

YODAI – A NEW VARIETY OF GRASS PEA (*Lathyrus sativus* L.)

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The biological performance of grass pea (*Lathyrus sativus* L.) hybrid lines [LHL (BGE027129 × LA5108), LHL-2 (BGE025277 × LA5108) and LHL-3 (LA5108 × BGE027129)] and their parental components (BGE027129, BGE025277 and LA5108 varieties) were studied in a three-year field experiment. Biometric analysis of each variety and line was done for main quantitative traits and phenological stages and periods. The height of the plants at the technological maturity of the grain reached 46 cm. The vegetation period has an average duration of 93 days. New variety Yodai was created, which was obtained by multiple individual selection from the cross BGE027129 × LA5108 (line LHL). The new variety ripens 4-5 days before the varieties BGE027129 and LA5108. On average, 13 well-fed pods per plant were formed with a total of 22 normally developed seeds. The seeds were medium-large with a white seed coat, with a flat oval shape. The seed productivity (4.41 g/plant) exceeds the average of the parental varieties (3.80 g/plant). The weight of 1000 seeds was about 172 g. The crude protein content was 23.85%. In addition, the variety has good resistance to cracking of the pods. It is drought tolerant and weakly attacked by diseases and enemies. In 2022, by the decision of the Expert Commission at the Executive Agency for Variety Testing, Field Inspection and Seed Control, Bulgaria (appointed by order RD-10-1/14.01.2022) and by order No. RD-14-3 of 02.03.2022, the Yodai variety was recognized as new and original.

Keywords: crude protein content, grass pea, new variety, productivity

INTRODUCTION

Grass pea (*Lathyrus sativus* L.) is an annual legume crop with a wide distribution range. The main areas of its cultivation are countries with an arid and semi-arid climate. Wild or semi-wild populations are extremely rare, mainly in the steppes of the Caspian Sea, in the northern

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regions of India and as a weedy plant among cereals and legumes in the western Mediterranean and in the mountainous regions of Southwest Asia (VISHNYAKOVA and BURLYAEVA, 2006).

Among the grass pea species currently cultivated, *Lathyrus sativus* is one of the most famous and widely distributed, as it is used not only for fodder but also for human consumption. Compared to it, the other types of grass pea were mostly used for decorative purposes. The centers of diversity of this species are in the Mediterranean and Central Asia, suggesting that it may have been one of the first plant species cultivated in Europe as a result of the agricultural 'expansion' from the Middle East (SAMMOUR *et al.*, 2007).

The seeds of the grass pea plant are used as feed for farm animals in the same way as the seeds of the pea. The flour obtained by grinding the seeds of the grass pea, as well as other annual legumes, can be added in an amount of up to 20% when making bread and other pasta products, increasing the total protein content and digestibility by the human body (ZAICHKOVA *et al.*, 2001). In addition, the seeds of the grass pea can also be used for technical purposes. From the casein obtained from the seeds of the grass pea, a valuable glue can be prepared, which glues plywood, wood, cardboard, paper, etc. This adhesive is suitable for the aviation and textile industries (KENICER *et al.*, 2005).

In the selection of self-pollinating annual leguminous crops such as grass pea, lupine, pea, chickpea and others, the selection process is carried out by the generally accepted methods of pedigree, mass selection, backcross and complex crosses. In cases where the inheritance of the trait is more complex and the decaying generations are many, the study of too large populations is required and the desired combination of two traits is very rarely obtained in the early hybrid generations (ROZHANSKAYA, 2005).

Artificial sexual hybridization is the main method of creating new varieties and in the grass pea, and the selection of parental components to perform the crosses ensures success in the selection process (DIXIT *et al.*, 2016). The aim of this study was a more complete characterization of the distinguishing characteristics as well as the biological qualities of promising genotypes of grass pea to be done.

MATERIALS AND METHODS

The experiment was carried out during the period 2019-2021 at the experimental field of the Institute of Forage Crops – Pleven, Bulgaria. The sowing was done mechanized. The plant material was planted in four replicates with a harvest plot size of 10 m². The productive possibilities were studied of the following grass pea hybrid lines (obtained by multiple individual selection of F₂ hybrids): - LHL (BGE027129 × LA5108); LHL-2 (BGE025277 × LA5108) and LHL-3 (LA5108 × BGE027129), and BGE027129 and BGE025277 varieties originating from Spain and LA5108 from Portugal.

Biometric measurements were done on 10 plants of each variety and line in two phenological stages of plant development. The next characteristics were recorded: plant height (cm), number of pods per plant, number of seeds per pod, number of seeds per plant, weight of seeds per plant (g), mass of 1000 seeds (g), grain yield (kg/da).

The relevant phenological stages and periods were recorded, viz. date of germination, beginning of flowering, full flowering, technical maturity, duration of the growing season (days). Yodai variety was created by multiple individual selection in the cross BGE027129 × LA5108

(line LHL). Since 2018, it has been included in a comparative variety test at the experimental field of the Institute of Forage Crops – Pleven, Bulgaria. In 2020, it was presented in the Expert Commission at the Executive Agency for Variety Testing, Field Inspection and Seed Control system for testing for distinguishable homogeneity and stability. At a meeting of the Expert Council on Legume Crops at Expert Commission at the Executive Agency for Variety Testing, Field Inspection and Seed Control it was approved as a new and original variety.

Variance analysis according to DIMOVA and MARINOV (1999) was used to establish reliable differences between individual genotypes (varieties and lines) in terms of yield and the studied elements of productivity.

RESULTS AND DISCUSSION

Productivity and resistance of the variety are integral (inseparable) indicators. They are formed as a result of the interaction of many genetic systems, physiological and biological processes in the plant, which in different stages of ontogenesis can correlate to different degrees with the final productivity and yield. These indicators reflect the quantitative and qualitative characteristics of the individual genotype. The determination of these indicators, especially in the parental forms and their hybrid lines, is widely used in breeding practice.

It is known that the growth of the stem of the plant organism can continue until full maturity. Climatic conditions have a significant effect on it. A change in mean daily air temperature within a small range has no significant effect on the growth rate, while precipitation during the period from germination to flowering is of primary importance.

The occurrence of the phenological stages of development in the cultivars and lines was recorded by dates as follows - sowing, beginning of flowering, technical maturity. Table 1 presents data on the main periods of plant development for the lines and varieties of grass pea. Certain differences were found in the onset of flowering, as well as in the rates of growth and reaching technical maturity. The main influence on the speed of full germination and initial development of plants in the experimental conditions was the average daily air temperature, with a sufficient amount of moisture in the upper layer of the soil before sowing. The earliest flowering phenological stage occurred in cultivar LA5108 and line LHL in all three years of the study (Table 1).

Lines LHL-2 and LHL-3 start flowering 2-3 days later than LHL, with the latest blooming variety BGE025277 emerging.

At the end of the growing season, differentiation was observed in the early flowering genotypes, with the LA5108 variety reaching technical maturity in a period of 80 to 104 days, and the LHL line in 77-101 days. The vegetation period of the plants of the varieties BGE025277 and BGE027129 lasts from 81 to 107 days, depending on the date of sowing and climatic conditions. Lines LHL-2 and LHL-3 mature slightly later with a difference of 3-5 days compared to LHL, due to slower growth and development.

In 2021, at an average daily temperature of 5.16°C for the month of March, the plants germinated for a relatively long period of time - 35 days after sowing. In 2019, at higher daily temperatures of 9.50°C, due to the small and unevenly distributed amounts of precipitation, plants germinated in about 30 days, and in 2020, at a temperature of 8.18°C, germination

occurred after 13 days. In these initial phenological stages of plant development, no differences were found between cultivars and lines.

Table 1. Phenological developments of lines and varieties grass pea (2019-2021)

Stages/ Variety (line)	Year	Data of sowing	Data of germination	Beginning of flowering
BGE027129	2019	05.03.	05.04.	17.05.
	2020	20.03.	02.04.	10.05.
	2021	04.03.	08.04.	18.05.
LA5108	2019	05.03.	05.04.	16.05.
	2020	20.03.	02.04.	08.05.
	2021	04.03.	08.04.	13.05.
BGE025277	2019	05.03.	05.04.	19.05.
	2020	20.03.	02.04.	12.05.
	2021	04.03.	08.04.	20.05.
LHL	2019	05.03.	05.04.	15.05.
	2020	20.03.	02.04.	07.05.
	2021	04.03.	08.04.	11.05.
LHL-2	2019	05.03.	05.04.	17.05.
	2020	20.03.	02.04.	07.05.
	2021	04.03.	08.04.	11.05.
LHL-3	2019	05.03.	05.04.	17.05.
	2020	20.03.	02.04.	10.05.
	2021	04.03.	08.04.	18.05.

It is noteworthy that for BGE025277 and BGE027129 cultivars the plant height was 48-49 cm, while for the other parental component cultivar LA5108 it does not exceed 44 cm (Tab.2).

Table 2. Phenological developments of lines and varieties grass pea (2019-2021) (continues)

Stages/ Variety (line)	Year	Full maturity	Technological maturity	Vegetation period, days
BGE027129	2019	27.05.	19.06.	106
	2020	20.05.	09.06.	81
	2021	25.05.	16.06.	104
LA5108	2019	23.05.	17.06.	104
	2020	17.05.	08.06.	80
	2021	21.05.	14.06.	102
BGE025277	2019	26.05.	20.06.	107
	2020	19.05.	09.06.	81
	2021	27.05.	13.06.	101
LHL	2019	22.05.	14.06.	101
	2020	16.05.	05.06.	77
	2021	20.05.	11.06.	99
LHL-2	2019	22.05.	17.06.	104
	2020	16.05.	08.06.	80
	2021	18.05.	10.06.	98
LHL-3	2019	26.05.	17.06.	104
	2020	18.05.	10.06.	82
	2021	28.05.	13.06.	101

Close to the LA5108 variety were the LHL and LHL-2 lines, which occupy an intermediate position with a plant height of 45-46 cm. On this basis, line LHL-3 emerged as the genotype forming plants with the highest stems (53 cm), and the differences with LA5108 and BGE027129 were statistically significant.

The study of the main elements of productivity is an important stage in establishing the best genotype for the specific agro-climatic conditions. The productive potential of the genotypes depends on the number of pods and the number of seeds per pod. BGE027129 and LA5108 formed a higher number of pods per plant (14).

Similar results we found for line LHL-2, which also had 14 pods, followed by LHL having 13 pods. The values of this indicator for line LHL-3 and variety BGE025277 were lower, 9 and 10 pods per plant, respectively.

As a result of the study, significant phenotypic variation was found in another main component affecting productivity - the number of seeds per plant. According to this morphological indicator, the genotypes are usually presented in an analogous way, as the previous trait. In line LHL-2 and varieties LA5108 and BGE027129, the number of seeds reaches 24-26. The fourth position was occupied by line LHL (22), and BGE025277 and line LHL-3 share the last two places with 15 and 16 seeds per plant, respectively. Of the tested plant forms, varieties LA5108 and LHL-2 differed from the others in terms of the number of seeds per pod and formed an average of 3 seeds per pod. Plants of cultivars BGE027129 and BGE025277 and lines LHL and LHL-3 set up to 2 seeds per pod. The mass of seeds per plant is a trait that is highly correlated with grain yield and gives an indirect idea of the magnitude of biological yield. The lowest values of this indicator were found for LA5108 (2.97 g), followed by LHL-2 (3.03 g) below the sample mean (3.98 g) (Figures 1, 2 and 3). Regarding this quantitative trait, variety BGE027129 (4.64 g) and lines LHL (4.41 g) and LHL-3 (4.57 g) are distinguished by the highest and statistically significant seed productivity.

Seed productivity

One of the main trait characterizing the economic value of the genotype is its productivity, which mainly depends on the weight of the seeds from one plant. The last parameter is determined by several of its components - the number of productive nodes per plant, number of seeds in one pod and mass of 1000 seeds.

A high percentage of germinated and developed plants was found during the study period, both in the cultivars and in the lines. This has enabled an even more objective assessment of the tested selection materials. The plants of the varieties BGE025277 (285 g) and BGE027129 (268 g) have the highest mass per 1000 seeds, which can be referred to the large-seeded genotypes. Of the selected hybrid lines, LHL-3 had a slightly lower mass per 1000 seeds (246 g) and was not significantly different from them. Lines LHL (172 g) and LHL-2 (204 g) obtained values for the mass of 1000 seeds, which characterized them as medium-seeded. In the group of small-seeded genotypes with a mass of 1000 seeds below 150 g, variety LA5108 (115 g) can be included.

Weather conditions over the years did not have a significant effect on the formation of grain yield in the grass pea genotypes and they did not differ significantly (Table 3). In the conditions of the favorable year 2019, the grain yield varied from 80.93 kg/da for LA5108 to

138.85 kg/da for BGE027129. Line LHL occupied an intermediate position with a yield of 116.33 kg/da, exceeding the average yield of the parental forms (109.89 kg/da). In 2020, yields were found generally slightly lower compared to the previous year. It is noteworthy that the differences between LA5108 (75.10 kg/da) and LHL line (98.95 kg/da) are smaller, and variety BGE027129 again took the first position (131.19 kg/da). The year 2021 characterized by a significant amount of precipitation in the second half of the growing season. Of the tested cultivars, 131.78 kg/da for cultivar BGE027129, 111.08 kg/da for line LHL and 77.62 kg/da for LA5108 were obtained, respectively.

Table 3. Grain yield (kg/da) in varieties-parental components and hybrid line grass pea LHL (2019-2021)

Variety/line	2019	2020	2021	Average	%
Grain yield					
BGE027129	138.85	131.19	131.78	133.94c	126.06
LA5108	80.93	75.10	77.62	77.88a	73.94
LHL	116.33	98.95	111.08	108.79b	107.04
Mean (P1+P2)	109.89	103.145	104.70	105.91b	100.00

means followed by the same letter are not statistically different at the $p < 5\%$ probability level

Precipitation is unpredictable from year to year. The tested years are characterized by precipitation well below the norm and with an unfavorable distribution by months (CAMPBELL *et al.*, 1993; LAMBEIN *et al.*, 2019; CHOWDHURY *et al.*, 2020; LAKIĆ *et al.*, 2019; KOSEV *et al.*, 2022). The lowest average grain yields during the studied period were recorded for variety LA5108 (77.88 kg/da). BGE027129 realized the highest yields (133.94 kg/da), followed by line LHL (108.79 kg/da). LHL exceeded by 7.04% the average yield obtained from the parental cultivars, although the differences were not statistically significant.



Figure 1. Line grass pea LHL (BGE027129 x LA5108)



Figure 2. Line grass pea LHL-2 (BGE025277 x LA5108)

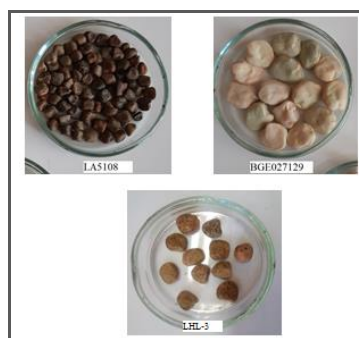


Figure 3. Line grass pea LHL-3 (LA5108 x BGE027129)

Biochemical composition

In order to analyse the biochemical composition of the grain of the released candidate varieties and promising forms, the main parameters - dry matter, crude protein (%), crude fiber (%), calcium and phosphorus were determined. The calcium: phosphorus ratio was also calculated. The results of the study showed that the dry matter percentage of the established line (LHL) was 89.57 (Figure 4).

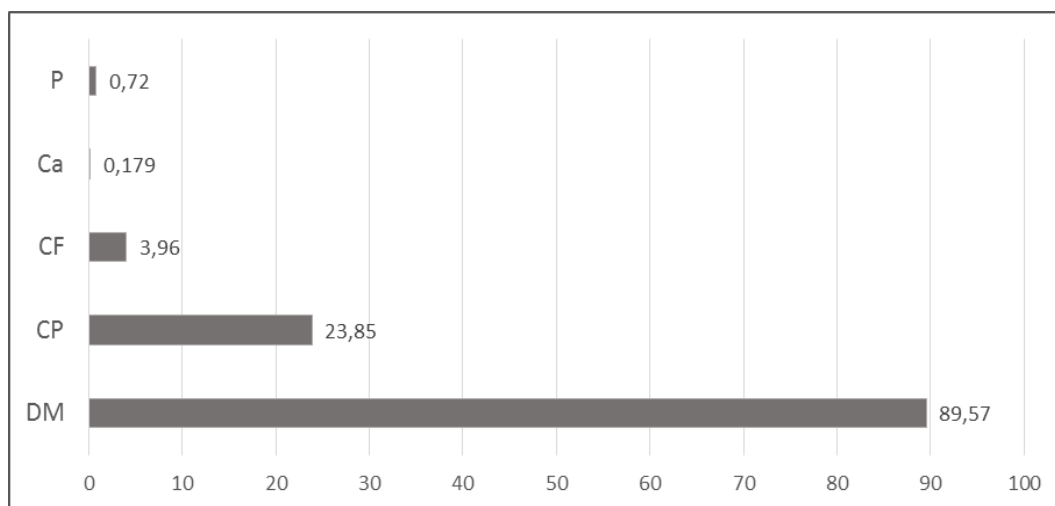


Figure 4. Biochemical evaluation of grass pea line LHL (%); (Dry matter (%), CP–crude rotein (%), CF–crude fiber (%), Ca–calcium (%), P–phosphorus (%))

The crude protein content was over 23%. A relatively low crude fiber content (3.96%) was found. The calcium and phosphorus content values were 0.179% and 0.720%, respectively, and the calcium: phosphorus ratio was 0.248.

CONCLUSIONS

Lines LHL-3 and LHL were considered of interest for the breeding in the direction of grain productivity. The LHL line is early-ripening, with a short vegetation period (77-101 days). The BGE027129 and BGE025277 varieties showed good characteristic of the structural elements of the yield and can be used as parental components in breeding programs in the creation of new promising forms grass pea in the direction of the grain production.

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IODAI – NOVA SORTA GRAŠKA (*Lathirus sativus* L.)Valentin KOSEV¹, Vilijana VASILEVA², Vera POPOVIĆ³¹ Institut za krmne biljke, Poljoprivredna akademija, 5800 Pleven, Bugarska² Institut za kukuruz, Poljoprivredna akademija, 5835 Kneža, Bugarska³ Institut za ratarstvo i povrtarstvo, Institut od nacionalnog značaja za Republiku Srbiju, Novi Sad, Republika Srbija

Izvod

Biološke performanse hibridnih linija stočnog graška (*Lathirus sativus* L.) [LHL (BGE027129 × LA5108), LHL-2 (BGE025277 × LA5108) i LHL-3 (LA5108 × BGE027129)] i njihovih roditeljskih komponenti (BGE027129 × LA5108) i (12712750) sorte) proučavani su u trogodišnjem poljskom ogledu. Urađena je biometrijska analiza svake sorte i linije za glavne kvantitativne osobine i fenološke faze i periode. Visina biljaka u tehnološkoj zrelosti zrna dostigla je 46 cm. Vegetacijski period u proseku traje 93 dana. Stvorena je nova sorta Iodai, koja je dobijena višestrukom individualnom selekcijom iz ukrštanja BGE027129 × LA5108 (linija LHL). Nova sorta sazreva 4-5 dana pre sorti BGE027129 i LA5108. U proseku je formirano 13 dobro hranjenih mahuna po biljci sa ukupno 22 normalno razvijena semena. Seme je bilo srednje veliko sa belom semenskom omotačem, ravnog ovalnog oblika. Produktivnost semena (4,41 g/biljci) je veća od proseka roditeljskih sorti (3,80 g/biljci). Težina 1000 semena bila je oko 172 g. Sadržaj sirovih proteina bio je 23,85%. Pored toga, sorta ima dobru otpornost na pucanje mahuna. Otporna je na sušu i slabo je napadaju bolesti i štetočine. Godine, 2022. odlukom Stručne komisije pri Izvršnoj agenciji za ispitivanje sorti, terenskih inspekcija i kontrole semena u Bugarskoj (imenovana naredbom RD-10-1/14.01.2022.) i naredbom br. RD-14-3 od 02.03.2022, sorta Iodai je prepoznata kao nova i originalna.

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