Assessment of the influence of genotype and climatic conditions on the elements of productivity of peas in Eastern Siberia

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Abstract. The studies were carried out in the conditions of the Krasnoyarsk forest-steppe on the basis of the Krasnoyarsk Research Institute of Agriculture. The weather conditions of the years of the study differed from each other: 2018 - very dry Hydrothermic Coefficient (HC) 0.60; 2019 - arid HC 0.89; 2020 - moderately humidified HC 1.32. The soil of the plot is ordinary heavy loamy chernozem with an acidity of the soil solution of 6.8 and humus content of 7.8 (according to Tyurin). The researches were carried out in accordance with the guidelines for the study of the collection of the world's genetic resources of cereal legumes. For the study, 9 samples of peas of different morphotypes were taken. The proportions of the influence of genotype and year conditions on the characteristics of the productivity of the samples were determined - the number of unproductive and productive joints, the number of beans and seeds per plant, and the length of plants. The climatic conditions of the year of cultivation had the greatest influence on the main characteristics of productivity, such as the number of beans per plant, the number of seeds per plant, and the number of productive joints. In terms of the number of beans and seeds per plant, 75% was attributed to the influence of the conditions of the year and 45% to the influence of the variety and the interaction of factors, variety x year. The length of the plants was significantly influenced by the year of cultivation - 66%, the influence of the genotype was estimated at 24%, the interaction of factors at 10%. The factor of the year had a minimal effect on the number of unproductive joints - 19%, the influence of the variety was 80%.

1. Introduction
Peas are the main leguminous crop. The area of distribution and cultivation of the culture is quite large, which indicates its great ecological plasticity [1]. The productivity of peas is influenced by many different factors - the timing and rate of seeding, soils and fertilizers applied, disease incidence and damage by pests, folding climatic conditions, variety, its resistance to lodging, plasticity and stability [2-6].

The weather conditions that develop in the year of cultivation have a great influence on both the growing season of the crop and the yield of the crop, which is a connecting factor of the elements of productivity, which is reflected in the works of many scientists [5, 8-13].

The contribution of the variety to increasing yields is obvious, but the data on the share of its influence from the authors differ.

The yield is a complex trait that is influenced by many factors [14]. The yield consists of the elements of productivity that form it. First of all, these are such elements as the number of productive nodes, the...
number of beans, the number of seeds per plant and their weight. Productivity cues are closely related. For example, according to A.N. Fadeeva, an increase in seed productivity of peas is accompanied by a decrease in the mass of 1000 seeds and an increase in the plumpness of the bean [15].

The height of plants and the number of unproductive joints have an indirect effect on the productivity. Both of those elements have an effect on plant lodging resulting in crop losses. It should be noted that seed weight per plant also increases lodging.

In connection with the above, the relevance of the work is dictated by the need to determine the proportion of the influence of the genotype and cultivation conditions, as well as the interaction of these factors on individual characteristics of productivity in the forest-steppe conditions of the Krasnoyarsk Territory.

2. Purpose and objectives
The aim of this work was to identify the proportion of the influence of factors year and genotype on the main elements of productivity of Pisum sativum L.

Task 1. To analyze the elements of productivity for each of the studied morphotypes;
Task 2. To identify the proportion of the influence of factors year and variety, as well as the interaction of these factors on the entire sample of samples and to determine the proportion of the influence of these factors on individual elements of productivity:

- the number of beans per plant;
- the number of seeds per plant;
- the number of productive joints;
- the number of unproductive joints;
- plant length.

3. Conditions for conducting experiments
The weather conditions of the years of the study were very different from each other and were characterized by moisture content from very dry to excessively wet.

The growing season of 2018 was characterized as a very dry HC 0.60.

Sowing of crops at the earliest possible date - in the first ten days of May, contributed to a more complete accumulation of moisture necessary for seed germination and the emergence of even sprouts. The lack of moisture characteristic of June, July and August 2018 not only adversely affected the yield of the samples, but also was a limiting factor for the growth and development of weeds, as a result of which weeds were present in the crops in a minimal amount.

The growing season of 2019 can be characterized as arid (HC 0.89), due to insufficient precipitation in May and August.

![Figure 1. Weather conditions during the years of the research (2018 – 2020)]
For the growing season of 2020, the HC was more than 1.3 (1.32), which characterizes the period as moderately humid - the amount of precipitation exceeded the average annual values in all months of the growing season of the crop. The distribution of average temperatures and precipitation of the growing season 2018-2020 by decades is shown in Figure 1.

4. Research methodology
The research was carried out in the forest-steppe of the Krasnoyarsk Territory in the fields of the Krasnoyarsk Research Institute of Agriculture. The soil of the site is represented by ordinary heavy loamy chernozem, the acidity of the soil solution is 6.8, the humus content is 7.8 (according to Tyurin).

The researches were carried out in accordance with the guidelines for studying the collection of the world's genetic resources of cereal legumes (VIR, 2018).

For the analysis, 9 samples of seed peas were taken, of which 3 samples of each morphotype: leafy medium-stalked - Radomir, Zh-58, Zh-60, medium-stalked with a leafless type - Yakhont, G-259, Zh-55 and short-stalked with a leafless type - D-94, D-40, G-171.

The counting of productivity elements was carried out in laboratory conditions. For this, 10 non-extreme plants of each of the studied samples were selected and analyzed with each of the four replicates. The calculation of the structure was carried out according to the following indicators: the length of plants, the number of unproductive joints, productive joints, beans and seeds per plant.

The influence of the share of factors was calculated in the Snedekor program by two-factor analysis of variance with repetitions: factor A - year, factor B - variety, factor AB - interaction of factors variety x year. The coefficient of variation was calculated according to Dospekhov (2011), as the standard deviation, expressed as a percentage of the arithmetic mean, the range of variation of the R indicators, as the difference between the maximum and minimum values.

5. Results
The short-stalked samples had a smaller number of productive joints and beans per plant in comparison with the medium-stalked ones among the samples studied by us. The average indicator for leafy mid-stalked was 3.3, for medium-stalked leafless samples 4.0, for short-stalked leafless ones 2.7. In terms of the number of beans per plant and seeds per plant, over the years of research, short-stalked samples were also inferior to both medium-stalked leafy and medium-stalked leafless (table 1).

| Sample name | Plants length | unproductive joints | productive joints | beans per plant | seeds per plant |
|-------------|---------------|---------------------|-------------------|----------------|----------------|
| 1.Radomir   | 111.1         | 14.5                | 3.9               | 6.1            | 24             |
| 2.Zh-58     | 94.6          | 14.7                | 3.4               | 5.6            | 19             |
| 3.Zh-60     | 109.1         | 14.6                | 2.7               | 4.4            | 20             |
| Average by morphotype | 10.9            | 14.6               | 3.3               | 5.4            | 21             |
| 1.Yakhont   | 88.2          | 14.7                | 3.2               | 5.4            | 21             |
| 2.G-259     | 93.8          | 11.2                | 4.6               | 6.8            | 23             |
| 3.Zh-55     | 114.2         | 15.1                | 4.1               | 6.3            | 24             |
| Average by morphotype | 98.7            | 13.7               | 4.0               | 6.2            | 23             |
| 1.D-94      | 68.8          | 16.6                | 2.9               | 5.0            | 21             |
| 2.D-40      | 59.1          | 14.3                | 2.6               | 4.2            | 17             |
| 3.G-171     | 56.2          | 14.1                | 2.5               | 4.0            | 16             |
| Average by morphotype | 61.3            | 15.0               | 2.7               | 4.4            | 18.0           |
| Least significant difference0.5 year | 0.65          | 0.11                | 0.31              | 0.98           | 2.23          |
The coefficient of variation of productivity traits for the entire population over the years of the study was significant: for the number of beans per plant, it corresponded to 44.0%, for productive nodes, 41.0%, and for the number of seeds from plants, 42.3%. For the indicator, the number of internodes up to the first bean $V = 12\%$.

In accordance with the morphotype, the short-stemmed specimens corresponded to a shorter plant length - from 56.2 cm (G-171) to 68.8 cm (D-94), with the length of medium-stemmed specimens from 88.2 cm (Yakhont) to 114.2 cm (Zh-58). The length of accessions in moderately humid 2020 increased significantly compared to the very dry 2018 and dry 2019, which caused significant crop lodging. The difference in different years in the length of plants of the same sample in some cases exceeded 100% (G-259, G-171, D-40) (figure 2).

![Figure 2. Plant length of specimens in the years of the research (2018 - 2020)](image)

Despite the fact that the length of plants is an important varietal trait, it still varied significantly over the years $V = 39\%$, the range of fluctuations over the years for the medium-stalked group of samples was $R = 64$, for the short-stalked group $R = 38$.

The plant length was significantly influenced by the year of cultivation - 66%, while the influence of the variety was estimated at 24%, and the influence of the interaction of factors at 10%. It should be noted some non-typicality in the meteorological conditions of the years of research, namely, excessive humidification of the climatic conditions of 2020, which had a significant effect on the length of plants.

The climatic conditions of the year of cultivation had the greatest influence on the main characteristics of productivity, such as the number of beans per plant, the number of seeds per plant, and the number of productive nodes. The influence of the variety in this case was limited for the number of seeds per plant to 9%, the number of beans - 15%, the number of productive joints - 24%.

The factor of the year had the minimum influence on the number of unproductive joints - 19%, while the influence of the variety was 80%, which confirms the justification of using this indicator as an important varietal trait.

In terms of the number of beans and seeds per plant, 75% was attributed to the influence of the conditions of the year and 45% to the influence of the variety and the interaction of factors, variety x year (Table 2).
Table 2. The share of the influence of factors (variety, year) on the elements of peas productivity, %

|                              | Year | Cenotype (variety) | Year x variety |
|------------------------------|------|--------------------|----------------|
| The number of beans per plant| 75   | 15                 | 10             |
| Number of seeds per plant    | 75   | 9                  | 16             |
| Number of productive joints  | 66   | 24                 | 10             |
| Plants length                | 66   | 24                 | 10             |
| Number of internodes before the first bean | 18   | 80                 | 2              |

6. Conclusions

Thus, the productivity of peas, which is determined by the number of productive joints, beans, and seeds per plant, was mainly influenced by the weather conditions of the year.

The plant length was also mainly influenced by the year of cultivation (66%).

The maximum effect on the number of unproductive joints was influenced by variety 80%.

Taking into account the fact that the studies were carried out in years of very different weather conditions, over a three-year period, it should be noted that more reliable results can be obtained over a longer research period.

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