Advantages and economic efficiency of cultivation of pea varieties of morphotype chameleon

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Abstract. Pea morphotype with layered heterophyllia chameleon has a high potential for seed productivity. Developed at Federal Scientific Center of Legumes and Groat Crops (FNTs ZBK) the best varieties-chameleons at the average for 3 years (2017-2019) at yield 0.44 t/ha surpassed standard leafletless varieties by 0.54 t/ha. Moreover, they contained 1.2% more protein in the seeds. Chameleon varieties fully realize their potential with a yield of more than 3.0 t/ha. The data of the state test of the Spartak variety shows that, despite the additional production costs, the profitability of cultivation of this variety and net income increase with an increase in yield, and the cost of seeds decreases.

1. Introduction
The afaf tactic genotype has been known for a long time in the world diversity of Pisum sativum L. [1]. In our Center this form was obtained in 1989. Its distinctive feature is layered heterophyllia. In the conditions of Central Russia, complex leaves with leaflets are formed in the lower tier of the stem, in the middle – tendriled (leafletless); in the upper, in the fruiting zone – tendriled with rare leaflets of irregular shape, randomly placed on them (figure).

Figure 1. Variety of morphotype chameleon Spartak.
In the northern regions, where the light intensity is low, the middle tier with tendril leaves may be absent; in the southern regions, on the contrary, most of the leaves can be tendriled. Due to the changeable expressiveness of the leaf architectonics, this form of pea is called the chameleon. In the botanical taxonomy of the genus Pisum L. it is designated as a variety of Zelenov (var. zelenovii Serd. et Stankev.) [2].

The main advantage of the chameleon form is the high physiological activity of the production process. According to the content of chlorophyll a+b and photochemical activity of chloroplasts in all chlorophyll-containing organs chameleon plants were superior to standard varieties. Due to this, in terms of the total biomass productivity, the breeding lines of the new form are 10-20% higher than leaflet (“ordinary”) varieties and by 25-37% - leafletless varieties. These advantages create an opportunity to increase the yield potential of peas, which in Central Russia is 6.0 t/ha. [3].

In our Center, over 30 years of working with the chameleon form, it was possible to eliminate lodging of the stem, increase the attractive activity of fruits, and optimize the structure of seed productivity. As a result, the Spartak and Jaguar varieties were created, which, respectively, since 2009 and 2020, have been included in the State Register of Breeding Achievements Admitted for Use in the Russian Federation. State test of the Jaguar variety continues [4].

During cultivation of these varieties it was found that they fully realize their productive potential at a high level of fertility. Such conditions require additional material costs. The purpose of this study - to determine their return on investment.

2. Methods
Varieties of the chameleon morphotype were studied in 2017-2019 in a selection crop rotation of FNTs ZBK on a dark gray forest medium loamy soil, which contained 4.2-4.9% humus, 13.1-17.0 mg/100 g P2O5, 11.7-15.3 mg/100 g K2O, pH salt extract 5.1-5.5. In autumn, N30P60K60 was introduced under autumn plowing. The experiments were laid on plots with an area of 18 m² in 6 replicates. The leafletless varieties Faraon and Gambit, recommended for the region, were used as standards. The weather conditions during the years of the trial were different. The most favorable year was 2017 with an air temperature close to long-term and sufficient precipitation. In 2018 and 2019, the air temperature during the growing season was higher than the average annual, and the amount of precipitation was lower.

The mass fraction of protein (N x 6.25) in the seeds was determined by the Kjeldahl micro-method on an IDK-152 automatic system after burning samples on a DK-5 digester from Velp Scientifica (Italy).

To determine the economic efficiency of pea cultivation, the results of the state testing of the Spartak variety in 2008 and 2008 at 71 variety plot of the European part of Russia were used as a model set. [5, 6]. Yield data of the average standard were divided into clusters with an interval of 1.0 t/ha. In each cluster, the average yield of Spartak was calculated based on the test results corresponding to this cluster. Production costs were determined according to the technological map of pea cultivation according to the standards of 2020, the cost of the harvest obtained - at the average selling price of seeds of the first reproduction in 2020 year - 22 thousand rubles per ton. The costs of post-harvest seed treatment are included in the cost estimate.

3. Results and discussion
The three-year average seed yield of the ten best chameleon varieties tested was 0.50 t/ha, or 11.4%, higher than the yield of standard varieties (table 1). In a favorable 2017, the excess was 0.80 t/ha. In less favorable years (2018 and 2019), it decreased to 0.44 and 0.27 t/ha, respectively. Promising varieties Yag-16-95 and Yag-10-384 in 2017 exceeded the average standard by more than 10 c/ha.
Table 1. Seed yield and their protein content in pea varieties in a competitive test FNTs ZBK.

| Varieties     | Seed yield, t/ha | Mass fraction of protein, % |
|---------------|------------------|-----------------------------|
|               | 2017  | 2018  | 2019  | average | 2017  | 2018  | 2019  | average |
| **Chameleons**|       |       |       |         |       |       |       |         |
| Yag -16-95    | 5.37  | 3.94  | 3.45  | 4.25    | 25.0  | 26.1  | 25.3  | 25.5    |
| Yag -16-721   | 5.26  | 3.76  | 3.43  | 4.15    | 24.7  | 24.0  | 23.9  | 24.2    |
| Yag -10-384   | 5.36  | 3.87  | 3.18  | 4.14    | 23.9  | 26.0  | 23.5  | 24.5    |
| Yag -07-652   | 5.20  | 3.48  | 3.68  | 4.12    | 27.3  | 27.3  | 26.8  | 27.1    |
| Jaguar        | 5.22  | 3.66  | 3.43  | 4.10    | 27.2  | 24.8  | 25.8  | 25.9    |
| Yag -06-83    | 4.95  | 3.79  | 3.32  | 4.02    | 26.4  | 239   | 25.6  | 25.3    |
| TM-06-455     | 5.03  | 3.52  | 3.47  | 4.01    | 26.8  | 27.0  | 26.0  | 26.6    |
| Yag -07-643   | 5.04  | 3.52  | 3.19  | 3.92    | 26.8  | 25.1  | 25.7  | 25.9    |
| Spartak       | 4.78  | 3.35  | 3.58  | 3.90    | 26.4  | 25.8  | 24.9  | 25.7    |
| Sibirskii 1   | 4.94  | 3.55  | 2.96  | 3.82    | 27.4  | 26.1  | 25.8  | 26.4    |
| Average by morphotype | 5.12 | 3.64 | 3.37 | 4.04 | 26.2 | 25.6 | 25.3 | 25.7 |
| **Leafletless (standards)** |       |       |       |         |       |       |       |         |
| Gambit        | 4.53  | 3.28  | 3.12  | 3.64    | 24.7  | 25.9  | 25.2  | 25.3    |
| Faraon        | 4.10  | 3.12  | 3.07  | 3.43    | 24.1  | 23.7  | 23.4  | 23.7    |
| Average by morphotype | 4.32 | 3.20 | 3.10 | 3.54 | 24.4 | 24.8 | 24.3 | 24.5 |
| LSD\textsubscript{0.05} by trial | 0.27 | 0.18 | 0.17 | – | – | – | – | – |

As shown by the results of the state test of the Spartak variety (table 2), with a yield of 2.0 t/ha and below, it is inferior to the standard. In this regard, it can be concluded that the agroecological niche for chameleon varieties is the conditions that provide a yield of at least 3.0 t/ha. This pattern is confirmed in the studies of the Moscow Research Institute of Agriculture «Nemchinovka » [5], where for 3 years the Spartak variety was studied in comparison with the average standard of four varieties of leaflet and leafletless morphotypes: Nemchinovsky 50, Nemchinovsky 100, Fitotron and Madonna. In 2013, the average standard yield was 2.55 t/ha, of the Spartak – 2.64 t/ha (+0.09 t/ha). In 2014, respectively, 3.24; 3.65 (+0.47 t/ha); in 2015 – 3.86; 5.25 (+1.39 t/ha).

Table 2. Economic efficiency of cultivation of the Spartak variety according to the state test (2008 and 2009).

| Varieties  | Yield, t/ha (average 2008 and 2009) | Production costs, rubles/ha | Net income, rubles/ha | Cost price, t/rub. | Profitability, % |
|------------|-------------------------------------|-----------------------------|-----------------------|-------------------|-----------------|
| Average st | 1.00                                | 158025.3                    | 6197.7                | 15802.0           | 39.2            |
| Spartak    | 0.82                                | 15510.0                     | 2530.0                | 18915.0           | 16.3            |
| Average st | 2.00                                | 23731.5                     | 20268.5               | 11866.0           | 85.4            |
| Spartak    | 1.94                                | 23634.1                     | 19045.9               | 12183.0           | 80.6            |
| Average st | 3.00                                | 26505.7                     | 39494.3               | 8835.0            | 149.0           |
| Spartak    | 3.24                                | 26895.5                     | 44384.5               | 8301.0            | 165.0           |
| Average st | 4.00                                | 30629.9                     | 57370.1               | 7657.0            | 187.3           |
| Spartak    | 4.43                                | 31328.3                     | 66131.7               | 7072.0            | 211.1           |
At the N.V. Parakhin State Agrarian University, Oryol, in research on the responsiveness of varieties Spartak, Temp (leaflet), Faraon (leafletless) to various factors of intensification of cultivation, the highest increase in seed yield was found in the variety Spartak in the variant with lime application. At pH5.5 (control) the yield was 3.20 t/ha, at pH5.8 – 4.17 t/ha [6]. The efficiency of physiologically active radiation in Spartak in this variant increased by 1.5 times, from 1.41% in the control to 2.08% in terms of lime. The net productivity of photosynthesis significantly increased from 4.32 g/m² to 5.02 g/m² [6].

It should be noted that chameleon varieties also have an increased mass fraction of protein in seeds. Among them, the Yag-07-652 variety stands out with a consistently high mass fraction of 26.8-27.3%. This feature of chameleons is confirmed by the research of the N.I. Vavilov Federal Research Center of VNIIGR (VIR), N.V. Parakhin State Agrarian University, Oryol; V.R. Williams Federal Research Center of Forage Production and Agroecology (VIC). A detailed analysis of the biochemical merits of chameleons was carried out at the VIC [7]. It was shown that the Az-26 and Az-23 chameleon lines stood out among other morphotypes in the absolute concentration of essential amino acids and especially in the mass fraction of lysine (18.81 and 18.18 mg/g of dry matter, respectively), and the Az-23 line also stood out in the high mass fraction of the amino acid methionine, which is critical for peas - 3.98 mg/g of dry matter. Biological value of the protein in Az-26 was 73.3%, in Az-23 - 69.9%, with the average for the experiment - 63.3%. Both lines have a relatively low amount of trypsin inhibitor: 77 and 81 mg/100 g of flour, respectively (the average of the experiment is 98 mg/100 g of flour).

The Az-23 line is the parent line in hybridization when creating the Spartak variety. Some of the lines shown in Table 1 have good culinary merit. So the digestion time for the Spartak variety is 129 minutes, for the Jaguar - 106 minutes, for Yag-06-83 - 112 minutes, for Yag-10-384 - 113 minutes, for Yag-16-721 - 129 minutes. For leafletless standards: Gambit - 138 min., Faraon - 148 min.

The above facts testify to the undoubted advantages and prospects of the chameleon morphotype for selection and cultivation. But in market conditions, the final factor of expediency is the economy.

The results of the state test of the Spartak variety represent a good model for studying the economic efficiency of the cultivation of chameleon varieties (table 2). They cover a large territory with different soil and climatic conditions, contain a fairly representative sample of data, and have a large amplitude of variability in seed yield. The highest yield of Spartak – 6.23 t/ha, 1.54 t/ha higher than the standard variety Talovets 70, was obtained in 2008 at the Bolsheboldinsky variety plot of the Nizhn Novgorod region.

The results of economic analysis showed that with the maximum average yield of Spartak (5.64 t/ha), production costs to the minimum level (0.82 t/ha) increased 2.5 times, for the average standard almost 2.4 times. But at the same time, Spartak's net income increased 33.9 times to its minimum and 13.8 times to the minimum of the standard. Due to the exponential increase in yield, Spartak reduced the cost of grain production to a greater extent than the standard and increased its profitability.

In the already mentioned study of N.V. Parakhin State Agrarian University, Oryol [6] in terms of economic efficiency, Spartak also responded better than other varieties to intensification factors. In 2010 prices, this variety in the best variants has the lowest cost of 1 ton of commercial grain: 2.58-2.63 thousand rubles, the highest net income: 15.08-15.86 thousand rubles and the highest profitability: 130, 2-135.6% [8].

4. Summary
The chameleon morphotype has a high yield potential and increased protein accumulation in seeds. Chameleon varieties fully realize their potential in conditions of intensive farming with a seed yield of more than 30 c/ha. The additional production costs associated with this fully pay off and generate a lot of income.
5. References
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