Field Crops Studies (2021) XIV(2-3-4): 17-26
http://fcs.dai-gt.org/bg/
ISSN: 2535-1133 (Online)
ISSN: 1312-3882 (Print)

ORIGINAL PAPER

Study of breeding lines and varieties of-spring forage peas (*Pisum sativum* L.)

Valentin Kosev[1] • Natalia Georgieva[1] • Ina Stoycheva-Mavrovska[1]

[1]Institute of Forage Crops, Pleven, Bulgaria

Corresponding Author: Natalia Georgieva; E-mail: imnatalia@abv.bg

Received: April 2021 / Accepted: May 2021 /
Published: December 2021

Abstract

Kosev, V., Georgieva, N., Stoycheva-Mavrovska, I. (2021). Study of initial material from spring forage peas (Pisum sativum L.) genotypes. Field Crops Studies, XIV(2-3-4), 17-26.

The investigation was conducted during the period 2016-2018 at the Institute of Forage Crops - Pleven in order to evaluate five breeding lines (№115, №29, №9A, №8, №11) and two varieties (Crystal, Kerpo) of spring forage peas. For the study period, high values of the variation coefficient were found for the traits of pods number (24.23%) and seeds number per plant (25.08%), medium ones – for plant height (17.75%), 1st pod height (13.95%), weight of 1000 seeds (13.57%) and seeds weight per plant (11.77%), and low – for seeds number in a pod (8.70%). Line №29 was of breeding interest in the grain direction. It was characterized by average height (74 cm), short vegetation period (78-90 days), and exceeds the control varieties in terms of weight of 1000 seeds (209.88 g) and seed productivity (4.88 g). The varieties Crystal and Kerpo were distinguished by good characteristics of the structural elements and can be used as parental components in the combination selection in the development of new forms in the grain direction.

Keywords: Breeding, Productivity, Spring pea, Lines

Introduction

In many countries around the world, peas occupy a significant share of all areas planted with legumes. It is grown both for the purposes of the food industry and for the needs of animal husbandry (Zotikov et al., 2014). Field peas have a high forage value and can be grown for grain, hay and green forage. It grows well on poor and

sandy soils, has a wide distribution area and can be cultivated in cooler northern regions (Kosolapov et al., 2009; Chekmarov, 2014). Varieties intended for green mass yield are characterized by a longer stem, late ripening, increased tendency to lodge and lower seed yield. In most grain varieties these shortcomings have been eliminated (Kondykov et al., 2010).

The development of new peas varieties to meet the modern requirements of agricultural production is unthinkable without extensive use of the gene pool of the crop. A key role in the development of such varieties has the initial material, the main source of which are plant collections. This would considerably increase the efficiency of breeding work (Vishnyakova 2012; Vishnyakova 2017; Ashiev et al., 2018). It is known that the broader the genetic basis of the source material, the wider its adaptive capabilities. Breeding regarding productivity is one of the most complex areas in the genetic improvement of crop, as the manifestations of this multicomponent trait are largely determined by environmental conditions (Sobolev and Shchetinin, 2008).

The aim of the research was to study the productive possibilities of spring pea lines and varieties for the region of Central Northern Bulgaria.

Material and methods

The study was conducted in the period 2016-2018 at the Institute of Forage Crops, Pleven.The field experiment was conducted as the seeds of individual spring pea accessions were sown in rows, at a distance of 0.20 m between rows and 0.05 m inside the row, in three replications and a plot size of 10 m^2. Sowing was done manually in optimal time, according to the technology of growing the crop. The objects of this research were 5 advanced forage pea (*Pisum sativum* L.) breeding lines (№115, №29, №9A, №8 and №11) which are result of hybridization between Bulgarian and introduced varieties in the grain direction. The varieties Crystal and Kerpo were used as controls. At the technical maturity stage, the following traits were recorded – plant height (cm), 1st pod height (cm), pods and seeds number per plant, seeds number in a pod, seed weight per plant (g) and weight of 1000 seeds (g). The duration of the phenological stages up to the beginning of flowering (number of days), full flowering (number of days) and the vegetation period (number of days) was monitored.

The data obtained were processed by two-factor analysis of variance for each trait to determine the influence of genotype and environment factors. The degree of early maturity was determined according to Kuzmova (2002). The date of the beginning of flowering was accepted as a criterion for evaluation of the degree of early maturity, and the coefficient of early maturity was used for quantitative evaluation.For ultra-early varieties the value of this coefficient was from 1.00 to

ISSN: 2535-1133 (Online)
ISSN: 1312-3882 (Print)

1.17, for early varieties from 1.17 to 1.33, for medium-early varieties from 1.34 to 1.66 and for late varieties it was greater than 1.66. The coefficient of variation (CV,%) was determined by the formula of Dimova and Marinkov (1999).

Results and discussion

The study period covered years that differ in terms of meteorological conditions (Figure 1). The third year of the study (2018) had the highest values in terms of the vegetation rainfall amount and average daily air temperature (321 mm and 15.9 ºC, respectively). The experimental years 2016 and 2017 were characterized by relatively lower amounts of rainfalls compared to 2018, respectively by 15.3 and 11.8%, and similar values in terms of average daily air temperature, respectively 15.8 and 15.6 ºC. These two years are defined as more favorable for the growth and development of spring peas, in contrast to 2018, whose unfavorable conditions are due to the uneven distribution of precipitation during the growing season, the strong spring drought in May and heavy rainfall that fell at the end of the vegetation period and negatively affected the yield formation.

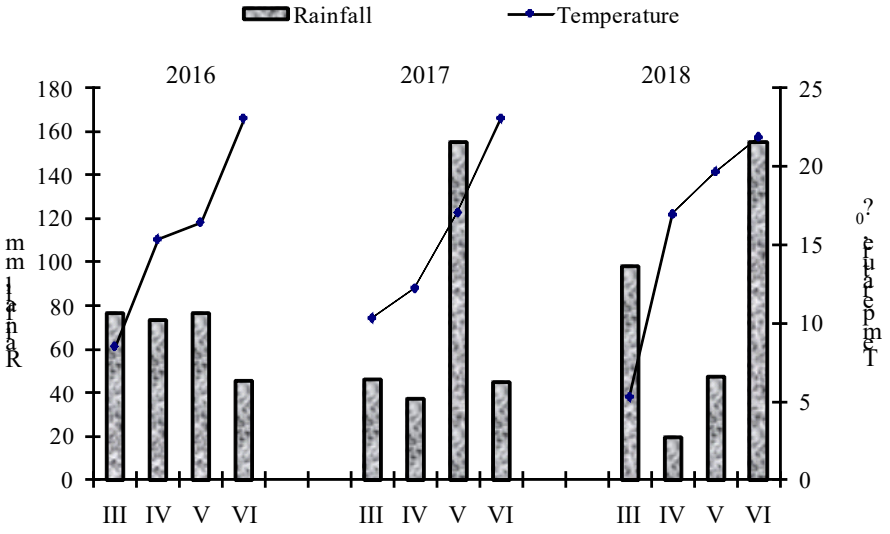

Figure 1. Meteorological conditions during the period 2016-2018

The detailed characterization of genotypes is very important for future scientific work with them. The accumulated specific information facilitates the selection process in creating forms not only with high productivity, but also with high values of the individual elements of the yield (Lysenko & Korobova, 2019). Breeding in regard to productivity is an important and difficult task, as it involves the need to

combine a large number of valuable traits into one genotype. It is known that such signs in peas are the number of productive nodes, seeds and pods number per plant, seeds number in a pod and weight of 1000 seeds (Belyaeva et al., 2017; Likhacheva et al., 2017).

The two-factor analysis of variance in terms of genotypes (varieties, lines) and years (environments) presented in Table 1 shows the presence of statistically significant differences between genotypes in terms of plant height, 1st pod height, seeds number in a pod, seed weight per plant and weight of 1000 seeds. Between genotypes, statistically significant differences were not found regarding pods number and seeds number per plant.

Table 1. Dispersion analysis of the studied traits by genotypes and years

Source of variation	DF	Mean square						
		Plant height, cm	1st pod height, cm	Pods number per plant	Seeds number per plant	Seeds number in a pod	Seeds weight per plant, g	Weight of 1000 seeds, g
Years	2	1039.92*	237.94*	6.33*	96.37ns	0.15ns	0.74*	466.92*
Genotypes	6	1174.10**	378.91**	5.60ns	63.53ns	0.466**	3.17**	5751.08**
Residuo	12	160.2956	46.1733	2.3544	29.6267	0.0827	0.1511	479.2082
CV(%)		17.75	13.95	24.23	25.08	8.70	11.77	13.57

The second factor – environment (years) – had an essential impact on the expression of the manifestation of plant height, 1st pod height, pods number, seeds weight per plant and the weight of 1000 seeds. Therefore, longer-term studies should be performed on these traits. The factor of environment was responsible for the larger share of the total variation in plant height and weight of 1000 seeds, and the influence of genotype was also greater in regard to plant height and and especially for the weight of 1000 seeds.

The variability of the traits of spring pea genotypes determined on the basis of the coefficient of variation (Table 1) gives grounds to assume that the manifestation of the seeds number (25.08%) and pods number per plant (24.23%) was strongly dependent on the environmental conditions. On average for the three years of the study, with average variability were distinguished the traits of plant height (17.75%), 1st pod height (13.95%), weight of 1000 seeds (13.57%) and seed weight per plant (11.77%). The analyzed genotypes of spring peas showed a slight variation only in regard to seeds number in a pod (8.70%).

Data on the phenological development of the studied lines and varieties of forage peas show some differences in the calendar occurrence of flowering and reaching technical maturity (Table 2). The earliest onset of the beginning of flowering stage was observed in the varieties Crystal, Kerpo and line №29 (12-28. 05.). The lines

№115 and №9A started to bloom 10-12 days later than the Kerpo variety. Lines №8 and №11 were emerged as the latest flowering. It is notable that compared to 2016, flowering in 2018 began later, but most genotypes entered technical maturity earlier and the growing season was shorter. This was due to the high average daily air temperatures in the first two weeks of June during 2018 (on average by 2.1 ºC), which accelerated the plant development and shortened the period of flowering-technical maturity. For this reason, the indicated period in 2016 lasted 30 days, and in 2018 – 24 days.

On average for the three experimental years, Crystal, Kerpo and №29 had the shortest duration of the sowing-flowering period (58 days), while for the other genotypes this period lasted 66-67 days. Regarding the length of the period flowering-technical maturity, considerable differences between the studied lines and varieties were absent, and it lasted 30-32 days.

At the end of the vegetation, the early flowering genotypes (Crystal, Kerpo and №29) differentiate, reaching technical maturity in 78-90 days. The other lines matured later with a difference of about 7-8 days. The longest vegetation period was characterized by №11, №8 and №115 (between 85 and 96 days), due to its slower growth and development. The findings made in the present study regarding the length of the growing season were in line with the results obtained in previous studies. Gul et al. (2005) reported that on this parameter the accessions studied by them showed wide variability, from 143 to 167 days. Hussain et al. (2002) indicated that the length of the growing season of pea varieties from their collection varied from 94 to 150 days. The authors believed that the different duration of the phenological phases of plant development were the result primarily of the influence of environmental conditions.

Depending on the climatic conditions and their genetic resources, the lines and varieties of spring peas can be divided into the following groups by early maturity (Figure 2): ultra-early (1.00) - Kerpo, Crystal and №29, and late-maturing genotypes (1.83-1.91) – №9A, №8 and №11. Line №115 matured the latest, with a coefficient of early maturity of 2.00.

Analysis of the data in terms of values for most quantitative traits determining yield showed essential differences between forage pea genotypes (Table 3). The stem height largely determines the resistance to lodging and suitability for mechanized harvesting. Bozoglu et al. (2007) and Hussain et al. (2005) pointed out that this quantitative trait, although genetically determined, is strongly influenced by climatic factors. With close and statistically insignificant differences in terms of height were the varieties Crystal (48 cm), Kerpo (51 cm) and line №115 (62 cm). According to this trait, lines №11 and №8 appeared as genotypes forming plants with the highest stems (91-101 cm). Lines №9A and №29 occupied an intermediate

position with plant height in the ranges of 71-74 cm.

A similar dependence was observed with respect to the height of formation of the 1st pod. The Crystal variety formed its first pods the lowest (32 cm). The values of this indicator at Kerpo, №115 and №9A were 39, 43 and 48 cm, respectively, and at №29 - 56 cm. The lines forming longer stems (№11 and №8) laid the 1st pod at a greater height of about 61 cm.

Table 2. Phenological development of studied spring pea genotypes (2016-2018)

Genotype		Sowing	Begining of flowering	Technical maturity	Vegetation period, days
Kerpo	2016	31.3.2016	25.5.2016	24.6.2016	90
	2017	06.3.2017	12.5.2017	23.6.2017	81
	2018	05.4.2018	28.5.2018	22.6.2018	78
Crystal	2016	31.3.2016	25.5.2016	24.6.2016	90
	2017	06.3.2017	12.5.2017	23.6.2017	81
	2018	05.4.2018	28.5.2018	22.6.2018	78
№115	2016	31.3.2016	31.5.2016	30.6.2016	96
	2017	06.3.2017	23.5.2017	30.6.2017	96
	2018	05.4.2018	06.6.2018	29.6.2018	85
№29	2016	31.3.2016	25.5.2016	24.6.2016	90
	2017	06.3.2017	12.5.2017	23.6.2017	81
	2018	05.4.2018	28.5.2018	22.6.2018	78
№9A	2016	31.3.2016	30.5.2016	27.6.2016	93
	2017	06.3.2017	22.5.2017	30.6.2017	91
	2018	05.4.2018	05.6.2018	28.6.2018	84
№8	2016	31.3.2016	30.5.2016	29.6.2016	95
	2017	06.3.2017	22.5.2017	29.6.2017	91
	2018	05.4.2018	05.6.2018	29.6.2018	85
№11	2016	31.3.2016	30.5.2016	29.6.2016	95
	2017	06.3.2017	22.5.2017	29.6.2017	91
	2018	05.4.2018	05.6.2018	29.6.2018	85

The investigation of the main elements of productivity is an important stage in establishing the best genotype for specific agro-climatic conditions. The productive potential of genotypes is determined by the pods number, seeds number in a pod and weight of 1000 seeds. Lines №11 and №8 formed the greatest pods number per plant (8), followed by Crystal with 7 pods. Kerpo, with 5 pods, was inferior in this indicator to almost all genotypes. According to Qasim et al. (2001) and Chadha et al. (2010), the higher pods number was associated with their smaller size (length, width), as the development of small pods requires less nutrients than larger ones.

The results regarding the seeds number per plant showed that the total number of seeds in the genotypes, forming a smaller pods number, was offset by a larger seeds number per plant. As a result of these compensatory reactions, a change in the

ISSN: 2535-1133 (Online)
ISSN: 1312-3882 (Print)

arrangement of the genotypes was observed, with line 11 reached a maximum value of 28 seeds, followed by line №8 with 26 seeds. The third position was occupied by line №9A (24). Plants of line №29 and variety Crystal managed to feed 20-21 seeds, and line №115 and variety Kerpo shared the last place with 16-17 seeds.

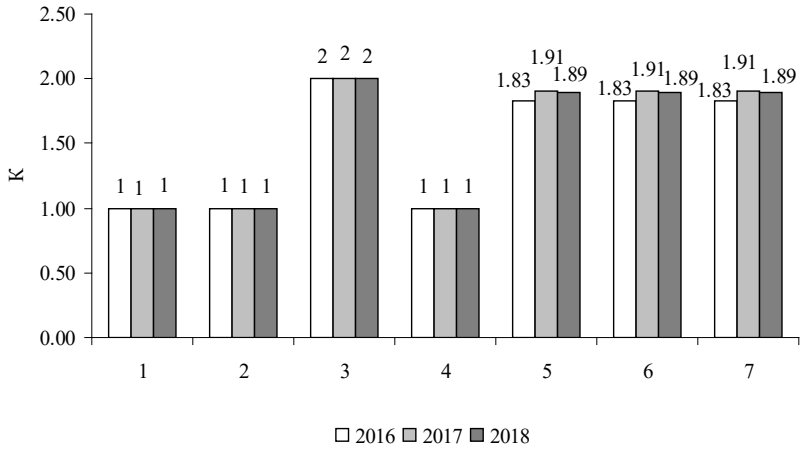

Figure 2. Coefficient of early maturity (K) in forage pea genotypes
1 – Kerpo , 2 – Crystal, 3 – №115, 4 – №29, 5 – №9A, 6 – №8, 7 – №11

Table 3. Morphological characteristic of the studied pea genotypes (2016-2018)

Genotype	Plant height, cm	1st pod height, cm	Pods number per plant	Seeds number per plant	Seeds number in a pod	Seed weight per plant, g	Weight of 1000 seeds, g
Kerpo	51ab	39ab	5a	17ab	3a	3.37c	196.28cd
Crystal	48a	32a	7ab	20abc	3a	4.47d	206.33d
№115	62abc	43ab	5a	16a	3a	3.15bc	162.00bc
№29	74cd	56bc	6ab	21abc	3a	4.88d	209.88d
№9A	71bcd	48cd	6ab	24abc	4b	2.14a	105.02a
№8	91de	61d	8b	26bc	3a	2.45ab	129.33ab
№11	101e	61d	8b	28c	3a	1.93a	120.05a

a, b, c, d, e – statistically significant differences at P=0.05

The tested genotypes did not differ considerably in the seeds number per pod and formed on average of 3 seeds. In the pods of the plants of line №9A were formed most seeds in a pod - an average of 4. According to the results of their research, the established minimum seeds number in a pod was 4, and the maximum 5, which was in accordance with the present study.

The seed weight per plant is a trait that largely correlates with grain yield and

gives an indirect idea of the magnitude of biological yield. The lowest values of this indicator were reported at №11 (1.93 g), followed by №9A (2.14 g) and №8 (2.45 g). Crystal variety and line №29 (4.47 and 4.88 g) were distinguished by the highest and statistically significant seed productivity.

The largest weight of 1000 seeds (> 200 g) was formed by the plants of line №29 (209.88 g) and variety Crystal (206.33 g), which can be attributed to large-seeded genotypes. In Kerpo and №115 (203 g), values between 150 and 200 g were obtained, which characterize them as medium-seeded ones. Lines №11, №8 and №9A belonged to the group of small-seeded genotypes, with weight of 1000 seeds less than 150 g.

Conclusions

The results of the three-year experimental activity with the studied seven genotypes of forage peas allow us to draw the following more important conclusions:

For the study period, high values of the variation coefficient were found for the traits of pods number (24.23%) and seeds number per plant (25.08%), medium ones – for plant height (17.75%), 1st pod height (13.95%), weight of 1000 seeds (13.57%) and seeds weight per plant (11.77%), and low – for seeds number in a pod (8.70%).

Line №29 was of breeding interest in the grain direction. It was characterized by average height (74 cm), short vegetation period (78-90 days), and exceeds the control varieties in terms of weight of 1000 seeds (209.88 g) and seed productivity (4.88 g).

The varieties Crystal and Kerpo were distinguished by good characteristics of the structural elements and can be used as parental components in the combination selection in the development of new forms in the grain direction.

References

Ashiev, A.R., Skulova, M.V. & Khabibullin, K.N. (2018). Yield and elements of its structure new pea lines. *Grain Economy of Russia*, 5 (59), 26-28. (Ru)

Belyaeva, R.V. & Naumkina, T.S. (2017). Search, study and reproduction of sources of economically valuable traits of peas. *Legumes and cereals*, 4 (24), 43-48. (Ru)

Bozoglu, H., Peksen, E., Peksen, A. & Gulumser, A. (2007). Determination of the yield performance and harvesting periods of fifteen pea (Pisum sativum L.) cultivars sown in autumn and spring.

Chadha, S., Sharma, A. & Paul, Y.S. (2010). Performance of different pea genotypes under organic farming ecosystem. *Himachal Journal of Agricultural Research*, 36 (2), 241-242.

Chekmarov, D.S. (2014). Comparative evaluation of collection samples of pea of

various directions of use. *Legumes and Cereals*, 4 (12), 69-72. (Ru)

Lysenko, A.A. & Korobova, N.A. (2019). Evaluation of collection samples pea productivity elements. *International Journal of Humanities and Natural Sciences*, 7 (1), 107-112.

Dimova, D. & Marinkov, E. 1999. *Experimental work with biometrics*. Sofia, Zemizdat. (Bg)

Gul, I., Sumerli, M., Bicer, B.T. & Yilmaz, Y. (2005). Heritability and Correlation Studies in Pea (Pisum arvense L.) Lines. *Asian Journal of Plant Sciences*, 4, 154-158.

Hussain, S.I., Khokhar, K.M., Hidayatullah M.T. & Laghari, M.H. (2002). Comparative studies on seed production capabilities of some pea cultivars under Islamabad conditions. *Asian Journal of Plant Sciences*, 1, 655-656.

Hussain, S.A., Hussain, M., Qasim, M. & Hussain, B. (2005). Performance and economic evaluation of pea varieties at two altitudes in Kaghan Valley. *Sarhad Journal of Agriculture*, 21 (4), 587-589.

Kondykov, I.V., Amelin, A.V., Soboleva, G.V. & Zotikov, V.I. (2010). Perspective directions and methods of selection of oblique varieties of peas. *Feed Production*, 3, 26-30. (Ru)

Kosolapov, V.M., Fitsev, A.I., Gaganov, A.P. & Mamaeva, M.V. (2009). *Peas, lupines, vetch, beans: evaluation and use in the feeding of farm animals*. Ugreshskaya printing house, Moskva. (Ru)

Kuzmova, K. (2002). Quantitative assessment of wintering and spring varieties of peas by degree of early maturity. *Jubilee scientific session-120 years of agricultural science in Sadovo*, p.109-112. (Bg)

Likhacheva, L.I., Himaletdinova, V.S. & Kozinova, E.G. (2016). Conjugacy of quantitative signs of pea cultivars in the Middle Urals. *Legumes and cereals*, 3 (19), 45-48. (Ru)

Qasim, M., Zubair, M. & Wadan, D. (2001). Evaluation of exotic cultivars of pea in Swat valley.

Sobolev, D.V. & Shchetinin, V.Yu. (2008). Variability of pea traits in ecological geographical study. *Agricultural Science*, 3, 12-13. (Ru)

Vishnyakova, M.A. (2012). The role of VIR in the mobilization, preservation and use of the gene pool legumes: history and modernity. *Legumes and Cereals*, 1, 27-37. (Ru)

Vishnyakova, M.A. (2017). Collection of genetic resources of legumes VIR as an integral part of the basis of food, environmental and bioresource security. *Legumes and cereals*, 3 (23), 29-32. (Ru)

Zotikov, V.I., Naumkina T.S. & Sidorenko V.S. (2014). Legumes in the Russian economy. *Agriculture*, 4, 6-8. (Ru)