Biological features and productivity of soybean varieties grown in the unstable moisture zone on leached chernozem

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Abstract. The article presents the results of studies on the biological characteristics and productivity of new promising varieties of different ripeness groups, Armavir experimental station selection - a branch of the Federal state budgetary scientific institution “Federal scientific center “V.S. Pustovoit All-Russian Research Institute of Oil crops”. The studies were carried out in an unstable moisture zone on the basis of the experimental station of the Stavropol State Agrarian University; the soils of the experimental plot are leached chernozem. On average, over three years of research, it was found that the highest yield in the group of quickly ripening varieties was obtained by Parus variety - 1.73 t/ha, which was 0.43 t/ha more than the standard Bara variety. In the group of early ripening varieties, the highest yield was obtained by the standard Duar variety - 1.58 t/ha. The mid-ripening Zara variety showed a maximum yield of 1.84 t/ha among the studied varieties, exceeding the standard Vilana variety by 0.19 t/ha. The highest protein content in soybean grain was noted in the Vilana variety - 43.2%, and the vegetable oil in the Vestochka variety - 24%.

1. Introduction

A wide range of use of soybean grain in the food industry, as well as in feed production, explains the stable and constant increase in its production in the world, including the Russian Federation. Over the past five years, soybean grain production in the Russian Federation has grown by 6.6%. Southern Federal District is one of the leading soybean growing regions.

Numerous studies have identified that soy has a particular adaptability to various growing conditions, and in this regard, the role of a variety or hybrid in increasing its productivity is essential. The task of selection and seed production of this crop is to create highly productive cultivated varieties and hybrids adapted to the particular environmental conditions when using modern and scientifically based agricultural techniques to increase the productivity of this crop. It was established that the role of the variety in increasing productivity is in the range of 30-60%. However, irregularities in cultivation technology or inconsistency of natural conditions for soybean varieties significantly reduce the potential of this crop. Thus, an important solution to the problem of increasing the gross yield of soybean grain is the optimization of variety testing and variety updating [1-4]. It should be noted that in the Stavropol Territory the low efficiency of using soybean grain as a feed is due to the existing imbalance in the production of grain and high-protein crops, although in some parts of the territory there are favorable conditions for cultivating it on dry land and almost everywhere under irrigation. At the same time, the
absence of high-yielding, drought-adapted and disease-resistant varieties also limits the high use of this crop in production [5-8].

2. Materials and research methods
The research material for assessing biological indicators and productivity was soybean varieties of different ripeness groups: quickly ripening - Bara, Parus, Kora, early ripening - Duar, Duniza, Romano and mid-ripening - Vilana, Vestochka, Zara. Varieties Bara, Duar and Vilana, corresponding to their ripeness group, were selected as standards. The originators of the Bara and Vilana varieties are The “SOKO” Company and V.S. Pustovoit All-Russian Research Institute of Oil crops, respectively. The originator of the Duar, Duniza, Romano, Vilana, Vestochka and Zara is Armavir Experimental Station - a branch of the Federal State Budgetary Scientific Institution Federal Scientific Center VNIIMK. The studies were conducted in the conditions of the experimental station of the Stavropol State Agrarian University. The soil is represented by leached chernozem, which is characterized by an average humus content of 5.2–5.9%. The reaction of the soil solution in the upper horizons of the soil is neutral; the pH is 6.2–6.7.

The preceding crop in the experiments is winter wheat. The agricultural technology in the experiments was generally accepted for the cultivation zone. The experiments was conducted with 4 repetitions, the allocation of plots was systematic. Trial establishment, records and observations were carried out in accordance with the “Field Experience Methodology” [9], and the “State Variety Testing Methodology for Agricultural Crops”, published under general editorship of M. A. Fedina (1985) [10], “Methodology for conducting field agrotechnical experiments with oilseeds” published under general editorship of V.M. Lukomets (2010) [11]. Harvesting was carried out by direct combining. The protein and vegetable oil content in soybean grain was determined using the nuclear magnetic analyzer AMB-1006M.

The purpose of the research is to study the productivity of new, promising varieties of soybean of the southern ecotype created at the Federal Research Center “VNIIMK named after V.S. Pustovojta” in the conditions of an area characterized by unstable moisture.

3. Results and discussion
As a result of studies, it was found that the growing season in the studied varieties was significantly different (figure 1).

*Figure 1.* The growing season of soybean varieties of different ripeness groups, the average for 2017-2019.
Under the conditions of the unstable moisture zone at the SSAU experimental station, for three years of research in the group of quickly ripening varieties Bara, Parus, Kora, the vegetation period was 95-104 days; the standard was the highest maturity - the variety Bara - 95 days on average. In the group of early ripening varieties Duar, Duniza, Romano it amounted to 111-114 days and in the group of mid-ripening varieties Vilana, Vestochka, Zara - 121-126 days. Varieties Vilana and Zara were distinguished by the longest growing season among the studied varieties - 124-126 days.

The studied soybean varieties had different plant heights (figure 2).

![Bara(St.) Parus Kora Duar(St.) Duniza Romano Vilana(St.) Vestochka Zara](image)

**Figure 2.** The height of plants of soybean varieties of different ripeness groups, the average for 2017-2019.

During the three years of research, the following varieties were regarded as the tallest: Vilana – 114 cm, Parus – 117 cm and Zara – 120 cm. The varieties Duar, Duniza, Vestochka and Romano had almost the same plant height, which was in the range of 99-108 cm. The varieties Bark and Bara had the lowest plant height - 88-97 cm. For soybean production, the lower bean attachment height is also of great practical importance, which significantly affects the preservation of the crop. According to the studied varieties, on average over the years of research, it varied from 7 to 15 cm. The lowest lower bean attachment among the studied varieties was noted in the quickly ripening variety Bara - 8 cm, the highest lower bean attachment had the varieties Romano, Vestochka and Zara - 14-15 cm. For other varieties, this indicator was 12–13 cm.

Accounting for productivity showed that it differed in varieties, and was different in the years of research (Table 1).

| Variety       | 2017 | 2018 | 2019 | Average | Standard addition |
|---------------|------|------|------|---------|-------------------|
| Quickley ripening |      |      |      |         |                   |
| Bara(St.)     | 1.54 | 1.23 | 1.14 | 1.30    | -                 |
| Parus         | 2.22 | 1.50 | 1.48 | 1.73    | +0.43             |
| Kora          | 2.11 | 1.46 | 1.44 | 1.67    | +0.37             |
| Early ripening |      |      |      |         |                   |
| Duar(St.)     | 1.74 | 1.42 | 1.59 | 1.58    | -                 |
| Duniza        | 1.62 | 1.10 | 1.32 | 1.35    | -0.23             |
In 2017, the highest yield in the group of quickly ripening varieties was observed by the varieties Kora and Parus - 2.11-2.22 t/ha, which is higher than the standard Bara variety by 0.57 - 0.58 t/ha; in the group of early ripening standard Duar variety, the yield of which was 0.13-0.33 t/ha higher than the Duniza and Romanno varieties; in the group of mid-ripening varieties Zara, the yield of which was 0.22 t/ha higher than the standard Vilana variety. In 2018 and 2019, the highest increase compared with the standards of the corresponding ripeness groups was noted in the varieties Parus - 0.27 - 0.34, Romano - 0.01 - 0.20 and Zara - 0.12 - 0.24 t/ha. On average for 2017-2019, in the quickly ripening group, a yield increase was obtained for promising new Kora and Parus varieties, compared to the standard it was 0.37-0.43 t/ha; in the early ripening group the standard variety Duar showed an increase in yield of 0.04 -0.23 t/ha compared to Romano and Duniza. Varieties of the mid-ripening group had the maximum yield among the studied varieties - 1.76 - 1.84 t/ha, while their yield was 0.11-0.19 t/ha higher than the standard Vilana variety.

Determining the protein and vegetable oil content in soybean seed showed that the studied varieties can be classified as high-protein with a sufficient amount of vegetable oil, however, the amount of protein and vegetable oil was different by variety (figure 3).

**Figure 3.** The protein and vegetable oil content in soybean seed of various ripeness groups, the average for 2017-2019.

The largest amount of protein in soybean seed was observed in the early ripening variety Duar and mid-ripening variety Vilana - 42.7 - 43.2%, the quickly ripening variety Kora and the mid-ripening variety Zara contained 42% in the seed, inferior to these varieties by 0.7 - 1.25. In the quickly ripening variety Parus and the early ripening varieties Duniza and Romano, the protein content in seed was less
than in the Duar and Vilana varieties by 1.5 - 3.7 and 2.0 - 4.2%, respectively. The lowest protein content in soybean seed was observed in the mid-ripening variety Vestochka (35.8%) and in the quickly ripening variety Bara (38.6%), which is 4.1 - 6.9 and 4.6 - 7.4% less than in the varieties Duar and Vilana, respectively. The vegetable oil content in seed of soybean varieties was also different; the Vilana variety had the smallest amount of vegetable oil in the seed - 20.5%. The largest amount of oil content in the seed was noted for the quickly ripening variety Bara - 23.2 and mid-ripening varieties Zara and Vestochka - 23.6 - 24.0%. Varieties Parus, Kora, Duar, Duniza and Romano had almost the same indicators.

4. Conclusion
Studies on the biological characteristics and determination of the productivity of soybean varieties showed that the vegetation period in the conditions of unstable moisture zone of the SSAU experimental station on average for three years in quickly ripening varieties was 94-105, in early-ripening 111-114 and mid-ripening - 121 -126 days. The quickly ripening variety Parus and the mid-ripening variety Zara were marked as the tallest with the height of plants 117 cm and 120 cm, respectively. The yields of varieties of different ripeness groups for an average of three years of research ranged from 1.3 to 1.84 t/ha. The highest yields in the group of quickly ripening varieties Parus were 1.73 t/ha, early ripening varieties Duar - 1.58 t/ha and mid-ripening varieties Zara - 1.84 t/ha. The early ripening Duar variety and mid-ripening Vilana variety contained the largest amount of protein in seed - 42.7 - 43.2%, and Zara and Vestochka varieties had the largest amount of vegetable oil - 23.6 - 24.0%.

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