agronomy

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Stability and Variability of *Camelina sativa* (L.) Crantz Economically Valuable Traits in Various Eco-Geographical Conditions of the Russian Federation

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Abstract: *C. sativa* is a valuable oilseed; it has a wide nutritional and technical use. The purpose of this study is a comprehensive study of *C. sativa* collection accessions in various ecological and geographical conditions to determine the environmental stability parameters. *C. sativa* All-Russian Institute of Plant Genetic Resources (VIR) collection accessions served as a material source for the study. The study was conducted in four different ecological and geographical regions of the Russian Federation. In the factor structure of the environmental parameters variability two factors are identified covering 94.8% of the variability. The first factor is associated with the precipitation sum (PS) and the temperatures sum (TS) for the vegetation period (68.7%), the second factor is associated with the average daily temperature (TM) for the same period (26.1%). Analysis of the system of correlations between the parameters of stability and plasticity and the value of regression coefficients for meteorological indicators showed that for all the studied features, indicator *b* closely correlates with regression coefficients for the temperatures sum (TS) and average daily temperature (TM) for the vegetation period. Indicator S_d—with coefficients for the precipitation sum (PS) and average daily precipitation (PM). The result of the study made it possible to identify collection accessions of *C. sativa* with a high stable adaptability to the contrasting climatic conditions of the studied regions.

Keywords: *C. sativa*; meteorological conditions; characters; stability analysis; regression analysis

Citation: Kon'kova, N.G.; Shelenga, T.V.; Gridnev, G.A.; Dubovskaya, A.G.; Malyshev, L.L. Stability and Variability of *Camelina sativa* (L.) Crantz Economically Valuable Traits in Various Eco-Geographical Conditions of the Russian Federation. *Agronomy* **2021**, *11*, 332. https://doi.org/10.3390/agronomy11020332

Academic Editors: Federica Zanetti and Christina Eynck

Received: 30 December 2020
Accepted: 10 February 2021
Published: 13 February 2021

1. Introduction

Currently, Russian Federation is facing the task of increasing the production of vegetable oil of food and technical usage, since 40% of all used oils in the country are imported. The problem can be solved through the introduction of low-spread oilseed cruciferous crops, such as camelina [1]. All-Russian Institute of Plant Genetic Resources (VIR) has a biggest camelina collection, the collection contains more than three hundred accessions of various origins and includes all the variety of forms found on the territory of the Russian Federation and a number of varieties and accessions obtained from gene-banks of different countries [2].

Camelina sativa (L.) Crantz is an oilseed crop belonging to the family Brassicaceae. On an industrial scale, camelina is grown in Western and Eastern Siberia, where traditionally oil from camelina seeds is used for nutrition [3].

Currently, interest in the study and cultivation of camelina is shown in Europe, Canada, the United States and other countries of the world [4–10]. In European countries, the yield of camelina amounts to: 1.9 t/ha in Germany, 2.8 t/ha in France [7]. In Canada, the yield of camelina can reach 3 t/ha [11], and in the USA 2.3 t/ha [12].

According to the Federal State Statistic Service (Rosstat), the acreage of camelina in Russia in 2019 amounted to 75.9 thousand hectares. Over 10 years, the acreage increased by 64.6 thousand hectares. These three regions are characterized by the highest camelina acreage: Orenburg region (the size of the area in 2019—(15.0 th. ha)); Rostov region (13.5 th. ha); Republic of Bashkortostan (10.4 th. ha). Seven regions with the largest acreage in 2019 included the Volgograd region, Omsk region, Altai territory, Ulyanovsk region, Chelyabinsk region, Novosibirsk region, Voronezh region. The average yield of camelina in Russia in 2019 amounted to 0.69 t/ha, which is 0.02 t/ha more than in 2018. For 10 years, the yield increased by 0.03 t/Ha. Yield by key producing regions in 2019: Ulyanovsk region—1.33 t/ha, Ryazan region—0.9 t/ha, Rostov region—0.88 t/ha [13]. This positive trend allows us to hope for an increase in the camelina production as it is a valuable raw material for the fat and oil industry of Russian Federation.

Camelina is a precocious crop, the duration of the vegetation period is 65–90 days, it matures earlier than other and spring crops such as spring rape, mustard, sunflower [3,14]. Considerable attention should be paid to the camelina cultivation technology. The use of intensive cultivation technology elements leads to a significant yield increase [15,16]. Camelina is a small seed crop so it is necessary to use specialized machinery for cleaning and sorting the seeds [17]. Conventional cereal machinery (equipped with a cereal header) that is used for harvesting grain crops is also effective for harvesting cleaning and sorting camelina seeds [18,19].

The total oil content in seeds is more than 40%, protein is about 30% [20,21]. The value of camelina oil lies in the high content of unsaturated fatty acids and fat-soluble vitamins, low content of erucic acid [22,23]. The amount of unsaturated acids reaches 87% and polyunsaturated acids 55% [24]. Linoleic and linolenic polyunsaturated fatty acids are essential (vitamin F) and have the ability to reduce cholesterol levels, normalize blood pressure and give elasticity to blood vessels [25]. The content of carotenoids (provitamin A) significantly exceeds their amount in other vegetable oils [26]. Camelina oil is rich in tocopherols (vitamin E), which are powerful natural antioxidants [27,28]. Camelina oil is widely used in cosmetology: medical cosmetics based on camelina oil helps to increase the skin's resistance to environmental chemical factors [29,30]. Camelina seeds are characterized by a low content of glucosinolates [31], camelina oil cake and meal are used in the production of compound feeds and biological mineral and vitamin supplements [32–34].

Camelina oil is used not only for food but also for technical purposes. It is applied for the manufacture of drying oil, paints, lacquers [27]. Recently, technologies for producing biodiesel from camelina have been developed and implemented [35–38]. Camelina seed is among the most preferred sources of vegetable raw materials for the production of biofuels for aviation (biokerosene) [39]. A comprehensive study of the physical and chemical properties of biodiesel derived from camelina oil shows that it can be successfully used along with biodiesel derived from canola, palm and soybean oils [40–42].

It is established that the main economically valuable characteristics of camelina are affected by the climatic conditions [7,21,22,43,44]. Therefore, the identification of adaptive properties under changing environmental factors in various conditions of ecological study is relevant.

Plasticity and stability characterize the potential for modification variability and genotypic variability of individual plant traits. Plasticity—the ability to change characteristics, as well as characteristics stability under the influence of environmental factors are considered as necessary properties of adaptability. Plasticity refers to the degree of variety adaptability to environmental conditions that is ability of varieties to give a high yield in various soil and climatic conditions. Stability is the stable characteristic manifestation in various conditions. Stable genotypes are those in which changes in environmental conditions do not affect the characteristics development. Stability is defined as the degree of deviation of the form response to changes in environmental conditions of a particular genotype from the average response of the entire system of studied genotypes [45–47].

The purpose of our research is a comprehensive study of collection accessions in various ecological and geographical tests for determination of the ecological stability parameters.

2. Materials and Methods

Three hundred fifteen accessions from All-Russian Institute of Plant Genetic Resources VIR served as the source material for the study (Table 1).

Table 1. List of *C. sativa* accessions from the VIR collection used as a research material.

Species	Method	Origin	Quantity
C. sativa	Regression "character × meteorogical parameter"	Altai, Belarus, Central Asia, Africa, Transcaucasia, Central Europe, Central European part of Russian Federation, Eastern Siberia, Far East, North America, North Caucasus, North-East of European Russia, North-West European part of Russian Federation, South America, North Europe, South-East of the European part of the Russian Federation, Siberia, South-West of the European part of the Russian Federation, Ukraine, Urals, Volga region, Western Europe, Western Siberia	315
C. sativa	Eberchart—Russel model	Central Europe, Northern Europe, Western Europe, Altai, Transcaucasia, Ukraine, North America	50

The study was conducted in 2007–2009 years in different eco-geographical conditions: "Ekaterinino Research Station", Ekaterinino RS (52°98′ n.l., 40°80′ w.d.), Tambov region; "Kuban Research Station", Kuban RS (45°13′ n.l., 40°47′ w.l.), Krasnodar region; "Pushkin SIB", Pushkin SIB (59°71′ n.l., 30°38′ w.l.), Leningrad region; Caspian Institute of Arid Agriculture, Caspian I of AG (47°91′ n.l., 95°37′ w.l.), Astrakhan region. Three hundred fifteen accessions were studied in three geographical locations for two years (Ekaterinino RS, Kuban RS, Pushkin SIB, 2007–2008 years) and 50 samples-in four geographical locations within two to three years (Ekaterinino RS, Kuban RS, Pushkin SIB, 2007–2009 and Caspian I of AG, 2008–2009) (Figure 1).

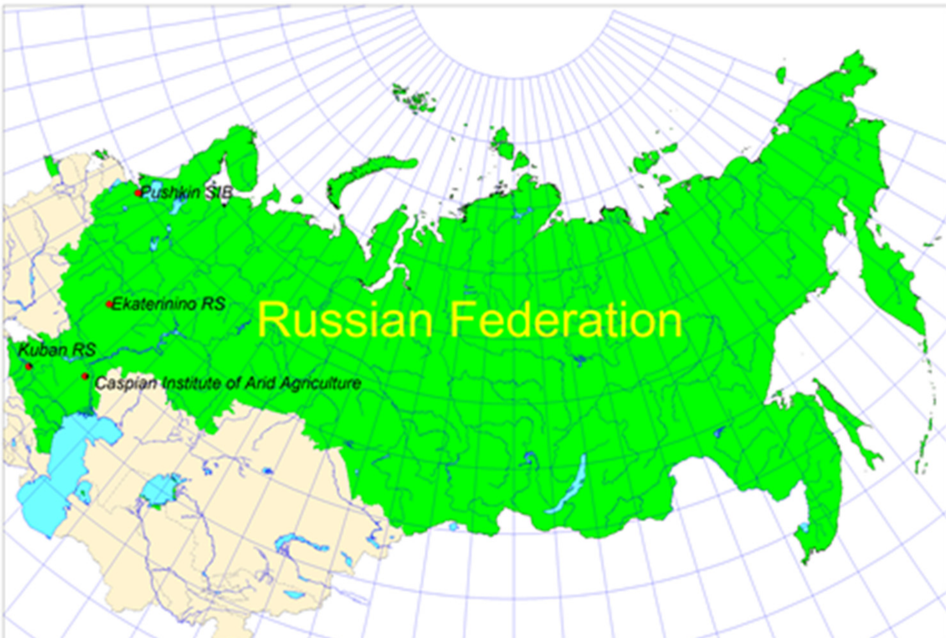

Figure 1. Location map of points of study of the ginger collection. RS—Research Station, SIB—Scientific industrial base.

The most arid and hot climatic conditions in all the years of study were observed on Caspian I of AA in Astrakhan region, wet and cool on the Pushkin SIB in Leningrad region. Weather conditions in 2007 on Ekaterinino RS in Tambov region are close to ones on Pushkin SIB, 2007 and 2009 on Kuban RS in Krasnodar region—to Caspian I of AA in Astrakhan region (Table 2).

Table 2. Climatic conditions of the experiments.

Location	Year	Sum of Temperatures, °C	Average Day Temperature, °C	Sum of Precipitation, mm	Average Day Precipitation, mm	Hydrotermic Coefficient
Ekaterinino RS	2007	1759.6	18.9	226.6	2.4	1.29
	2008	1705.3	18.1	188.0	2.0	1.10
	2009	1804.1	19.0	206.7	2.2	1.15
Kuban RS	2007	1528.2	16.8	136.2	1.5	0.89
	2008	1615.0	17.9	237.5	2.6	1.47
	2009	1764.0	19.4	161.0	1.8	0.91
Pushkin SIB	2007	1834.1	16.5	225.1	2.0	1.23
	2008	1676.4	14.8	279.7	2.5	1.67
	2009	1738.8	15.7	277.7	2.5	1.60
Caspian Institute of Arid Agriculture	2008	973.0	16.0	82.0	1.3	0.84
	2009	1127.9	18.8	70.6	1.2	0.63

During field research, methodological guidelines for the study of the world collection of oilseeds edited by Davidyan G.G. were used. The experiment material were laid on 1 m^2 plots in an ordinary way with row spacing of 15 cm [48].

Biochemical analyses were carried out using the methods of plant research described by Ermakov A.I. [49]. The oil content was determined by the mass of the dry fat-free residue using the Soxlet apparatus (ChemLab, Saint-Petersburg, Russia)) with petroleum ether as a solvent (boiling point 40–70 °C) and by infrared spectrometry on the "Matrix-I" device (Bruker, Billerica, USA). Protein analysis were conducted by the Kjeldahl method on the automatic analyzer "KJELTECAUTO 1030 Analyzer" (Tecator, Stockholm, Sweden) and by the method of infrared spectrometry on the device "Matrix-I".

Statistical data processing was performed using Statistica 12.0 and Systat 10.2 packages (StatSoft, Oklahoma, USA) and included: calculation of the main variability parameters (range, average and average error, variability coefficient); correlation analysis between economically valuable features and the main meteorological parameters (sum of temperatures (TS) and precipitation (PS) for the vegetation period, average temperature (TM) and average precipitation (PM) per day) for each sample to assess their possible impact on the resulting character.

The assessment of stability parameters and dependence on environmental conditions was carried out according to six criteria: vegetation period duration (VP), height of plants (HP), number of branches of 1st order (NBr1), seed productivity (SP), oil content (Oil) and protein content (Protein) in camelina seeds. The trait "number of branches of the 1st order" plays an important role in the formation of the seed yield and determines the potential of the plant in the formation of pods [50].

The following methods were used to assess the stability of samples based on the main economic characteristics and the influence of environmental parameters on them:

1. Calculation of the stability index and environmental plasticity of the accession according to the main characters by the method of Eberhart & Russell [51]. Calculations were performed for 50 accessions on 11 statistical environments;
2. Construction of linear regression equations $Y = a + bx$ between the economically valuable character and the environment parameter for each accession.

3. Results

Two factors are distinguished in the factor structure of the variability of environmental parameters in total covering 94.8% of the variability. The first factor is associated with the sum of precipitation (PS) and temperature (TS) for the vegetation period (68.7%), the second is associated with the average daily temperature (TM) for the same period (26.1%).

According to the totality of meteorological conditions during the vegetation period, three groups of observations are distinguished:

Dry with high average daily air temperature—observations in Caspian I of AA, Astrakhan region (2008 and 2009); conditions on Kuban RS Krasnodar region in 2007 are similar.

Moderately dry with high average daily air temperature—observations on Ekaterinino RS, Tambov region (all years), Kuban RS, Krasnodar Region (2008 and 2009) and Pushkin SIB, Leningrad region in 2007.

Humid with low average daily air temperature—observations on Pushkin SIB, Leningrad region, (2008 and 2009) (Figure 2).

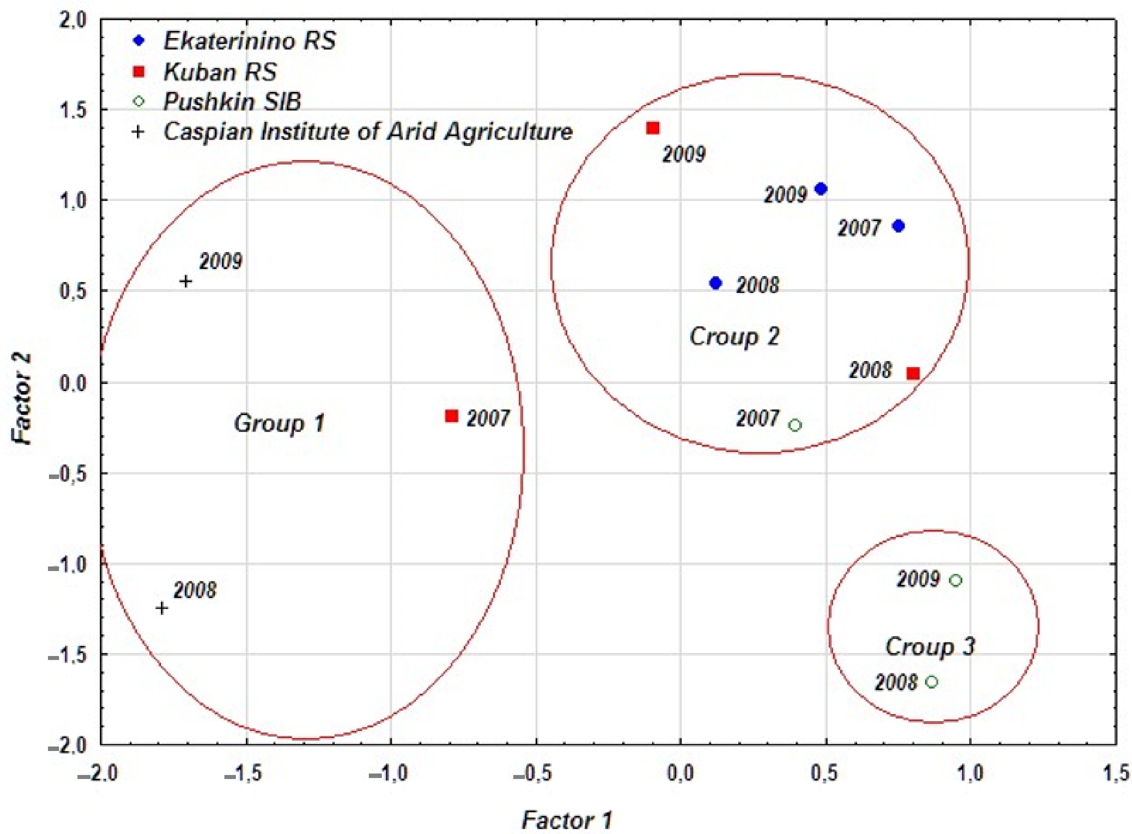

Figure 2. Distribution of environments by a set of meteorological conditions.

3.1. The Analysis of the Stability Characters

Analysis of the calculated environmental indices shows that the most favorable conditions for the "seed productivity" (SP) and "height of plants" (HP) traits were formed on Kuban RS, Krasnodar region 2008–2009 and Ekaterinino RS, Tambov region in 2007–2008, the least favorable—on the experimental fields of Caspian I of AA, Astrakhan region. The "oil content" indices (Oil) is higher on Pushkin SIB, Leningrad region and low on Kuban RS, Krasnodar region and Caspian I of AA, Astrakhan region; indices "protein" (Protein) and "number of branches of 1st order" (NBr1), on the contrary, are highest in conditions of Kuban RS, Krasnodar region and Caspian I of AA, Astrakhan region and low in conditions of Pushkin SIB, Leningrad region. The environment indices of the attribute "vegetation period duration" (VP) is high in Pushkin SIB, Leningrad region and low in Caspian I of AA, Astrakhan region (Table 3).

Table 3. Indices of the environment on the studied characters.

ENV	VP	SP	HP	NBr1	Oil	Protein
Ekaterinino RS, 2007	14.1	23.1	−8.5	−3.7	0.0	−0.1
Ekaterinino RS, 2008	10.5	67.1	11.1	−2.9	3.0	−2.5
Ekaterinino RS, 2009	7.0	−23.8	2.4	−3.0	−1.4	0.7
Kuban RS, 2007	−17.3	−34.6	−8.6	−2.1	−3.9	2.6
Kuban RS, 2008	2.4	72.0	16.3	6.2	0.5	−0.5
Kuban RS, 2009	−17.2	164.8	−0.3	4.5	−3.9	3.1
Pushkin SIB, 2007	17.1	−48.7	2.1	−2.1	4.4	−3.6
Pushkin SIB, 2008	22.7	23.8	18.8	−2.9	2.5	−0.7
Pushkin SIB, 2009	12.3	−57.6	6.7	−3.7	4.9	−2.9
Caspian I of AA 2008	−24.9	−135.3	−7.6	5.6	−2.9	2.4
Caspian I of AA 2009	−26.8	−50.8	−32.5	4.1	−3.1	1.4

NBr1—number of branches of 1st order, SP—seed productivity, VP—duration of vegetation period, HP—height of plants, ENV—environment, RS—Research Station, SIB—Scientific industrial base.

The parameter *b* in the studied samples is reliable and ranges from 0.541 NBr1 (number of branches of 1st order) to 1.609 SP (seed productivity). The variability of the parameter is also low 7.5% VP (duration of vegetation period)—25.1% SP (seed productivity). The range of variability of the S_d parameter is significantly higher—from 48.7% SP (seed productivity) to 77.7% Oil (protein content) (Table 4).

Table 4. Range of variability of stability (*b*) and plasticity (S_d) parameters.

Character	*b*		S_d	
	Minimum	Maximum	Minimum	Maximum
VP	0.879	1.212	1.14	25.97
SP	0.544	1.609	457.2	5336.1
HP	0.591	1.378	6.7	125.0
NBr1	0.541	1.429	1.30	13.53
Oil	0.722	1.238	0.195	2.327
Protein	0.738	1.300	0.110	1.605

In most samples, the value of parameter *b* is close to optimal (1) for all the studied characters. For the vegetation period (VP), samples k-2096 (Moscow region) and k1997 (Vologda region) have a *b* value exceeding the optimal level. As for seed productivity (SP), the accession from the Rostov region k-4134 had a lower indicator and k-1341 from the Orel region—higher than the optimal. In terms of plant height (HP) the indicator below the optimal level was observed in k-3973 from the Altai region, and higher—in k-447 from the Chernigov region of Ukraine. The stability index for number of branches of 1st order (NBr1) was low for k-2007 from the Kirov region and high for k4145 from Kyrgyzstan. The low stability index by the oil content (Oil) accession k-2030 from the Tver region and by the protein content (Protein)—k-4177 from the Czech Republic were distinguished.

By the value of the S_d parameter, extreme points are observed for all the studied characters. The parameter of adaptability for the vegetation period (VP) is high in samples k-2096 Moscow, k-1997 Vologda region, k-3002 (South-West Russia), seed productivity (SP)—k-1341 from the Orel region, height (HP)—k-1341 Orel region and k-2096 Moscow region, number of branches of 1st order (NBr1), oil and protein content—k-4192 from Ukraine, protein content also distinguished in sample k-4177 from the Czech Republic (Figure 3).

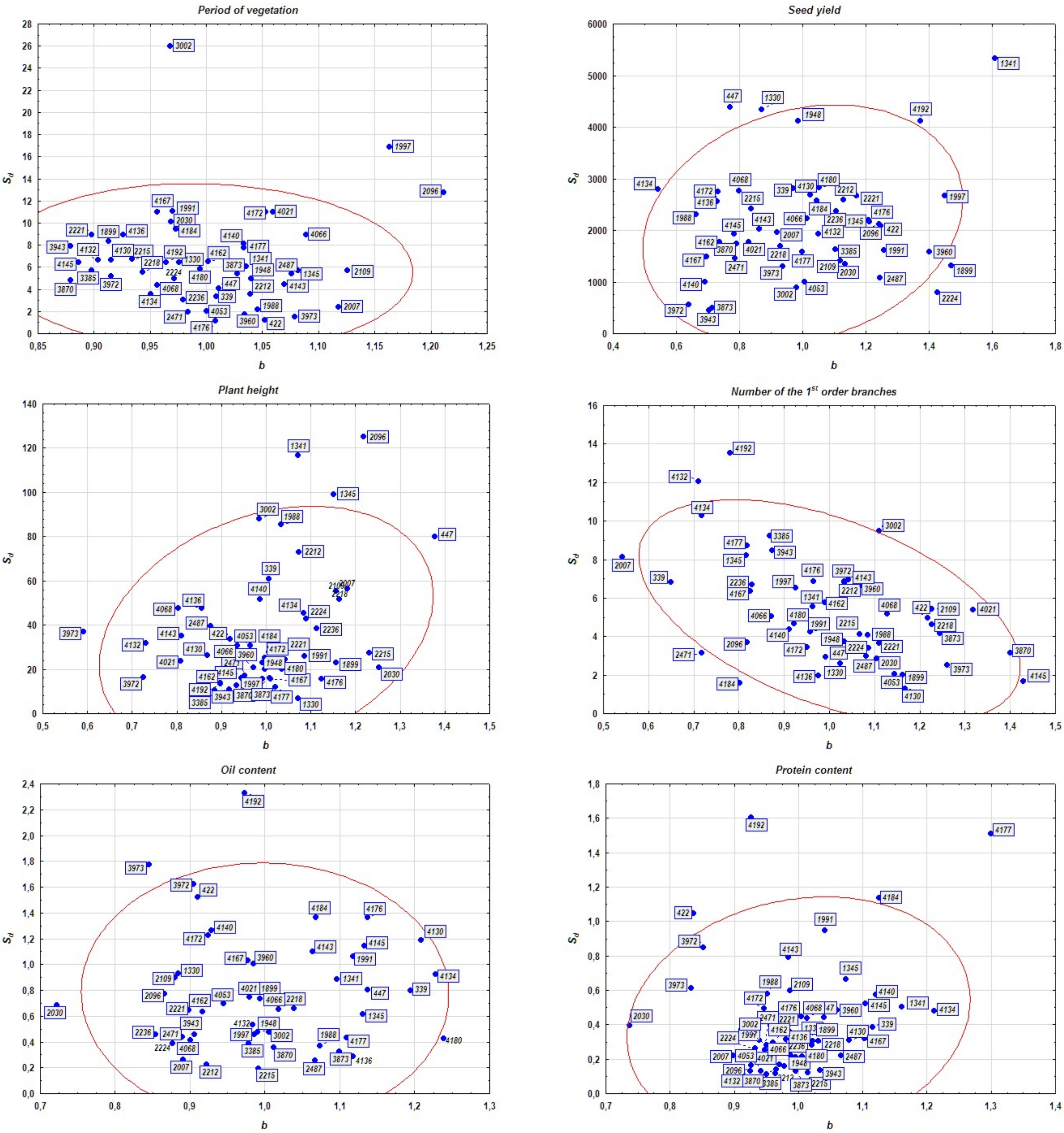

Figure 3. Distribution of the studied accessions by the parameters of stability (*b*) and plasticity (S_d).

3.2. Results of Regression Analysis

A significant influence of environmental parameters in a large number of studied accessions was revealed by the characters of the vegetation period duration and the content of oil and protein.

Seed productivity, plant height, number of first-order branches, oil and protein content are mainly affected by the sum of temperatures (TS) over the period from germination to seed maturation. The length of the growing season is mainly affected by the sum of precipitation (PS). The height of plants in 20% of the studied samples is significantly affected by the amount of precipitation (PS) and the average daily precipitation (PM).

There are few reliable regression coefficients for seed productivity and the number of branches of the 1st order (NBr1) (Table 5).

Table 5. Number of significant linear regression coefficients between plant characters and meteorological parameters.

Character	TS	TM	PS	PM
VP	126	0	224	50
SP	8	19	5	9
HP	20	2	56	54
NBr1	15	1	8	3
Oil	116	1	56	39
Protein	163	0	42	23

TS—sum of temperatures, TM—average daily temperature, PS—amount of precipitation, PM—average daily precipitation.

The range of variability of the coefficients is high for all the studied characters (75.0% or more). According to reliable regression coefficients, the scope is narrower, but also quite high. The sum of temperatures (TS) has a positive effect on the length of the vegetation period, seed productivity, plant height and oil and protein content, and a negative influence on the number of first-order branches. The amount of precipitation (PS) has a positive effect on the length of the vegetation period, seed productivity, height and oil content, and a negative effect on the number of branches of 1st order and protein content. The influence of average daily temperature (TM) and average daily precipitation (PM) is uncertain (Table 6).

Table 6. Range of variability of regression coefficients "character × environmental conditions".

<table>
<tr><th rowspan="2">Character</th><th rowspan="2">p</th><th colspan="2">TS</th><th colspan="2">TM</th><th colspan="2">PS</th><th colspan="2">PM</th></tr>
<tr><th>Min</th><th>Max</th><th>Min</th><th>Max</th><th>Min</th><th>Max</th><th>Min</th><th>Max</th></tr>
<tr><td rowspan="2">VP</td><td>All</td><td>0.042</td><td>0.153</td><td>−6.12</td><td>0.42</td><td>0.172</td><td>0.342</td><td>14.49</td><td>34.80</td></tr>
<tr><td>$p = 0.05$</td><td>0.042</td><td>0.153</td><td></td><td></td><td>0.189</td><td>0.342</td><td>27.40</td><td>34.80</td></tr>
<tr><td rowspan="2">SP</td><td>All</td><td>−0.414</td><td>0.553</td><td>−48.94</td><td>59.23</td><td>−0.822</td><td>1.819</td><td>−55.39</td><td>236.50</td></tr>
<tr><td>$p = 0.05$</td><td>0.190</td><td>0.190</td><td>−22.03</td><td>50.18</td><td>0.904</td><td>1.419</td><td>107.31</td><td>236.50</td></tr>
<tr><td rowspan="2">HP</td><td>All</td><td>−0.169</td><td>0.107</td><td>−8.61</td><td>1.57</td><td>−0.012</td><td>0.347</td><td>1.98</td><td>37.35</td></tr>
<tr><td>$p = 0.05$</td><td>0.029</td><td>0.047</td><td>−7.28</td><td>−7.31</td><td>0.092</td><td>0.347</td><td>13.57</td><td>37.35</td></tr>
<tr><td rowspan="2">NBr1</td><td>All</td><td>−0.044</td><td>0.021</td><td>−1.30</td><td>3.76</td><td>−0.054</td><td>0.064</td><td>−5.91</td><td>11.16</td></tr>
<tr><td>$p = 0.05$</td><td>−0.016</td><td>−0.010</td><td>2.00</td><td>2.70</td><td>−0.051</td><td>−0.038</td><td>7.37</td><td>11.16</td></tr>
<tr><td rowspan="2">Oil</td><td>All</td><td>0.004</td><td>0.033</td><td>−1.83</td><td>1.09</td><td>−0.017</td><td>0.068</td><td>−5.39</td><td>6.20</td></tr>
<tr><td>$p = 0.05$</td><td>0.007</td><td>0.033</td><td>−1.83</td><td>−1.83</td><td>0.028</td><td>0.055</td><td>−2.41</td><td>6.20</td></tr>
<tr><td rowspan="2">Protein</td><td>All</td><td>−0.024</td><td>0.018</td><td>−0.72</td><td>2.49</td><td>−0.039</td><td>0.063</td><td>−3.89</td><td>6.89</td></tr>
<tr><td>$p = 0.05$</td><td>−0.024</td><td>0.018</td><td></td><td></td><td>−0.030</td><td>−0.017</td><td>−3.89</td><td>6.45</td></tr>
</table>

4. Discussion

The studied characters form two groups by the structure of variability of the stability indicator: Factor 1—oil and protein content in seeds, and Factor 2—vegetation period duration, seed productivity and plant height. Three factors are distinguished in the system of characters variability by the plasticity parameter: Factor 1—correlates with the plasticity parameters of the oil and protein content, Factor 2—parameters of seed productivity and plant height and Factor 3—parameters of the vegetation period duration and number of branches of 1st order. Based on the obtained results, it can be assumed that the mechanisms that determine the stability and plasticity of the genotype under different environmental conditions in the characters associated with the biochemical composition and the characters describing the development of the plant itself are significantly different (Figure 4).

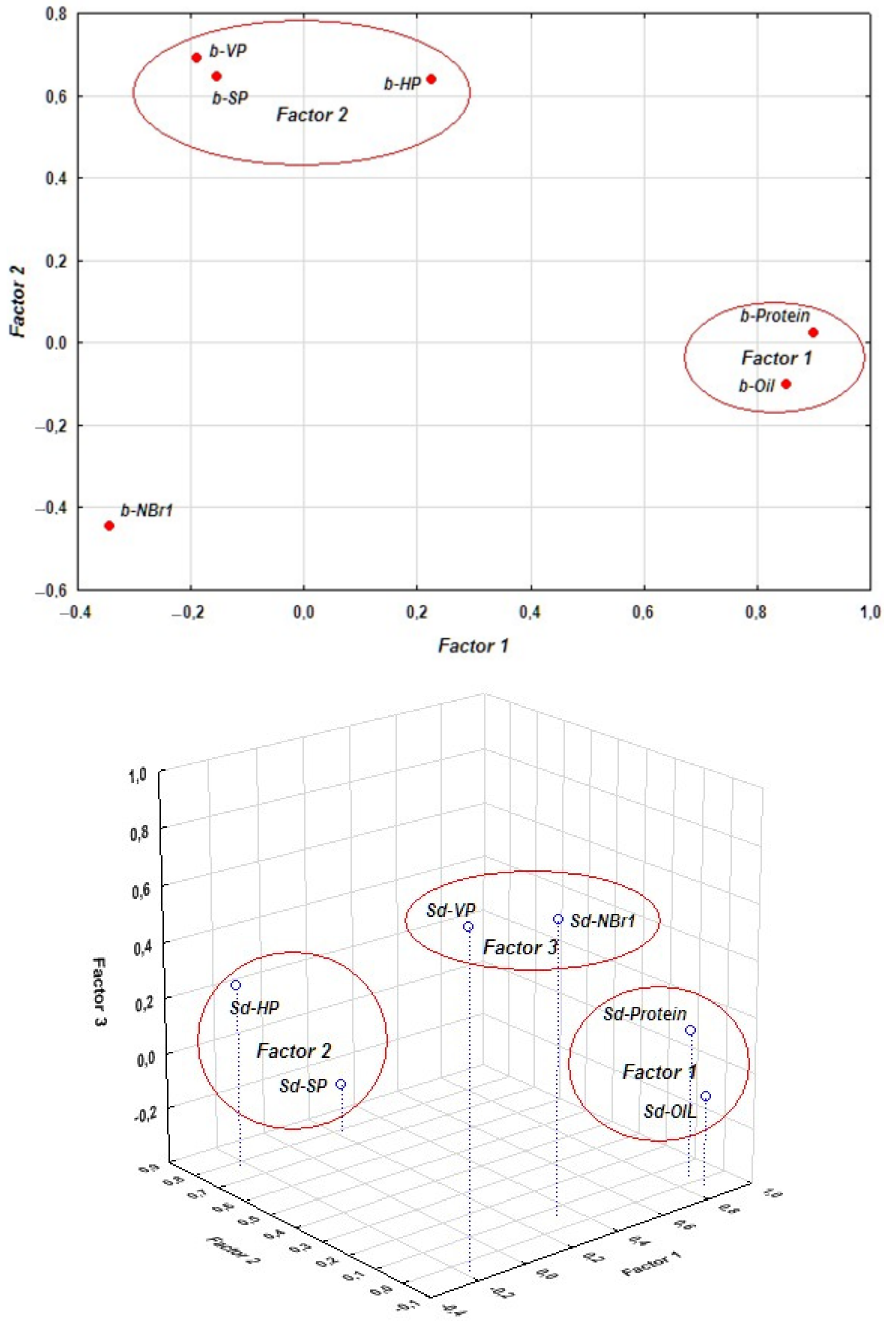

Figure 4. Factor structure of the variation of the studied characters by the stability and plasticity parameters.

The positive effect of the precipitation amount for the period from germination to seed maturation on seed productivity and oil content was also noted when studying the collection of winter rapeseed [52]. In the structure of variation of economic characteristics by the value of the regression coefficient "feature × environmental parameter", the following are distinguished:

- Regression on the sum of temperatures (TS) for the vegetation period and average daily temperature (TM)—two factors each: Factor 1 it is associated with the value of the coefficient with the duration of the growing season and the content of oil and protein. Factor 2 correlates with the value of coefficients between these parameters and seed productivity, height and number of branches of 1st order.

- Regression on the amount of precipitation (PS) for the vegetation period and the average daily precipitation (PM)—three factors each: Factor 1 determines the variation of regression coefficients with oil and protein content. Factor 2 correlates with the value of the regression coefficient between these parameters, seed productivity and plant height and Factor 3 it is associated with the variability of coefficients for the duration of the vegetation period and number of branches of 1st order (Figure 5).

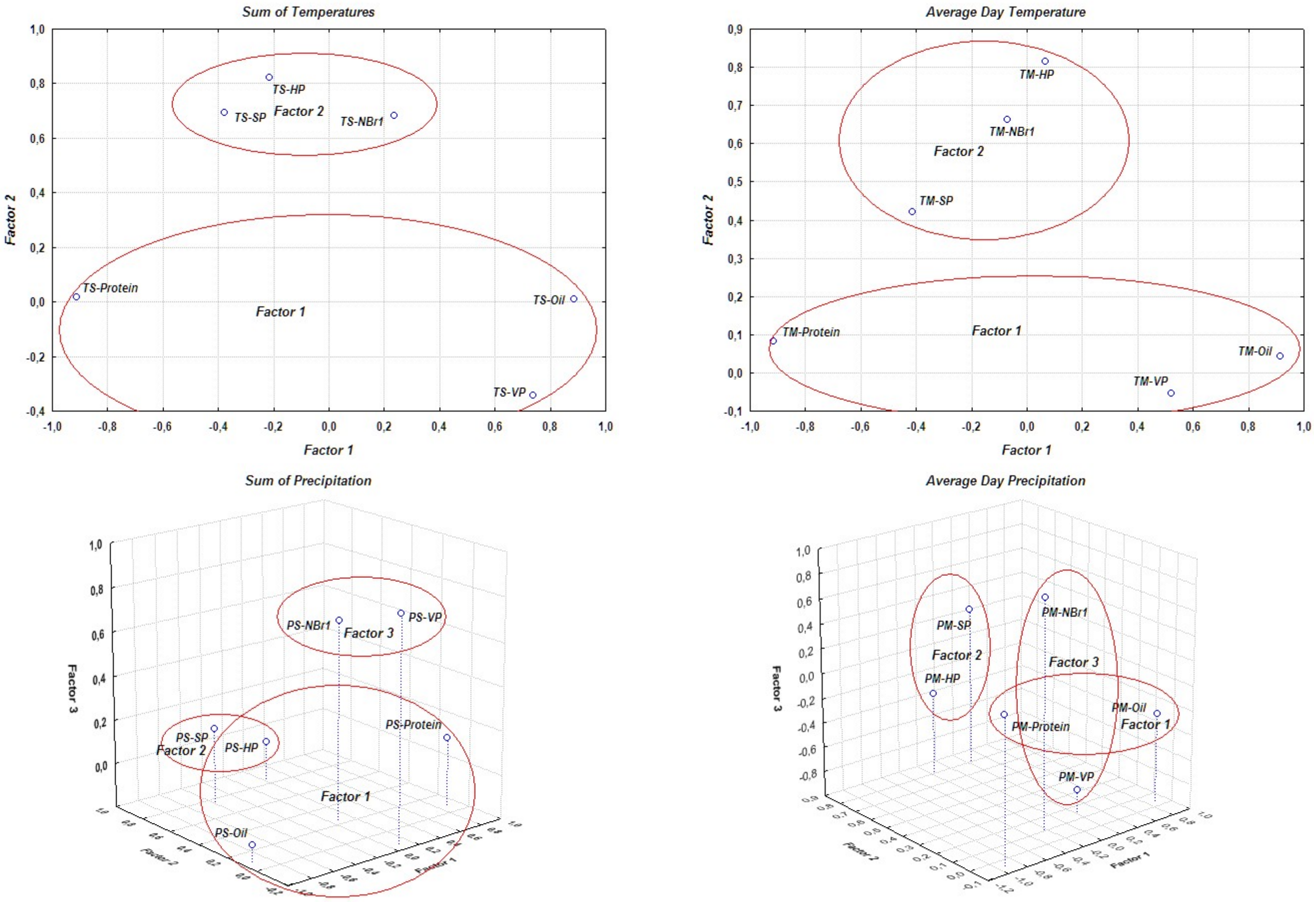

Figure 5. Factor structure of variation of the studied characters by the value of the regression coefficients “trait × environment parameter”.

Thus, in the variation structure of regression coefficients, a group of indicators of seed biochemical composition and a group of signs related to the total capacity of the plant are clearly distinguished. The influence of the climatic factor on the quality of ginger seeds was noted in the work of Zubr J. [43].

The relation between the stability parameters and the responsiveness of the variety to favorable environmental conditions was observed in rapeseed [53]. In our research the analysis of correlations between the parameters of stability and plasticity and the magnitude of the regression coefficients by meteorological indicators showed that for all studied characteristics parameter b is quite closely correlated with the regression coefficients for the sum of temperatures (TS) and average daily temperature (TM) over the growing period, and the parameter S_d—with coefficients of the amount of precipitation (PS) and average daily precipitation (PM).

5. Conclusions

As a result of the *C. sativa* study on the main parameters of stability and ecological plasticity in four contrasting eco-geographical conditions, accessions that are characterized by high resistance to various climatic cultivation conditions were identified. Most of the studied samples were characterized by stability close to optimal. These samples have a high breeding value; they can be used to create varieties with stable productivity and adaptability to the contrasting conditions of these regions. The local variety k-4192 from Ukraine was characterized by high plasticity in terms of oil and protein content. On the basis of the breeding material obtained as a result of the study, we have developed the variety of camellina "Ekaterininsky", which is successfully cultivated in the Tambov, Krasnodar and North-Western regions of the Russian Federation. In the future, it is planned to continue the study of signs in other ecological and geographical zones of Russian Federation. In the selected camelina samples, the variability of the oil fatty acid composition and the ratio of saturated and unsaturated fatty acids in the oil will be evaluated. It is planned to conduct molecular studies in order to create molecular markers of economically valuable camelina traits.

Author Contributions: Conceptualization: N.G.K., T.V.S.; Data curation: L.L.M., N.G.K.; Formal analysis: L.L.M., N.G.K.; Methodology: T.V.S., A.G.D.; Resources: N.G.K., G.A.G.; Software: L.L.M.; Supervision: N.G.K., T.V.S., A.G.D.; Validation: T.V.S., L.L.M., G.A.G.; Visualization: L.L.M.; Writing—original draft preparation: N.G.K.; Writing—review and editing: T.V.S., N.G.K., L.L.M.; A.G.D. All authors have read and agreed to the published version of the manuscript.

Funding: The study was carried out within the framework of the state task according to the VIR thematic task № 0662-2019-0001 "Collection of oil and fiber crops VIR: conservation, study, expansion of genetic diversity".

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data available in a publicly accessible repository.

Acknowledgments: The study used the material from All-Russian Institute of Plant Genetic Resources (VIR) collection of *C. sativa*.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

VP	vegetation period
SP	seed productivity
HP	plant height
NBr1	number of branches of 1st order
TS	sum of temperatures
PS	precipitation sum
TM	average daily temperature
PM	average daily precipitation

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