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The role of habitat on the yield of spring soft wheat varieties

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The role of habitat on the yield of spring soft wheat varieties

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Abstract. This article used 72 samples of spring soft wheat from the genetic Fund of the Federal research center all-Russian Institute of plant genetic resources named after N. I. Vavilov (VIR). During the research work, the influence of agro-climatic conditions on the yield of different varieties with different genotypic characteristics was studied. Two varieties with the highest yield were selected: Arhat by 18.2 % and Icarus by 17.82 %. Studies have shown low plasticity of the studied varieties due to strong yield variability. Only one variety had a low rate of variability. As a result of four years of study, all samples have a complete correlation between yield and weather conditions of the growing season.

1 Introduction

Wheat remains one of the three most important crops in the world. It has no equal in the area of cultivation and the ability to adapt to different soil and climatic conditions [1]. In the course of vegetation, the growth, development of plants, yield and its quality are affected to some extent by the entire set of environmental factors [2]. The formation of highly productive crops that can make maximum use of natural and agrotechnical factors depends more on the variety. The variety is one of the cheapest and most affordable means of increasing yields. Without it, it is impossible to realize the achievements of scientific and technological progress in agriculture. The variety is the biological foundation for the construction of all other elements of the technology. Therefore, the study of the variety in specific zonal conditions for its productivity, resistance to adverse environmental factors is an important task [3, 4].

The environmental feature of many regions of Russia is the sharp continental climate, severe aridity and variability of weather conditions over the years, and the random nature of precipitation during the growing season. Under these conditions, there is a high dependence of grain production on adverse climatic factors. The main indicators used in agrometeorology to assess prevailing weather conditions are the amount of precipitation and the sum of active temperatures, and an integral indicator that takes both of these indicators into account at the same time (hydrothermal coefficients – GTC). The most famous of them is the Selyaninov hydrothermal coefficient, used to characterize humidification conditions and defined as the precipitation ratio (∑R) in mm for a period with average daily air temperatures above 10°C to the sum of temperatures (∑t) for the same time, reduced by 10 times [5].

2 Materials and methods

The source material for research in 2016-2019 was varieties and varietals of spring soft wheat obtained from the VIR collection. The study of varietal samples took place in the nursery of the source material according to the generally accepted method [6]. As a grade-control used national variety Simbircite. The research was carried out on the experimental field of the Chuvash research Institute, the soil is gray forest heavy loam with a humus content of 4.6, a neutral reaction of the soil solution-6.1, and an increased content of mobile phosphorus and exchange potassium. The predecessor is black steam. Sowing was carried out in the optimal time, the area of the plot is 20 m^2, the repeatability is three times. Phenological observations and accounting for disease damage [7].

In terms of moisture availability: long-term conditions (SCC = 1.11), the dry ones were 2016 and 2018 - SCC = 0.86 and 0.68; the climate norm was higher in 2017, where the SCC was 1.47 [11]. The sum of active temperatures (∑t> 10°C) in 2016 was 2402ºC, in 2017 – 1825ºC and in 2018 – 1782ºC. 2019 was a moderately warm year with a lack of moisture at the beginning of the growing season and high moisture content in the maturation phase of the culture of the SCC of the growing season was 1.09.

3 Results

In the nursery of the initial test, among the studied 72 varieties, 20 varieties were distinguished by yield (Fig. 1.) that have this indicator on average over the 2016-2019 exceeded the grade standard Simbircit (Russia). According to the literature, the most productive varieties have the most adapted to local soil and climate conditions [8]. Our research shows that the

average varietal yield of spring wheat in the southern part of the Volga-Vyatka region over the years of study was on average 37 C / ha of grain. The highest yield on average for the years of study was noted in the Arhat variety-44.1 C / ha (Russia) and in the Icarus variety – 44.0 C/ha (Kazakhstan, Russia), which is 18.15 and 17.82% higher than the standard, respectively. These varieties in the studied conditions are able to make the most of natural and agrotechnical factors to realize potential productivity.

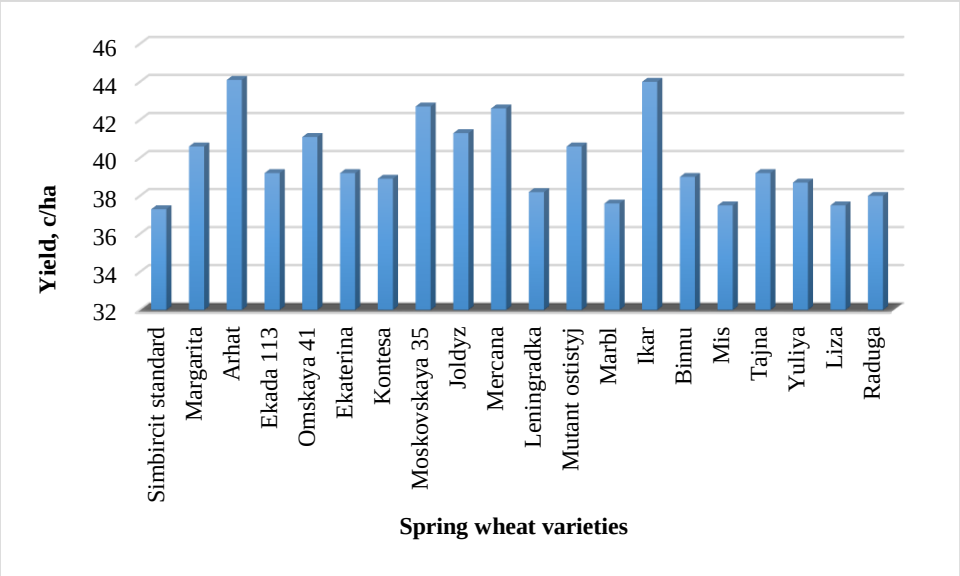

Fig. 1. Productivity of spring soft wheat for 2016-2019

Crop production is interested in the level and stability of the yield of cultivated varieties. The main requirement for modern varieties is resistance to environmental factors that limit yield. Instability of the variety, even at a high level of yield, can cause some damage to the production economy. High grain yields in some years cause difficulties with transport for harvesting and transportation, with primary processing and drying of grain, and storage facilities for storing grain. In years with low yields, production does not receive enough products for sale to the state or for its own needs, and the equipment is not fully loaded. High environmental stability with a low average yield of the variety also gives an insufficiently high level of profitability of production. Therefore, it is necessary to choose such varieties that will give high and stable yields for several years/

Mismatch of grain yield indicators for varieties in different years gives an index that reflects the interaction of the studied factors. The more the yield level of varieties varies and does not match, the higher the share of variability due to the interaction of "genotype × environment". In the current weather and climate conditions of 2016-2019, all varieties that showed high yields relative to the standard variety were more variable (Fig. 2) compared with grade Simbircite (V=11.87 per cent). The exception was in the Lisa variety (Russia), where V=5.68 %.

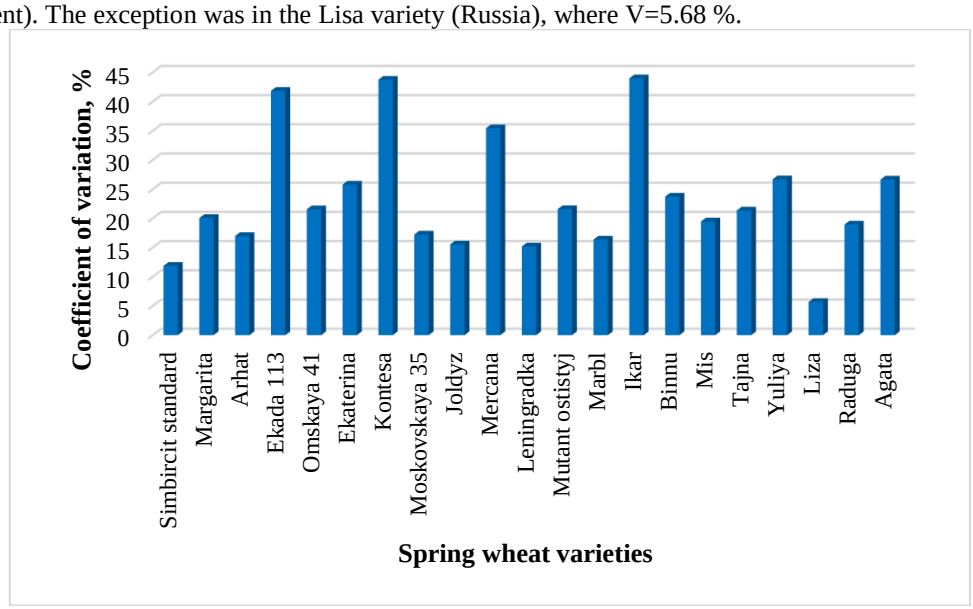

Fig. 2. Variability of varietal yield for 2016-2019

The correlation of yields in the studied varieties of spring soft wheat with meteorological indicators for the four years of study is presented in the table.

Table Correlation coefficients (r) between spring crop yields and agrometeorological conditions of the year (2016-2019)

№	Spring wheat varieties	Precipitation, mm	∑t > 10°C	Hydrothermal coefficient
1	Simbircit standard	-0,79	0,72	0,51
2	Margarita	-0,91	0,52	0,36
3	Arhat	-0,87	0,28	0
4	Ekada 113	-0,03	0,82	0,99
5	Omskaya 41	-0,08	0,08	-0,43
6	Ekaterina	-0,85	0,32	0,52
7	Kontesa	0,05	0,96	0,91
8	Moskovskaya 35	-0,79	-0,39	-0,48
9	Joldyz	-0,27	-0,21	-0,64
10	Mercana	0,92	-0,07	0,14
11	Leningradka	-0,25	0,82	0,43
12	Mutant ostistyj	-0,41	0,90	0,60
13	Marbl	0,51	0,10	-0,33
14	Ikar	-0,55	0,45	0
15	Binnu	-0,44	0,27	0,67
16	Mis	-0,95	0,19	0
17	Tajna	-0,69	-0,54	-0,35
18	Yuliya	-0,37	-0,79	-0,85
19	Liza	-0,61	-0,19	-0,54
20	Raduga	-0,60	0,81	0,52
21	Agata	-0,76	0,23	0,52

When calculating the correlation coefficient between yield and weather conditions of the growing season for 2016-2019, a complete correlation was found from moisture availability, which showed low plasticity of the studied varieties to drought conditions. In addition to varieties Ekada 113 (Russia), Omsk 41 (Russia), Kontesa (Poland), Yoldyz (Russia) and Leningradka (Russia), which have a weak correlation ($R<0.3$).

According to the results of the analysis, nine varieties (Arhat, Omsk 41, Yoldyz, merzana, marble, MIS, Lisa, Agata –Russia; Binni – Australia) showed a weak correlation of yield from the sum of active temperatures during the growing season. This circumstance induced by the fact that security with heat is not a limiting factor for this crop.

The relationship between the yield and the value of the SCC of the growing season in Arhat, Icarus and MIS varieties is completely absent.

4 Conclusions

Long-term environmental tests of varietal samples of the VIR genetic collection in the southern part of the Volga-Vyatka region allowed us to select varieties that exceed the yield of the variety standard when grown in different climatic conditions in years. This approach to the study of yield variability of the studied varieties allows us to select promising wheat genotypes for use as donors in the selection process.

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