties and recommended for the fourth region in Russia (Volga-Vyatka). In this paper, an assessment was made of the variation in the structure elements of the harvest of spring wheat variety Moskovskaya 35 depending on the growing season of the year 2014-2018 in the conditions of the southern part of the Volga-Vyatka region in Russia. A study of the morphostructural indicators of spring wheat of the variety Moskovskaya 35 for five years revealed that the most stable of those is the mass of 1000 grains (coefficient of variation – 13.1%), and the most variable is the length of the ear (coefficient of variation – 20.6%). It was found that the vegetation weather conditions for the years of testing had a strong influence on the intravarietal variability, which is confirmed by the calculation of correlations between yield and the sum of active temperatures during the vegetation period (regression coefficient – 0.92). Analysis of the coefficient of variation showed that the variety Moscovskaya 35 has good ecological plasticity, the coefficient of yield variation was 21.4%.

1. Introduction

The most important property of a variety is its potential yield. This indicator is the main factor among the selection tasks. Under natural conditions, the main breeder is nature, which has been painstakingly conducting natural selection for hundreds of years, leaving only those species of living organisms that are more adapted to the conditions of existence [1,2]. Some works pay keen attention to the study of this issue today [3]. Due to the instability of meteorological conditions, the selection on the stability of parameters affecting the productivity of a variety is of particular importance [4,5]. But the hereditarily determined yield potential cannot by itself guarantee high productivity. It depends more on the adaptability of the variety, which is part of heredity - ecological tolerance of the variety. This indicator determines the ability of a variety to use changing soil, agronomic and climatic influences [6].

The main means of studying the formation of the productivity of cultivated plant varieties is the analysis of the phenotypic variability of morphophysiological traits. Morphophysiological approaches to solving the problem of productivity are associated with the interaction of genotype and environment [7,8]. The absolute values of morphophysiological signs of productivity are not constant, but vary depending on the soil and climatic conditions. The influence of a complex of factors ensuring the development of plants during the growing season at a specific geographic point is taken into account, in particular, when repeating observations in time [8]. Biometric analysis of plants in the period of full ripeness allows us to judge the degree of development of individual elements of productivity and yield.
in general, the nature and conditions of the processes of growth and formation of organisms under specific conditions [9].

The Chuvash Republic in Russia is an agricultural region with a high proportion of spring wheat in the grain wedge of crops – 42% (as of 2018). In the structure of sown areas of spring soft wheat in the republic, Moskovskaya 35 occupies 12-14%. This variety was zoned back in the 70s, but its yield potential is quite high (57.8-60.0 centners per hectare) [10]. Due to a complex of economically valuable traits, the Moskovskaya 35 variety has quickly spread in production and remains in demand today. But the yield as a culture of spring soft wheat is subject to significant fluctuations. Therefore, the question of how strongly the elements of the crop structure of the Moskovskaya 35 variety can differ depending on the weather conditions of the vegetation period is of scientific interest and is of great importance for practical selection.

2. Materials and methods
In Chuvash Agricultural Research Institute in 2014-2018 in the process of seed production, the nature and degree of manifestation of variability of various economic and biological features of spring wheat variety Moskovskaya 35 were studied. The object of the study were plants of spring soft wheat of the Moskovskaya 35 variety, elite reproductions.

The purpose of this work was to study the degree of variability of morphological features of spring soft wheat of the Moskovskaya 35 variety in the southern part of the Volga-Vyatka region of Russia. To resolve this issue, the following tasks were set:
- determine the phenotypic variability of the elements of the crop structure;
- to identify the correlation of the elements of productivity and yield from weather conditions;
- assess the effect of morphological variability on yield.

Geomorphology of the territory-the area is located in the North-Eastern part of the Volga upland, called the Chuvash plateau. The relief is weakly slope of the South-Eastern exposure. The elevation above sea level is 110 m. the coordinates of the center of the Tsivilsky district can be considered 55°49' s. w. and 47°29' w. d. [11].

One-factor field experience was based on the method of B. A. Dospekhov (1986) by the method of randomized repeats [12], the accounting area was 16 m², the repetition was fourfold. The soil of the experimental site is gray forest, granulometric composition medium loamy, slightly washed away. The topsoil of the test plot has a weakly acidic soil reaction, the humus content is average, the phosphorus and exchange potassium levels are above average.

The predecessor is pea. The main tillage was carried out at the end of September with the KOS-3.0 unit to a depth of 15-17 cm. Spring tillage consisted of harrowing (in order to close moisture) with a trailed wide-grip harrow and a single pre-sowing cultivation in the transverse direction with a Spider-6.0 unit to a depth of 4-6 cm. Sowing was done with a CH-16 planter with a norm of 6 million viable seeds per 1 ha.

Phenological observations, accounting, analysis of sheaf material was carried out in accordance with the methodological guidelines of VIR (1999) [13] and the Methodology of the state variety testing of agricultural crops (1989) [14]. In the phase of complete ripeness, plants were sampled from sites of 0.25 m² in quadruplicate to analyze the structure of the crop. The number of plants and productive shoots per unit of sown area was calculated. A sample of 10 typical habit plants was compiled. All the productive shoots of these plants took into account the following morphological parameters: the height of the shoot, the length of the ear, the number of spikelets in the ear, the number of kernels in the ear (in the text - the ear grain size), the mass of grain from the ear. By calculation (the ratio of the number of spikelets in the ear to the ear length), the parameter “ear density” (number of spikelets per 10 cm of the ear length) and “mass of grains” (the ratio of the weight of grain from the ear to its grain content) were obtained [15].

The Moskovskaya 35 variety was bred at the Federal State Budget Scientific Establishment Scientific Research Institute of Agriculture “Nemchinovka” Federal Scientific Agroengineering Centre VIM by individual selection from the hybrid population P obtained from crossing the spring wheat variety...
Minskaya with the winter wheat variety Bezostaya I in 1971. Variety were lutescens, grain oval, and red. The variety was mid-season, matured in 86-105 days. 

External description of the variety: Erect shrub. The leaves are wide, dark green. Straw of medium height 80-110 cm thick durable, medium height, slightly wilted under the ear. Spikes are awnless, white; scales scalded, red grain. Ear prismatic, slightly tapering to the top, medium length (8-10 cm), medium density; yellow with a cream shade, which in some years is very pronounced. The grain is oval, with a shallow groove, large. Weight of 1000 grains: 42-45 g.

The variety is characterized by high yield potential, is resistant to lodging and disease, belongs to the wheat most valuable in grain quality. The variety has a wide ecological plasticity, it adapts well to weather conditions. By creating the variety Moskovskaya 35, the expediency of attracting winter forms to hybridization with spring ones was practically proved, which makes it possible in a short time to dramatically increase the ear productivity in spring wheat [16,17].

In 2014-2018, mass planting of spring crops started in late April-early May. In 2014, the development of spring wheat plants took place against the background of a high level of air temperature with little precipitation during the growing season. The hydrothermal coefficient (SCC) was 0.1 (May), 0.8 (June) and 0.1 (July), for the growing season as a whole = 0.8. The sum of active temperatures of the growing season of spring soft wheat amounted to 2085°C.

The year 2015 was characterized by moderately warm weather with frequent precipitation at the beginning of the growing season. Good moisture recharge of the arable layer of soil contributed to the friendly development of plants. However, the formation of the spike of grain crops took place in conditions of dry, hot weather and insufficient moisture supply, which adversely affected the yield formation. SCC in 2015 amounted to 1.21. The sum of active temperatures of the growing season of spring soft wheat amounted to 2288°C.

In 2016 and 2018 The growth and development of field crops took place under conditions of lack of moisture against the background of a high temperature during the entire growing season. Spring grain tillering was very weak. SCC in 2016 amounted to 0.58, and in 2018 = 0.68. The sum of active temperatures of the growing season of spring soft wheat in 2016 amounted to 2402°C, and in 2018 = 2250°C.

In 2017, the growth and development of agricultural crops took place under conditions of excess moisture against the background of cold temperature at the beginning of the growing season (May, June) and close to the average multiyear norm during the rest of the growing season. SCC amounted to 1.49. The sum of the active temperatures of the spring wheat growing season was 1825°C.

3. Results and discussion
In the literature, there are conflicting data on the relationship of yield and its elements in different agroecological conditions. Fluctuations in weather conditions during the years of research complicate the objective assessment of genotypes due to their high modification variability. In addition, the phenotypic manifestation of the trait in optimal and stressful conditions can vary greatly [18,19]. Many researchers recommend carrying out selections in years typical for each area [20]; to estimate plants on a favorable background at the maximum manifestation of signs; indicate the difficulty of selection under stress due to increased contributions of nonadditive effects in the genetic dispersion of quantitative traits [21]. Other authors argue that in years with stressful conditions, there is a natural increase in the correlation coefficients between the harvest and the signs of productivity of the ear, which gives the breeder the opportunity to select the most adapted genotypes [22-24].

One of the important characteristics of many crops is the height of the plants [25-27]. As a varietal trait, it is closely related to lodging resistance. An analysis of the phenotypic variability in the height of the stems suggests that this morpho-parameter is to a lesser extent due to the ecological conditions of cultivation varying over the years when compared with other elements of the crop structure (figure 1).

According to the results of a five-year study, it was established that the height of the stems remained at the level declared during the registration of the variety and was in the range of 80-110 cm. A strong
direct correlation was observed between this indicator and the hydrothermal coefficient \((r = 0.73)\), as well as the sum of active temperatures, but the inverse \((r = -0.86)\).

![Figure 1. The height of the stems of spring soft wheat varieties Moskovskaya 35 by years, cm.](image)

Elements of the crop structure of spring soft wheat plants are characterized by a large genotypic diversity \([28]\). Comparison of indicators of the structure of the harvest of spring soft wheat varieties Moskovskaya 35 in the phase of full ripeness of the crop, which were obtained in 2014-2018, found that the maximum spike length was in the most favorable year for the growth and development of spring wheat plants in 2017 (Table 1). Due to the large ear in a given year, the number of grains in it was also maximum – 30.1 pcs.

**Table 1. Biometric indicators of crop structure spring wheat Moscovskaya-35.**

| Variant | Spike length, cm | Number of grains per ear, pcs. | Weight of 1000 grains, g |
|---------|------------------|-------------------------------|------------------------|
| 2014    | 7.2              | 25.50                         | 45.58                  |
| 2015    | 5.6              | 17.00                         | 38.10                  |
| 2016    | 9.3              | 25.50                         | 45.58                  |
| 2017    | 9.5              | 30.10                         | 48.80                  |
| 2018    | 8.9              | 27.50                         | 35.64                  |
| Average | 8.1              | 25.12                         | 42.74                  |
| Coefficient variation, % | 20.57 | 19.57 | 13.07 |

Elements of spike productivity are formed at different stages of organogenesis. The length of the ear depends on the availability of growth factors in the tillering phase of the crop. Such an important element of the crop structure as the number of grains in an ear depends on the length of an ear. On average over the years of research, the length of an ear in the studied variety varied from 5.6 to 9.5 cm, the number of grains per ear varied from 17.0 to 30.1 pcs. But at the same time, the constituent indicators of the spike were the most variable: the coefficient of variation of the length of the ear was 20.6%, and the number of grains in the ear was 19.6%. The lowest value of the coefficient of variation was in the weight of 1000 grains – 13.1. The size of the seeds is one of the important commercial indicators of the variety and has a high genotypic conditionality \([28]\). In the years of research, the average weight of 1000 seeds varied from 35.6 to 48.8 g. Soil and climatic factors have a decisive influence on the size and quality of the crop. Recently, there has been a tendency to increase the share of the influence of weather conditions on the variability of yields \([29]\). In our experiment, the in-port variability was influenced by the weather conditions of vegetation of plants over the years of testing, which is confirmed by the calculation of
correlations between the elements of the crop structure and the hydrothermal coefficient (SCC) for the vegetative period of spring wheat in the conditions of the southern Volga-Vyatka region. It was established that the main biometric indicators of the yield structure had a weak correlation with the SCC of the vegetation period: the spike length was 0.16, the number of grains was 0.03, and the weight of 1000 grains was 0.29. According to the sum of active temperatures that developed in the years studied, it was found that the studied elements of the crop structure had an average negative relationship with this indicator, this is exactly the number of grains (0.55) and the weight of 1000 grains – 0.56, and the length of the ear is the connection was also inverse, but weak and amounted to 0.24. When analyzing the average spike length and the weight of 1000 seeds for 2014-2015, it was established that the studied elements of the crop structure are within the stated parameters of the characteristics of the variety and variability is not revealed.

During the growing season of 2017, which was favorable moistening period, the yield of Moskovskaya 35 variety significantly exceeded the other years – the maximum indicator was 44.5 centners per hectare, and in the conditions of severe drought in 2016 and 2018, productivity was 28-29% lower than the maximum (figure 2). The lowest value of the yield index was obtained in 2015 (27.7 centners per hectare), as the formation of the ear of grain crops in this period took place in dry, hot weather and insufficient moisture supply. The average daily temperature was 28 °C, and the SCC-0.1.

![Figure 2. Productivity of spring soft wheat for 2014-2018.](image)

Yield indicators of spring soft wheat Moskovskaya 35 studied during 2014-2018 ranged from 27.7 till 44.5 centners per hectare. These fluctuations were related to the weather conditions during the growing season of the plants. It is known that the level of moisture supply is crucial for the formation of grain yield [30]. The correlation coefficient for the SCC was 0.35, and by the sum of active temperatures – 0.92, which indicates a direct close connection between the yield of the variety and the last indicator. The connection with the SCC was somewhat less. It also has a positive, but only average connection.

Analysis of the coefficient of variation showed that the variety Moskovskaya 35 has good ecological plasticity, the coefficient of yield variation was 21.4%.

4. Conclusion
When studying the morphostructural indicators of spring wheat of the Moskovskaya 35 variety for five years in the southern part of the Volga-Vyatka region, it was found that all the elements of productivity...
of the variety were within the declared parameters. The most informative features of this variety for breeding work are revealed: the weight of 1000 grains, the length of the ear.

It was found that the intra-variety variability is strongly influenced by the weather conditions of vegetation of plants, which is confirmed by the calculation of correlations between yield and the sum of active temperatures during the growing season \( r = 0.92 \). A strong direct correlation of this indicator was observed from the hydrothermal coefficient \( r = 0.73 \), and from the sum of active temperatures the reverse \( r = -0.86 \).

Certain relationships allow us to assert that the variety of spring soft wheat Moscow 35 is environmentally plastic in all morphoparameters responsible for productivity. The results obtained allow to include this variety in the selection process for high environmental stability.

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