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PHENOTYPIC CHARACTERIZATION OF THE ACCESSIONS OF FABA BEAN (VICIA FABA L.) STORED IN THE GENETIC BANK OF ALBANIA

SUMMARY

The study was done to determine the variation of 12 morphological and agronomic traits in 17 landraces of faba bean (*Vicia faba*), collected in areas of Albania and stored in the Genetic Bank of Albania, to use them for cultivation purposes or in genetic improvement programs in function of agricultural production. For the purpose of this study, 12 morphological and agronomic traits were analyzed: leaf length, leaf width, plant height, number of branches on the main stem, number of pods per plant, number of kernels per pod, number of kernels per plant, pod length, pod width, kernel length, kernel width and 100 kernel weight. Validated differences were found for all 12 morphological and agronomic traits. The landraces of faba bean are valued as material for the cultivation of faba bean for the production of legumes and grains. We consider that the large load of the plant with fruit organs can affect the reduction of the weight of 100 kernels.

Key words: faba bean, landrace, phenotypic variation, *Vicia faba*

INTRODUCTION

Faba bean (*Vicia faba* L.) is a winter leguminous crop originating in the Middle East in prehistoric times, belonging to the genus *Vicia* and the Family Leguminosae (*Fabaceae*) and traditionally used as a main source of protein for human and animal nutrition (Multari *et al*., 2015). The leguminosae family

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(*Fabaceae*), in terms of economic importance, is the second family, only after the grasses (*Poaceae*).

Under optimal cultivation conditions, the germination of faba bean seeds takes 10–14 days (Etemadi *et al*., 2015). However, it will take much longer to germinate in dry conditions or when the soil is cold. On average, the faba bean plant grows one node per week. As the stem of the faba bean is relatively strong and grows vertically, the plant can grow to a height of 90–130 cm, depending on the genotype. At the growth stage of nodes 8–10, when the plant is about 30 cm high, the faba bean forms the first flowers. The flowers and pods appear about 20 cm above the ground. Approximately 25% of the flowers will set pods, which usually contain three to six seeds (Etemadi *et al*., 2015). Therefore, the application of appropriate cultivation technology, including irrigation, soil fertility and planting time can significantly reduce the number of aborted flowers, thus improving the final yield of grains/pods.

In general, seed germination of most legumes is sensitive to low soil temperature. However, faba bean is one of the few winter grain legumes whose germination can tolerate cold soil temperatures better than most legumes. Attempts to select for improved seed germination at soil temperatures below 15°C have shown success rates (Singh and Jauhar, 2005). Better germination rate at 12.5°C has been reported in large-seeded cultivars than in small-seeded cultivars (Kang *et al*., 2008).

Due to superior nutritional values including proteins, carbohydrates, B group vitamins and minerals (Crépon *et al.,* 2010), faba bean is considered one of the most important leguminous crops in the world. As a winter legume, faba bean can be incorporated into various farming systems.

Faba bean is partially self-pollinating plant, however the flowers attract various pollinators, especially bees. Current reports showed that bees and other natural pollinators can increase the pollination rate and therefore the grain yield of ryegrass (Musallam *et al*., 2004, Marzinzig *et al*., 2018).

Legumes are a sustainable source of high protein food and are widely cultivated throughout the world. Among legumes, faba bean (*Vicia faba* L.) is one of the oldest agricultural crops cultivated worldwide (Mínguez & Rubiales, 2021). Faba bean is considered an ecologically, nutritionally and economically important agricultural crop (Xiao *et al*., 2021). It is a multipurpose plant that provides various ecosystem services, that is, it is cultivated mainly as a source of food for humans living in Asia and Africa, as food for humans and/or animals in the European region, and for fixing atmospheric nitrogen in agricultural soils by significantly reducing the use of chemical fertilizers (Zhou *et al*., 2018). Nutritionally, mature grain faba bean are rich in protein (26.1%), carbohydrates (58.3%), and dietary fiber (25.0%), (USDA, 2021). Faba bean also contains bioactive compounds, for example, total phenolics and flavonoids with demonstrated antioxidant activity (Valente *et al*., 2018). Faba bean consumption can cause the condition known as favism – a severe form of hemolytic anemia

(Mínguez & Rubiales, 2021; Singh *et al.,* 2013). Hulse (1994) reported that the concentration of lectins (hemagglutinins) is higher in faba bean than in other legumes. Also, oligosaccharides (stachyose, raffinose and verbascose) are also present in faba beans (Toklu *et al.,* 2021), which can be fermented and produce flatulence, which leads to abdominal discomfort. Lectins are destroyed during normal cooking processes due to high heat.

Faba bean has been identified to have the ability to efficiently fix N, and this ability is the highest among winter legumes (Mekkei, 2014). Reports indicate that faba bean can fix 50–330 kg N/hm (Galloway *et al*., 2004, Etemadi *et al.*, 2018) depending on cultivation technology and environmental conditions (Hu and Schmidhalter, 2005). Legumes have an essential role in maintaining soil fertility, not only through biological N fixation, but also by dissolving insoluble phosphorus (P) in the soil, improving the soil's physical environment and increasing soil microbial activity (Rashid *et al.* , 2016).

Genetic variation for N fixation has been identified in faba bean (Graham and Vance, 2000). It is well known that legumes generally respond to existing soil N concentration (Graham, 2008). In soils with relatively high N content, legumes use more N that is in the soil instead of engaging in symbiosis with rhizobia to fix air N (Divito and Sadras, 2014). But the use of N at minimal rates can stimulate N fixation by improving the early stages of plant cultivation until N fixation provides adequate N for plant growth and development (Huang *et al.*, 2017, Abdul Rahman *et al*., 2018).

Faba bean is one of the main leguminous crops that is cultivated in Albania mainly on land above water. In Albania, the farmer's cultivars (landraces) of faba bean have not been genetically evaluated. Characterization of the genetic variation of available faba bean germplasm is important for further improvement of faba bean yield and resistance to biotic and abiotic stresses. In Albania, faba bean grain can potentially be an important alternative source of protein in the feeding of non-ruminant and ruminant animals (Dalipaj, 2021). However, faba bean grain also contains some secondary metabolites, such as phenolic compounds, which for years have been considered as antinutrients, but some later studies have shown their positive effects in the animal organism, considering them as micronutrients (Dalipaj, 2021). Interest in identifying and quantifying the phenolic compounds present in faba bean has increased based on their positive biological effects on health (Dalipaj, 2021). Moreover, the antioxidant activity of phenolic compounds has the property to prevent some diseases and improve the productive performance of animals (Dalipaj, 2021). The kernel of faba bean has lower protein, methionine and cysteine content than soybean, but higher lysine and starch content (Dalipaj, 2021) and higher ruminal degradation of protein (Dalipaj, 2021). Several studies have shown the positive effects of including kernel faba bean in the diet of cows and sheep (Dalipaj, 2021). Its nutritional values have shown variation more as a result of the cultivar than from the methods of their cultivation (Dalipaj, 2021).

The world production of faba bean in 2019 was 5.43 million tons, which represented about 25% increase compared to 4.35 million tons in 1990. The more than 50 countries producing faba bean, about 90% of the production is concentrated in the Asia region with 33.55% of the total world production, followed by the countries of the European Union, with 29.36%, and from African countries with 27.04% of world production (FAO, 2020). Mediterranean countries, Ethiopia, Egypt, China, Afghanistan, India, Northern Europe and North Africa, are the main producers of faba bean (Rahate *et al.,* 2020). China has been the leading producer of faba bean, followed by Ethiopia (Barri and Shtaya, 2012); these two countries represented about 50% of total world production, while the countries of the European Union, the United Kingdom and France were among the top five producers. Also, in 2019, Australia was the leading exporter of faba bean with 265,543 tones or nearly 30% of total exports, followed by the United Kingdom, Lithuania, Egypt and Latvia (FAO, 2020). Egypt leads the importers with 309,355 tons or 40.48% of world imports, followed by Norway, Germany, Saudi Arabia and France (FAO, 2020)

The aim of the study was to know the characteristics of the accessions of the Albanian faba beans. By determining the values of 12 morphological characteristics in 17 accessions of faba beans (*Vicia faba*), collected in the areas of Albania and stored in the National Genetic Bank, to evaluate their morphological and agronomic variation in order to use them for cultivation purposes or and in genetic improvement programs in function of agricultural production.

MATERIAL AND METHODS

Plant materials used in the study

In the study, 17 accessions of faba bean (*Vicia faba*), collected in areas of Albania and stored in the National Genetic Bank, were taken, as follows: 1) AGB2476, 2) AGB2477, 3) AGB2478, 4) AGB2479, 5) AGB2480, 6) AGB2481, 7) AGB2482, 8) AGB2483, 9) AGB2484, 10) AGB2485, 11) AGB2486, 12) AGB2487, 13) AGB2488, 14) AGB2489, 15) AGB2490, 16) AGB2491, 17) AGB2492.

The study was conducted in the Didactic Experimental Economy of Agriculture of the University of Tirana (latitude: 402405N; longitude: 0194108E; altitude of 40m). The study was conducted in two agricultural years, 2018–2019 and 2019–2020. The design of the experiment was a randomized complete block with four replications. All accessions were planted on November 5, 2018 and November 10, 2019. Each variety was planted in 5 rows of 3 m length and 60 cm row spacing; the seed was planted at a distance of 20 cm from each other, in each replication. So, each variant was represented with an area of 10.5 m^2 in every replication. For each accession, 30 seeds were planted in a row. After planting, the plot was immediately irrigated. Then, during the vegetation, all the necessary agrotechnical services of the faba bean were performed.

Obtained data of morphological characteristics:

During the vegetation and until the ripening of the pods, the data were recorded for the purpose of the study. At the stage of full pod development (green pods) the following data were obtained on 5 plants in the middle of the row from each variant for all four replicates.

1.Leaflet length, cm; measured in the middle of the leaflet;

2.Leaflet width, cm; measured in the length of the leaflet;

3.Plant height, cm; measured at near maturity from ground surface to the tip of the plant;

4.Number of branches/plant; recorded as total number of branches from the basal node;

5.Number of pods per plant; recorded as the average of five plants;

6.Number of kernels/pod; was counted for ten random pods;

7.Number of kernels/plant; was number of pods/plant x number of kernels/pod;

8.Pod length, cm; for five random pods, measured as the distance between the edges and pod;

9.Pod width, cm; measured for five random pods at the center of pod using a caliper;

10.Kernel length, cm; measured for five random kernels, using a caliper;

11.Kernel width, cm; measured for five random kernels, using a caliper;

12.100 kernels weight, g; determined by mixing the whole samples, then 100 kernels were randomly counted and weighted.

Field observations

Field observations of the experiment and various measurements were based on the standards of the Genetic Bank (FAO, 2014), Recognized Reconstruction Guidelines (Salcedo, 2008) and Faba Bean's Descriptors (IBPGR /85/116 June 1985).

Statistical analysis

All the experiment data were subjected to analysis of variance to know the validity of the experiment data. In order to find any correlation between the traits under study, correlation coefficients were also calculated. The evaluation of the correlations was done according to this order: r = ±3, the correlation is weak; ±3 to ±5, correlation is medium; ±5 to ±7, correlation is good; ±7 to ±9, the correlation is strong. Finally, cluster analysis was done using the full linkage method.

RESULTS AND DISCUSSION

The data obtained from the comparative field trial of 17 accessions of faba bean landraces for their 12 field characteristics were first subjected to analysis of variance to see if the experimental data are validated. According to the data of this analysis, the data of all 12 morphological and agronomic characteristics for the two years of the study (2018–2019 and 2019–2020) the differences between the variants (accessions) are confirmed for the level of probability $P \leq 0.01$, which will show that the differences between the accessions are statistically proven, that is, the differences between the accessions are controlled by genetic factors. For some morphological and agronomic traits, differences between replicates are also established. Thus, for example, for the year 2018-2019, differences are confirmed for 7 traits, while for the year 2019-2020, differences are confirmed for 10 traits, which shows that these traits, in addition to genetic factors, are also influenced by environmental factors. Based on the results of this analysis, let's further examine the data of the study.

1. Leaflet length

Even the variation of leaflet length in 2019 was relatively narrow (table no. 1), 6 accessions (35.3%) were in the first group with 7.39a–6.40 cm and 11 accessions (64,7 %) had the smallest leaflet length (5.66–6.29 cm). In 2020, the variation for leaflet length was more pronounced, all 17 accessions were divided into 4 groups; accession AGB2482 had the highest value (10.51a cm), while accession AGB2489 had the lowest value, with 9.01de cm. However, the greatest average value of leaflet length was in 2020, with 9.49 cm, compared to 2019, which was 6.21 cm.

2.Leaflet width

The variation for leaflet width in 2019 was good (table no. 1) where 3 accessions (AGB2484, AGB2481 and AGB2487) had the widest leaf, respectively 3.37a cm, 3.18a cm and 3.09ab cm. In this year, the narrowest leaflet was recorded in accessions AGB2477, AGB2486 and AGB2485, respectively with 2.15df cm, 2.34de cm and 2.23de cm. In 2020, the average leaflet width was greater (4.68 cm), compared to 2019 (2.66 cm), but the variation of its width was also wider (table no. 3). Interestingly, only one accession (AGB2478) entered the first group with the widest leaflet (5.62a cm), 3 accessions (AGB2476, AGB2486 and AGB2488) had the narrowest leaflet, respectively 4.31gi cm, 4, 34gi cm and 4.36gi cm.

3.Plant height

For plant height, the highest average value was in 2020, with 96.83 cm, from 64.31 cm in 2019 (table no. 1). For both years of the study, there was good variation for this trait. In 2019, there were two accessions (AGB2479 and AGB2483) with the highest plant height, respectively 79.36a cm and 76.81a cm, while the shortest plant was accession AGB2492 with 48.94gi cm. In 2020, accession AGB2476 grew the tallest plant with 111.1a cm, while the shortest plant was accession AGB2485 with 87.00gi cm. Since the plants were taller in 2020, it appears that conditions that year were better for this plant.

Table no. 1: Average values of leaflet length, leaflet width and plant height, 2019 and 2020

Accession	df		Values of morphological and agronomic traits					
			Leaflet length, cm		Leaflet width, cm		Plant height, cm	
	Treatments	Replications	2019	2020	2019	2020	2019	2020
AGB2476	16	3	5,90**b**	9,64**bc**	2,52**cd**	4,31**gi**	70,17**bc**	111,19**a**
AGB2477	16	3	6,00**b**	9,29**cd**	2,15**df**	4,56**fg**	62,67**de**	94,04**ef**
AGB2478	16	3	6,29**b**	9,56**c**	2,72**bc**	5,62**a**	58,16**ef**	101,39**cd**
AGB2479	16	3	5,66**bc**	9,99**b**	2,43**cd**	4,58**fg**	79,36**a**	89,76**fh**
AGB2480	16	3	6,53**ab**	9,35**cd**	2,76**bc**	5,18**c**	64,98**de**	105,48**b**
AGB2481	16	3	5,74**bc**	9,56**c**	3,18**a**	4,68**eg**	60,71**df**	95,44**ef**
AGB2482	16	3	6,59**a**	10,51**a**	2,63**cd**	4,46**fh**	66,57**cd**	95,62**ef**
AGB2483	16	3	6,00**b**	9,85**bc**	2,68**c**	4,44**fh**	76,81**a**	94,43**ef**
AGB2484	16	3	7,39**a**	9,52**cd**	3,37**a**	4,24**gj**	66,04**cd**	95,62**ef**
AGB2485	16	3	6,94**a**	9,37**cd**	2,24**de**	4,78**ef**	60,48**df**	87,00**gi**
AGB2486	16	3	6,17**b**	9,25**cd**	2,23**de**	4,34**gi**	66,08**cd**	94,78**ef**
AGB2487	16	3	5,82**b**	9,16**de**	3,09**ab**	4,69**eg**	66,07**cd**	104,09**bc**
AGB2488	16	3	5,94b	9,22**cd**	2,96**b**	4,36**gi**	52,79**fh**	93,07**eg**
AGB2489	16	3	6,60**a**	9,01**de**	2,86**bc**	4,69**eg**	64,15**de**	100,90**cd**
AGB2490	16	3	5,95**b**	9,21**cd**	2,55**cd**	4,57**fg**	64,02**de**	94,87**ef**
AGB2491	16	3	6,40**ab**	9,23**cd**	2,41**cd**	4,64**eg**	65,32**cd**	94,58**ef**
AGB2492	16	3	5,72**bc**	9,55**c**	2,48**cd**	5,40**b**	48,94**gi**	93,85**ef**
Average			**6,21**	**9,49**	**2,66**	**4,68**	**64,31**	**96,83**
D_{01} / D_{05}			**1,07/0,8**	**0,44/0,33**	**0,32/0,24**	**0,20/0,15**	**4,75/3,56**	**3,87/2,90**

4.Number of branches per plant

In 2019, the variation in the number of branches on the main stem was weak; all 17 accessions were classified in only two groups (table no. 2).

Table no. 2: Average values of the branches per plant, pods per plant and of the kernels per pod, 2019 and 2020

Accession	df		Values of morphological and agronomic traits					
			Branches/plant		Pods/plant		Kernels/pod	
	Treatments	Replications	2019	2020	2019	2020	2019	2020
AGB2476	16	3	3,4**b**	5,6**de**	22,03**a**	24,8**cd**	5,93**b**	8,73**b**
AGB2477	16	3	3,1**bc**	5,4**ef**	16,44**v}**	15,6**hj**	6,59**a**	8,49**b**
AGB2478	16	3	3,0**bc**	4,7**fh**	17,50**rw**	21,6**ef**	5,56**b**	8,49**b**
AGB2479	16	3	3,4**ab**	4,8**fh**	12,49	25,9**cd**	5,60**b**	7,97**bc**
AGB2480	16	3	2,8**bc**	5,6**de**	18,46**nr**	25,3**cd**	6,02**ab**	8,29**b**
AGB2481	16	3	3,4**b**	4,4**gi**	15,43**y**	25,9**c**	5,68**b**	8,67**b**
AGB2482	16	3	3,4**b**	6,3**c**	14,37}	18,3**fh**	5,93**b**	8,16**b**
AGB2483	16	3	3,1**b**	5,6**de**	14,22~	22,4**df**	5,66**b**	7,36**bc**
AGB2484	16	3	4,1**a**	4,4**gi**	17,20**sy**	26,0**c**	4,85**bc**	8,34**b**
AGB2485	16	3	3,6**a**	6,1**cd**	17,28**rx**	23,1**de**	5,90**b**	8,17**b**
AGB2486	16	3	3,1**bc**	7,2**a**	15,05{	24,8**cd**	5,84**b**	7,66**bc**
AGB2487	16	3	3,3**b**	6,3**c**	15,44**y**	30,7**a**	5,87**b**	10,92**a**
AGB2488	16	3	2,9**bc**	5,8**de**	14,84|	20,7**eg**	6,14**ab**	8,50**b**
AGB2489	16	3	3,0**b**	4,6**gi**	14,60|	24,1**de**	6,62**a**	10,33**a**
AGB2490	16	3	2,9**bc**	4,7**fh**	17,04**sz**	15,8**gj**	7,86**a**	9,96**a**
AGB2491	16	3	3,6**a**	3,5**il**	14,44}	14,6**hk**	7,45**a**	9,54**ab**
AGB2492	16	3	3,4**b**	5,0**fg**	14,36}	23,6**de**	7,82**a**	11,64**a**
Average			**3,3**	**5,3**	**15,95**	**22,5**	**6,19**	**8,89**
D_{01} / D_{05}			**0,7/0,5**	**0,42/0.32**	**0,27/0,20**	**2,1/1,6**	**1,86/1,39**	**2,33/1,75**

Four accessions (AGB2484, AGB2485, AGB2491 and AGB2479) had the largest number of branches in this year with, respectively, 4.1a; 3.6a, 3.6a and

3.4ab branches per plant, while accessions AGB2480, AGB2488 and AGB2490 had the smallest number of branches with, respectively, 2.8bd, 2.9bc and 2.9bc branches. In 2020, the variation in the number of branches was considerable; all 17 accessions for this trait were classified into 7 groups. In this year, accession AGB2486 stood out for the largest number of branches on the main stem with 7.2 branches, while accession AGB2491 stood out for the smallest number of branches with 3.5 branches. By comparing the data of this trait between the two years of the study, we noticed that in 2020 the faba bean plants created an average of more branches (5.3) compared to 2019 when the plants had an average of 3.3 branches.

5.Number of pods per plant

The number of pods per plant, as a production trait, is important in the evaluation of planting material. In the analysis of this study, it is of interest that this feature is represented by the considerable variation for the faba bean accessions taken in the study. In 2019, accession AGB2476 had the highest number of pods per plant (table no. 2), which tied and developed 22.03a pods, while accession AGB2479 had the lowest number of pods per plant, which averaged only 12.49 pods. In 2020, accession AGB2487 had the largest number of pods per plant with 30.7 ha of pods, while accessions AGB2491 with 14.6 ha of pods, AGB2477 with 15.6 ha and AGB2490 with 15.8 ha had the lowest number of pods. The average number of pods per plant was reached in 2020 (22.5) compared to 2019 with 15.95 pods.

6.Number of kernels per pod

The number of kernels per pod was presented with weak variation in both years of the study (table no. 2). In 2019, the highest number of kernels per pod appeared in 6 accessions, out of 17 accessions in the study, which had from 7.86a to 6.14ab kernels per pod, while the lowest number of kernels per pod was had accession AGB2484 which had bound 4.85bc kernels per pod. In 2020, five accessions (AGB2492, AGB2487, AGB2489, AGB2490 and AGB2491) were distinguished for the highest number of kernels per pod, which they developed, respectively from 11.64a; 10.92a; 10.33a, 9.96a and 9.54ab kernels per pod. Whereas three accessions (AGB2483, AGB2486 and AGB2479) had the smallest number, which had, respectively, from 7.36bc; 7.66bc and 7.97bc kernels per pod. The highest average number of kernels per pod was in 2020 with 8.89 kernels, compared to 2019 with 6.19 kernels per pod.

7.Kernels per plant

The values of the number of kernels per plant had a relatively weak variation, but in 2020 somewhat better than in 2019 (table no. 3). In 2019, six accessions (AGB2490, AGB2476, AGB2492, AGB2480, AGB2477 and AGB2491) stood out for the highest number of kernels per plant with, respectively, 133.88a; 130,61a; 112,15ab; 111.09ab; 108.28ab and 107.59ab kernels per plant. As for the smallest number of kernels per plant, the accession AGB2479 appeared with only 66.93c kernels. In 2020 there was a higher number of kernels per plant for all accessions. But, for the largest number of kernels in

2020, the accessions AGB2487 with 334.79 kernels and AGB2492 with 274.69 a kernels per plant stood out and, for the smallest number of kernels per plant, the accessions AGB2477, AGB2491 and AGB2482 with, respectively, 132.15de; 139.03 and 149.10 kernels per plant. The average number of kernels per plant was in 2020 with 200.35 kernels compared to 2019 with 98.54 kernels per plant.

8.Pod length

For the length of the pod, there is satisfactory variation in the data of 2019 and somewhat poor in 2020 (table no. 3).

Table no. 3: Average values of the kernels per plant, of the pod length and of the pod width, 2019 and 2020

Accession	df		Values of morphological and agronomic traits					
			Kernels/plant		Pod length		Pod width	
	Treatments	Replications	2019	2020	2019	2020	2019	2020
AGB2476	16	3	130,61**a**	216,25**bc**	8,76**cd**	10,22**cd**	1,29**b**	1,45**bc**
AGB2477	16	3	108,28**ab**	132,15**de**	10,96**a**	9,75**cd**	1,16**bc**	1,68**ab**
AGB2478	16	3	97,22**b**	183,64**cd**	9,60**bc**	11,07**bc**	1,26**b**	1,63**b**
AGB2479	16	3	69,93**c**	205,03**c**	9,96**b**	9,92**cd**	1,47**a**	1,73**ab**
AGB2480	16	3	111,09**ab**	208,52**c**	8,85**cd**	10,28**cd**	1,23**b**	1,35**bc**
AGB2481	16	3	87,65**bc**	223,83**bc**	9,31**bc**	11,21**bc**	1,26**b**	1,38**bc**
AGB2482	16	3	85,02**bc**	149,10**de**	9,60**bc**	11,54**b**	1,56**a**	1,66**ab**
AGB2483	16	3	80,38**bc**	164,60**cd**	9,33**bc**	9,90**cd**	1,17**bc**	1,40**bc**
AGB2484	16	3	8342**bc**	217,07**bc**	10,95**a**	12,97**a**	1,49**a**	2,06**a**
AGB2485	16	3	101,79**b**	187,66**cd**	8,46**cd**	10,68**bc**	1,05**c**	1,34**bc**
AGB2486	16	3	87,95**bc**	189,21**cd**	6,94**eg**	9,22**de**	1,17**bc**	1,58**b**
AGB2487	16	3	90,58**b**	334,79**a**	6,56**fg**	9,21**de**	1,54**a**	1,61**b**
AGB2488	16	3	91,01**b**	175,32**cd**	7,44**ef**	9,44**de**	1,33**ab**	1,49**b**
AGB2489	16	3	96,58**b**	248,17**b**	6,53**fg**	10,60**c**	1,44**a**	1,58**b**
AGB2490	16	3	133,88**a**	156,90**cd**	8,21**de**	9,41**de**	1,45**a**	1,48**b**
AGB2491	16	3	107,59**ab**	139,03**de**	7,62**df**	9,27**de**	1,35**ab**	1,40**bc**
AGB2492	16	3	112,15**ab**	274,69**ab**	9,38**bc**	9,97**cd**	1,44**a**	1,55**b**
Average			**98,54**	**200,35**	**8,73**	**10,27**	**1,33**	**1,55**
D_{01} / D_{05}			**21,7/28,9**	**61,1/45,8**	**0,86/0,64**	**1,16/087**	**0,24/0,18**	**0,40/0,30**

From the 2019 data, accessions AGB2477 and AGB2484 stood out for longest pods with, respectively, 10.96a and 10.95a cm. For shorter pods this year, accessions AGB2489, AGB2487 and AGB2486 stood out with, respectively, 6.53fg; 6.56fg and 6.94eg cm. For the year 2020, the accession AGB2484 stands out for the longest pod with 12.97a cm, while for the shortest pod there are five accessions (AGB2487, AGB2486, AGB2491, AGB2490 and AGB2488) with, respectively, 9.21de; 9.22 de; 9.27 de; 9.41 and 9.44 cm. Average pod length was greater in 2020 (10.27 cm) compared to 2019 (8.73 cm).

9.Pod width

Even for the width of the pod, the data show weak variation for both years (table no. 3). From the 2019 data we note that 9 accessions are represented by the pod with the largest width, which fluctuates between 1.56a cm and 1.33ab cm; the other 7 accessions fall into the narrower beans group, with values ranging from 1.16bc cm to 1.29b cm. In 2020, four accessions (AGB2484 with 2.06a cm;

AGB2479 with 1.73ab cm; AGB2477 with 1.68ab cm and AGB2482 with 1.66ab cm) were distinguished for the largest pod width. For the smallest pod width for this year, 13 other accessions were distinguished, with values from 1.34bc cm to 1.63b cm. Average pod width was greater in 2020 (1.55 cm), compared to 2019 (1.33 cm).

10.Kernel length

For kernel length, the data of 2019 showed higher variation than in 2020 (table no. 4). Based on the 2019 data, we note that only the accession AGB2484 has the highest kernel length value (2.31a cm). Whereas the lowest value of kernel length has the accession AGB2489 (1.37jn cm). From the 2020 data, there are fewer accession groups for this trait, therefore, 10 accessions are in the first group with the largest kernel length (table no. 4) with values from 1.88a cm to 1, 65ab cm, the other six accessions have the smallest kernel length, from 1.41c cm to 1.62b cm. Interestingly, the average kernel length value is lower in 2020 (1.66 cm) compared to 2019, which was 1.76 cm.

11. Kernel width

In these positions are also the kernel width values, where the data of 2019 present a greater variation compared to those of 2020 (table no. 4). In 2019, only one accession stands out for the largest kernel width; accession AGB2489 with 1.96a cm, while for the smallest kernel width, accession AGB2485 stands out with a grain width of 1.25pv cm. For the year 2020, accession AGB2484 stands out for the largest kernel width with a value of 1.53a cm, while for the smallest kernel width, accession AGB2486 stands out with a kernel width of 0.95ef cm. Even for kernel width, the average value of 2020 is smaller (1.22 cm) compared to the average value of 2019 (1.52 cm).

12. 100 kernels weight

Table no. 4: Average values of the kernel length, kernel width and of the 100 kernels weight, 2019 and 2020

Accession	df		Values of morphological and agronomic traits					
			Kernel length		Kernel width		100 kernels weight	
	Treatments	Replications	2019	2020	2019	2020	2019	2020
AGB2476	16	3	1,75**gi**	1,62**b**	1,37**nr**	1,25**bc**	122,8**ik**	115,8**a**
AGB2477	16	3	1,77**fh**	1,83**a**	1,42**lp**	1,24**c**	113,3**pu**	107,0**b**
AGB2478	16	3	1,80**fh**	1,65**ab**	1,63**hj**	1,25**bc**	111,3**qw**	109,8**ab**
AGB2479	16	3	1,80**fh**	1,71**a**	1,38**mr**	1,27**bc**	116,0**nr**	99,5**cd**
AGB2480	16	3	1,77**fh**	1,53**b**	1,46**ko**	1,17**cd**	133,5**a**	95,8**de**
AGB2481	16	3	1,83**fg**	1,76**a**	1,45**lp**	1,27**bc**	116,7**mq**	113,8**a**
AGB2482	16	3	1,77**fh**	1,65**ab**	1,55**il**	1,28**bc**	127,8**ef**	99,8**cd**
AGB2483	16	3	1,76**fh**	1,50**bc**	1,36**nr**	1,20**cd**	126,8**fg**	105,9**bc**
AGB2484	16	3	2,31**a**	1,88**a**	1,84**cd**	1,53**a**	121,0**jm**	112,1**a**
AGB2485	16	3	1,66**gj**	1,72**a**	1,25**pv**	1,26**bc**	121,2**jm**	88,9**ef**
AGB2486	16	3	1,61**hj**	1,41**c**	1,63**hj**	0,95**ef**	128,8**de**	91,0**df**
AGB2487	16	3	1,74**gi**	1,57**b**	1,33**ns**	0,99**df**	126,8**fg**	88,7**ef**
AGB2488	16	3	1,66**gj**	1,59**b**	1,75**eg**	1,05**de**	124,5**gj**	97,8**cd**
AGB2489	16	3	1,37**jn**	1,71**a**	1,96**a**	1,23**c**	132,2**b**	93,3**de**
AGB2490	16	3	1,80**fh**	1,55**b**	1,76**ef**	1,19**cd**	109,0**sy**	89,7**ef**
AGB2491	16	3	1,65**hj**	1,72**a**	1,45**lp**	1,30**bc**	117,3**mq**	97,8**cd**
AGB2492	16	3	1,90**ef**	1,81**a**	1,34**ns**	1,29**bc**	97,6|	98,4**cd**
Average			**1,76**	**1,66**	**1,52**	**1,22**	**120,4**	**100,3**
D_{01} / D_{05}			**0,09/0,07**	**0,23/0,17**	**0,05/0,03**	**0,14/0,11**	**1,3/1,0**	**6,2/4,7**

The values of the weight of 100 kernels give rich variation for both years (table no. 4). In 2019, accession AGB2480 had the largest weight of 100 kernels (133.5a grams), while accession AGB2478 had the smallest weight (111.3qw grams). In 2020 there were four accessions with the largest 100-grain weight (AGB2476, AGB2481, AGB2484 and AGB2478) with corresponding 100-kernels weights of 115.8a grams; 113.8a grams, 112.1a grams and 109.8ab grams; while for the lowest weight, the accessions AGB2487, AGB2485 and AGB2490 were distinguished with the respective weights of 100 kernels 88.7ef grams, 88.9ef grams and 89.7ef grams. Again, after the length of the kernel and the width of the kernel, even for the weight of 100 grains, the value of the average weight of 100 kernels for the year 2020 is lower (100.3 grams) than that of the year 2019 (120.4 grams).

From the discussion of data on morphological and agronomic traits, it is noticeable that these traits are controlled by genetic factors but also influenced by environmental factors. This conclusion is confirmed by many studies, including two studies in Albania (Hobdari *et al*. 2019 and Gixhari *et al*. 2019).

Correlation between morphological and agronomic traits under study

The Pearson correlation coefficients between the studied characteristics were calculated separately for the data of 2019 and the data of 2020. From the data of 2019 we find four positive correlations (table no. 5), three of which are well connected:branches/plant: kernel length ($r_{02/08}$=0.53*), pod/plant:kernel/plant ($r_{03/05}$=0.66**) and kernel/pod:kernel/plant ($r_{04/05}$=0.65**), as well as a strong relationship, pod length:kernel length ($r_{06/08}$=0.72**). The data of 2020 give another panorama on the correlations (table no. 6); in them we find 8 positive correlations, of which: a medium link pod length:pod width ($r_{06/07}$=0.50*), four good links: kernel/pod:kernel/plant ($r_{04/05}$=0.61**), pod length:kernel length ($r_{06/08}$=0.53*), pod length: g/100 kernel ($r_{06/10}$=0.52*) and kernel width: g/100 kernels ($r_{09/10}$=0.55*) and three correlations of strength: pod/plant:kernel/plant ($r_{03/05}$=0.83**), pod length:kernel width ($r_{06/09}$=0.75**) and kernel length:kernel width ($r_{08/09}$=0.78**). According to these results, pods per plant, kernels per pod, kernels per plant, pod length, pod width, kernel length, kernel width and 100 kernel weight are important.

Despite the obtained correlations, the reduction of kernel indicators (kernel length, kernel width and weight of 100 kernels) in 2020 compared to 2019 is observed, while almost all morphological and agronomic traits had higher values in 2020. This fact gives us the right to judge that the greater load of the plant in 2020 with fruit organs (pod/plant, kernel/pod, kernel/plant) has influenced the smaller weight of the kernel, which may also be the result of competition for nutrients, this may be more pronounced than the number of kernel/pods, where the competition for nutrients is greater. Correlations between morphological and agronomic traits are also influenced by environmental conditions; therefore the relationships between different traits are not the same between the two years of the study. This judgment is also supported by other studies (Dollotovskij *et al*. 1989; Hyso and Kashta 2000), regardless of the agricultural crops with which they worked. The reason why the present correlations did not reveal such relationships could be the small number of accessions as well as the non-significant differences in the number of grains per pod in the study accessions.

Table no. 5: Correlations for 10 morphological and agronomic traits of *Vicia faba* for 2019

Traits	Plant height	Branch/ plant	Pods/ plant	Kernels/ pod	Kernels/ plant	Pod length	Pod width	Kernel length	Kernel width
	1	2	3	4	5	6	7	8	9
2.Branch/plant	0,15								
3. Pods/plant	–0,07	–0,03							
4. Kernels/pod	–0,40	–0,29	–0,13						
5. Kernels/plant	–0,32	–0,28	0,66**	0,65**					
6. Pod length	0,12	0,33	0,12	–0,27	–0,12				
7. Pod width	0,06	0,24	–0,30	0,15	–0,12	–0,07			
8. Kernel length	0,01	0,53*	0,18	–0,31	–0,11	0,72**	0,24		
9. Kernel width	–0,16	–0,12	–0,05	–0,01	–0,04	–0,19	0,33	–0,02	
10.g/100kernels	0,42	–0,12	0,07	–0,51	–0,32	–0,41	–0,09	–0,37	0,21

Table no. 6: Correlations for 10 morphological and agronomic traits of *Vicia faba* for 2020

Traits	Plant height	Branch/ plant	Pods/ plant	Kernels/ pod	Kernels/ plant	Pod length	Pod width	Kernel length	Kernel width
	1	2	3	4	5	6	7	8	9
2. Branch/plant	0,05								
3. Pods/plant	0,33	0,27							
4. Kernels/pod	0,21	–0,29	0,07						
5. Kernels/plant	0,38	0,09	0,83**	0,61**					
6. Pod length	0,01	–0,23	0,20	–0,24	0,01				
7. Pod width	–0,08	–0,09	0,14	–0,03	0,11	0,50*			
8. Kernel length	–0,27	–0,58	–0,11	0,26	0,06	0,53*	0,44		
9. Kernel width	–0,15	–0,65	–0,18	–0,04	–0,19	0,75**	0,40	0,78**	
10.g/100kernels	0,27	–0,35	0,02	–0,32	–0,16	0,52*	0,24	0,40	0,55*

CONCLUSIONS

Based on the data of the study, as well as on their review and discussion, we can draw some conclusions, among which we mention:

- Landraces of fava bean are an important genetic source for science and for Albanian agriculture;
- The landraces in the study have marked differences for all morphological and agronomic features;
- The morphological and agronomic traits in the study are controlled by genetic factors, but are also influenced by environmental factors;
- The large load of the plant with fruit organs is most likely to affect the smaller weight of the kernel;
- Correlations are influenced by environmental factors, so they do not provide the same data in every environment;
- Faba bean landraces must be preserved so that they are not subject to genetic erosion.

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