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STUDY OF THE VARIABILITY OF MORPHOLOGICAL AND PRODUCTION CHARACTERS IN SOME *VICIA FABA* L. GENOTYPES

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Abstract

Vicia faba L. is an annual species of the Fabaceae family, cultivated for the value of its seeds rich in vegetable proteins and for its contribution to improving and maintaining soil fertility by fixing atmospheric nitrogen. The study aims to analyze the variability of some morphological and productivity characters of an assortment of twelve faba bean genotypes. The following traits were analyzed: plant height, number of branches, minimum height of the first pod, pod length, pod width, number of pods per plant, number of seeds per pod, weight of 100 seeds, and total weight of pods per plant. Significant differences were observed between genotypes for the studied characters. From a productive point of view, genotypes G2, G3, G6, G7 and G10 were noted, whose production ranged between 41.33-54.17 g/pl. These genotypes can be recommended for cultivation in the South-West area of Romania and considered valuable and useful for future breeding programs.

Key words*: agro-morphological traits, faba bean, phenotypic variability.*

INTRODUCTION

Broad beans (*Vicia faba* L.), native to the Mediterranean and Central Asia, are an important vegetable crop that can be used as food for human consumption and as animal feed (Yu et al., 2023; Stavropoulos et al., 2024). Broad beans are cultivated in the continental area from northern Europe to Ethiopia and in all countries on the Mediterranean coast. China, Ethiopia, Morocco, France, Italy, Tunisia, and Spain are among the countries with the largest cultivated areas (Akgun and Canci, 2023).

Faba bean (*Vicia faba*) is one of the oldest vegetables in the world and is the fourth most important winter legume after chickpea, dried peas, and lentils (Barcanu et al., 2023). World production of faba bean is divided into two categories: fresh beans and dried beans. Fresh faba beans are mainly grown in Algeria (32,315 t in 2021), and dried faba beans are mainly produced in China (804,320 t in 2021). In the legumes category, globally, *Vicia faba* production ranks sixth, after common bean (*Phaseolus vulgaris* L.), chickpea (*Cicer arietinum* L.), field pea (*Pisum sativum* L.), cowpea (*Vigna unguiculata* L.) and lentils (*Lens culinaris* Medik.) (FAOSTAT, 2024).

Legumes are crucial for sustainable agriculture and provide essential plant-based proteins for both human and animal diets (Sokolović et al., 2025). Vicia faba seeds are rich in protein, essential amino acids, energy, and mineral compounds and have particularly high levels of unsaturated fatty acids (Meng et al., 2021). They also contain antinutritional factors such as vicine, convicine, and tannin. For a balanced and healthy diet, faba bean varieties should be improved for high seed yield with higher essential amino acid content and low antinutritional factors (Akgun and Canci, 2023). The dried seeds also have the potential to be used as a replacement for soybean meal and/or cereal seeds in animal diets to support milk, meat, and/or egg production (Meng et al., 2021). Legume production, including faba beans, is crucial to mitigate the growing challenges in agricultural production, such as global food stress, land degradation, and excessive use of chemicals (Yu et al., 2023). Faba beans are recommended in crop rotations to enrich the soil with natural nitrogen or used as green manure, because the vegetative part is vigorous and the roots form nodules with nitrogen-fixing bacteria. Due to its adaptability to climate conditions, it is considered a viable agronomic

alternative to cereals, with a potential for free nitrogen fixation of up to 300 kg N ha^{-1} (Singh et al., 2013).

Vicia faba is an annual, cool-season legume (Meng et al., 2021) with good adaptability to soil and climate conditions (Singh et al., 2013; Papastylianou et al., 2021). However, production results can be influenced by numerous environmental and technological factors (Soare et al., 2024). In general, crop production is also influenced by soil quality, such as texture, porosity, soil reaction (pH), $CaCO_3$ or nutrient content, as well as its interaction with climatic factors (Grecu and Pavel, 2016; Balan and Popescu, 2024;).

This annual species is not demanding on heat, but has high requirements for humidity during germination, flowering, and pod formation. It is frost-resistant; the more resistant varieties tolerate temperatures of -5°C. It cannot withstand excessive heat during flowering (Singh et al., 2013). The optimal growth and development temperatures are 20-22°C, and those higher than 25°C cause stagnation of development. Regarding the soil, it requires a medium texture, with a pH between neutral and alkaline (pH of 6.5 to 8.0) (Rajan et al., 2012; Vînătoru et al., 2019). Therefore, it is important to use stable genotypes, well adapted to the crop areas, which, together with good management practices, contribute to increasing production and cultivated areas (Papastylianou et al., 2021). It is important to implement Vicia faba crop management programs to maintain the genetic diversity of the species, primarily of local populations, at the best possible level (Avramidou et al., 2023).

Classification of *Vicia faba* populations using morphological and agronomic traits is imperative for their effective exploitation in breeding, conservation, and management (Terzopoulos and Bebeli, 2008). Recently, various molecular markers have been successfully used to characterize the genetic diversity of faba bean genotypes (Wang et al., 2012). *Vicia faba* L. crop often faces drought during its growth and development, so that soil moisture deficit limits its production (Khan et al., 2010; Bonea et al., 2022). In this regard, Memari et al. (2022) suggest investigating the effect of drought stress using stress tolerance indices for the selection of genotypes tolerant to this factor.

Plant breeding has significantly contributed to obtaining a large number of varieties with desired traits, and as a result, it is important to analyze some traits considered useful (yield potential, abiotic stress resistance) when choosing faba bean varieties (Yüce et al., 2023). In recent decades, in Romania, the Vicia faba crop has been underutilized, with decreasing areas. According to FAOSTAT, in Romania, in 2020 the harvested area of faba beans was less than 12,000 ha, with a production of only 11,250 tons (Barcanu et al., 2022). In 2024, the area cultivated in Romania with dry beans decreased drastically to 6,690 ha, the same trend having the production per hectare of 934 kg/ha (fao.org, 2026). The decline in areas and production is related to susceptibility to biotic and abiotic stresses and the instability of production.

The reduction in areas may also be due to the change in cropping systems in many areas where it was cultivated in the past (Vörösváry et al., 2011; Țigriș et al., 2020).

Plant genetic resources or germplasm are fundamental sources for plant improvement, and the assessment of genetic diversity among germplasm accessions is useful for facilitating a more efficient use of plant genetic resources (Karaköy et al., 2014). The use of genetic diversity is very important for the efficient selection of superior genotypes for all crops (Iacob and Ciulca, 2024). An important strategy for increasing yield and quality is choosing the most suitable cultivars for various environmental conditions (Bonea et al., 2026). In addition to qualitative improvement, abiotic stress management is becoming a major challenge in the research of this species (Torres et al., 2011).

In order to promote the cultivation of *Vicia faba* in Romania, studies were carried out on the behavior of some genotypes under the environmental conditions of different areas: in the East, Horaicu et al. (2023), in the West, in the Timiș Plain Țigriș et al. (2020), in central Romania Barcanu et al. (2022), highlighting the most productive ones. Recently, however, numerous foreign genotypes have arrived in Romania, whose behavior under local climatic conditions is unknown (Horaciu et al., 2024). In this regard, it was studied the behavior of some *Vicia faba* genotypes from local populations and

from abroad, in the climatic conditions of South-West Romania.

MATERIALS AND METHODS

The experiment was set up in the Didactic Field at the Didactica Station, University of Craiova, in 2023 and 2024, on a reddish-brown preluvosol in the south-west of Romania. A randomized complete block design with 3 replications was used. Sowing was carried out in the third decade of March; the spacing between rows was 0.75 m and between plants it was 0.20 m. During the vegetation period, standard grain cultivation practices were applied.

For this study, seeds were collected from producers from different regions of Oltenia (Romania) or from sources brought from outside Romania (Table 1). Of the 10 genotypes, Genotype 6 and Genotype 10 come from Italy, and the other 8 come from local populations cultivated in Romania (G1-Mătăsari, G2-Bălesti, Genotype 3, G4-Urdari, G5- Vâlcea 2, G7-Tetoiu, G8-Colonesti, G9-Băresti). For the study, the morphological characteristics were monitored: plant height, number of shoots and height of insertion of the first pod, and productivity characteristics: number of pods/plant, seeds/plant, mass of 100 seeds (g) and grain production (kg/ha).

The average climatic data for the vegetation period (April - September) are presented in Table 1. The recorded precipitation was higher in the first year of cultivation (2023) than in the second year (2024). Regarding the temperatures during the vegetation period, the plants were subjected to higher temperatures in the second year than in the first year. In 2023, the minimum temperature was 0.3°C in April and the maximum was +37.4°C in August, while in 2024, the minimum temperature was +2.0°C in April and the maximum was +39.6°C in July.

Table 1. Temperatura, total rainfall, and the relative humidity of the air during the experiment *

Month	Temperature (^{0}C)						The relative humidity of the air (%)		Rainfall (mm)	
	minimum		maximum		medium					
	2023	2024	2023	2024	2023	2024	2023	2024	2023	2024
April	+0.3	+2.0	+21.4	+31.4	+10.3	+15.2	74	59	43	33
May	+6.9	+7.9	+26.7	+27.7	+15.9	+16.8	73	66	53	32
June	+11.2	+13.5	+32.9	+36.3	+20.3	+25.4	75	53	116	47
July	+11.5	+14	+36.5	+39.6	+25.1	+27.4	62	48	57	18
August	+12.7	+16.2	+37.4	+38.2	+25.5	+27.0	54	43	28	10
September	+11.9	+7.4	+32.8	+34.4	+21.6	+20.3	56	55	21	30

*https://m.rp5.ru/Vremea_%C3%AEn_Craiova_(aeroport)

Statistics

For each analysis, three to five measurements were performed, calculating the mean, standard deviation (SD) and coefficient of variability (CV %). Production results were statistically analyzed using three-way analysis of variance (ANOVA), MINITAB 22.2.2 Statistical Software (2025), and differences between means were evaluated by Tukey's test ($p < 0.05$).

RESULTS AND DISCUSSIONS

In this study, data on the variability of the main morphological characters in the considered grain genotypes are presented in Table 2. Thus, the measurements made at harvest regarding the plant height character indicate an amplitude of variation from 84.83 cm and 105.17 cm, the highest value was at Genotype 4 and the lowest at Genotype 1. Regarding the value of the coefficient of variation, this was ≤ 8.62%, which indicates a low variability of this character. Vörösváry et al. (2011), in a study carried out in different ecological conditions of Transylvania (Romania), on grain germplasm, reported a variation in plant height from 43.9 cm to 62.9 cm, and Horaicu et al. (2023) reported for the eastern area of Romania, variation from 58.33 cm to 86.33 cm. This variability in plant height may be due to genotypes or agro-ecological zones.

Regarding the number of stems/plant, a number between 3-4 stems/plant is found, and the coefficient of variation presents values indicating medium to high variability. Horaicu et al. (2023) reported a variation from 2.2 to 2.73 stems per plant.

The height of the first pod insertion (cm), determined from the ground to the first pod, indicates a good capacity of the genotype for mechanized harvesting and the reduction of production losses. Thus, among the 10 genotypes studied, those with the highest first pod insertion, over 14 cm, were Genotype 9, 3, 4, 6, 7 and 8. The coefficient of variability recorded values from 7.23% to 19.97%, indicating a low to medium variability.

Several authors have analyzed the variation of the main agronomic traits in some grain genotypes cultivated in different regions of Romania, finding differences between them in terms of morphological and agronomic traits, and identifying, based on this, genetic resources with valuable potential for the selection and improvement of this crop can be identified (Vörösváry et al., 2011; Barcanu et al., 2023).

In the present study, the number of pods/plant showed a range of variation from 11 pods/plant (Genotype 5) to 18 pods/plant (Genotype 10), and the coefficient of variation ranged from 7.23% to 17.72%, indicating a low to medium variability. Horaciu et al. (2024), for the genotypes studied in eastern Romania reported range of variation was from 4.87 to 10.6 pods/plant.

Table 2. Variability of morphological production characters in *Vicia faba* genotypes

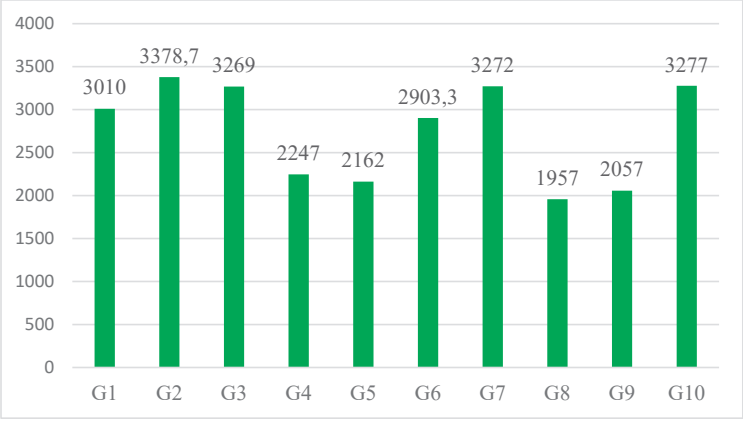
Genotypes	Plant height (cm)		Stems/plant (no)		Height to first pod (cm)	
	Mean ± SD	CV (%)	Mean ± SD	CV (%)	Mean ± SD	CV (%)
Genotype 1	84.83+5.46	6.43	3.67+0.82	22.27	12.33+1.63	13.24
Genotype 2	97.17+6.91	7.11	3.30+0.82	24.49	12.83+2.56	19.97
Genotype 3	94.33+5.75	6.10	2.83+0.75	26.57	14.50+1.38	9.51
Genotype 4	105.17+7.19	6.84	2.60+0.52	19.36	16.50+2.35	14.21
G5-Valcea 2	96.50+4.46	4.62	4.00+0.89	22.36	10.83+1.17	10.79
Genotype 6	104.67+4.50	4.30	4.33+0.52	11.92	17.17+0.98	5.73
Genotype 7	93.17+8.04	8.62	3.33+1.03	30.98	18.67+1.75	9.38
Genotype 8	99.50+5.72	5.75	4.17+0.41	9.80	16.33+1.51	9.22
Genotype 9	104.83+5.31	5.06	2.67+0.52	19.36	14.50+1.05	7.23
Genotype 10	96.67+6.65	6.88	3.83+0.75	19.64	13.00+1.26	9.73

Seed weight/plant (g), an important indicator of productivity, ranged from 25.17 g/plant (Genotype 8) to 54.17 g/plant (Genotype 6), and the coefficient of variation ranged from 2.16 % to 13.61 %, indicating low to medium variability. Mass of 100 dry seeds (g) showed a difference between the genotypes studied. Thus, the amplitude of variation ranged from 97.83 g to 129.17 g, and the coefficient of variation ranged from 2.27 % to 8.41%, indicating low variability (Table 3). Other authors reported that in central Romania, the 100-seed mass changed between 50-79.8 g (Vörösváry et al., 2011). Also, in Turkey, Yüce et al. (2022) reported values on 100-grain weight ranging between 48 and 214 g.

Table 3. Variability of production traits in *Vicia faba* genotypes

Genotypes	No. of pods/plant		Seeds/plant (g)		Mass of 100 dry seeds (g)	
	Mean ± SD	CV (%)	Mean ± SD	CV (%)	Mean ± SD	CV (%)
Genotype 1	16.33+2.16	13.23	36.00+4.90	13.61	102.83+4.07	3.96
Genotype 2	13.67+2.42	17.72	41.33+1.21	2.93	114.50+9.09	7.94
Genotype 3	16.67+2.42	14.53	43.33+2.42	5.59	110.00+9.21	8.37
Genotype 4	14.17+1.72	12.16	28.67+3.83	13.36	98.67+5.96	6.04
Genotype 5	11.00+1.79	16.26	26.50+2.17	8.18	118.33+3.27	2.76
Genotype 6	16.17+1.17	7.23	54.17+1.17	2.16	129.17+2.93	2.27
Genotype 7	15.50+2.07	13.38	42.00+2.97	7.06	115.83+1.72	1.49
Genotype 8	8.33+1.37	16.40	25.17+2.93	11.63	97.83+8.23	8.41
Genotype 9	14.50+1.87	12.90	28.83+2.32	8.03	98.67+7.87	7.97
Genotype 10	18.00+1.41	7.86	41.67+1.63	3.92	110.17+7.47	6.78

The results obtained regarding the yield of the studied genotypes are presented in Figure 1. Thus, the production of faba bean showed significant differences between genotypes; the highest production was obtained in Genotype 2, at 3378.7 kg/ha, followed by Genotypes 10 (3277 kg), 7 (3272 kg/ha), 3 (3269 kg/ha) and 1 (3010 kg/ha). It is observed that there are significant differences between the studied genotypes ($p < 0.05$). The lowest production was obtained in Genotype 8, at 1957 kg/ha. Other authors have reported that, under the conditions of the NE of the country, production depending on the genotype ranges between 2792.30 kg/ha and 4179.82 kg/ha (Horaciu et al., 2024), and that, under the conditions of the Timiș Plain, production was higher in grain crops, ranging between 2994 kg/ha, without nitrogen fertilization and 4876 kg/ha with nitrogen fertilization (Țigriș et al., 2020). This variability in production is influenced by the genotype, the cultivation area, and the technology applied. It can be noted that the species grows in different climatic conditions, ensuring good productivity. By Barilli et al. (2025) grain yield can be positively influenced by rainfall and negatively affected by high temperatures.



Means that do not share a letter are significantly different according to the Tukey test ($p<0.05$).

Figure 1. Dry seed production (kg/ha) of the studied genotypes

CONCLUSIONS

For *Vicia faba* cultivation, it is important to manage abiotic stress and to estimate its behavior in different cultivation areas in order to choose favorable genotypes. Under the conditions of South-West Romania, the studied faba bean genotypes showed good production stability across the cultivation years, recording productions ranging between 3010 kg/ha and 3378.7 kg/ha. These genotypes collected from different climatic zones, can be new genetic resources with valuable potential for breeding programs. In our country, there is low biodiversity, with a small assortment of cultivated varieties. More frequently, some local populations are found in traditional culture, but characterized by a wide fluctuation in production. Considering the adaptation potential, the lower temperature requirements, and the agrotechnical and food importance of this species, the genotypes with high production will be studied further, and those with good adaptability for this area of the country will be recommended.

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