

# Expressiveness of the Main Characters of a New Genotype of White Kidney Bean

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## Abstract

Currently, in Romania there are just a few autochthonous white kidney bean varieties and this is the main reason why Vegetable Research Development Station (VRDS) Buzau has chosen a breeding program for this species. The aim of this study was to assess the main quantitative characteristic of a new cultivar of kidney beans, 'Doina'. The correlation matrix showed a strong relationship between plant height and bush diameter and also with leaf length and a negative correlation between plant height and pods mass per plant. The cultivar has a yield potential of over 3000 kg/ha and a compact maturation of the pods, being suitable for mechanized harvesting. An important feature is plant hardiness, due to local genetic resources used in the breeding program. During the research it was found that the variety has a distinct phenotypic expressiveness with a high yield and quality potential.

**Keywords:** breeding, crop technology, 'Doina' cultivar, *Phaseolus vulgaris*, phenotype

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## Introduction

Beans are a member of *Fabaceae* family and there are about 20 leguminous species utilized as dry grain in substantial amounts for human nutrition (Costa *et al.*, 2006; Lin *et al.*, 2008). *Phaseolus vulgaris* L. has been recognized to be domesticated and originated in America on the basis of chronological, archaeological, botanical and linguistic evidences (Gepts and Dpbouk, 1991; Papa and Gepts, 2003; Papa *et al.*, 2005) and now is a worldwide grown plant from tropics, subtropics and temperate zone. It is recognized as 'poor man's meat' (Tharanathan and Mahadevamma, 2003), showing their importance for consumption in the third world countries where protein energy malnutrition often appear as major nutrition problem (Shimelis and Rakshit, 2005). Harlen (2018) states that beans contain a number of bioactive compounds such as phenolic substances that may play key metabolic roles in

humans and/or animals that frequently consume this food. From a nutritional point of view, beans are recognized as good source of proteins, which is 2-3 times higher than in cereal grains (Siddiq *et al.*, 2010). High dry matter content also contains high amounts of starch, dietary fiber, minerals and vitamins (Kutos *et al.*, 2003; Costa *et al.*, 2006). In addition to these, beans also contain rich variety of phytochemicals with antioxidant activity and an extensive array of flavonoids such as anthocyanins, proanthocyanidins, flavones, phenolic acids and isoflavones (Beninger and Hosfield, 2003; Choung *et al.*, 2003; Aparicio-Fernandez *et al.*, 2005; Lin *et al.*, 2008; Granito *et al.*, 2008).

Dry beans are the second most cultivated species after soybean, from *Fabaceae* family. In the world, the most cultivated areas are found in Asia, with 47.4%, followed by America 26.1%, Africa 23.1 and Europe 3.3%. The countries with highest yield and area harvested in 2018 were:

India, with 5,677,500 t, followed by Myanmar with 4,779,926 t and Brazil with 2,917,825. The world area harvested with dry bean has increased from 30,783,463 ha in 2015 to 34,495,662 ha in 2018, of course, the yield also had an increase from 27,614,253 t to 30,434,280 t in 2018 (FAOSTAT).

Unfortunately, in Romania, the dry bean sector has known a decrease during the past years, the cultivated area in 2015 was 22,122 ha with and yield of 12,231 t and dropped to 19,966 t in 2018, but the yield was higher due to favourable pedoclimatic conditions or maybe the use of different varieties and registered a value of 17,298 t (FAOSTAT).

In the present, in Romania there are just a few autochthonous white kidney beans and this is the main reason why Vegetable Research Development Station (VRDS) Buzau has chosen a breeding program for the species. The aim of this study was to assess the main quantitative characteristic of a new cultivar of kidney beans, 'Doina'.

### Materials and methods

VRDS Buzau has obtained so far a number of four varieties of French beans ('Anisia', 'Clarisa', 'Ioana' and 'Menuet') and two varieties of climbing bean ('Maura 2000', 'Teodora'), all with mixed destination, pods and beans, but mainly used for pods. 'Doina' cultivar is used strictly for bean consumption. The variety was obtained by repeated individual selection and now is submitted to a preservation program. Throughout the vegetation period, biometric and phenological observations were made with an emphasis on the main characters of the plants. The descriptors used were the one from UPOV guidelines. Morphophysiological descriptors used were: leaf colour, plant height (PH), bush diameter (BD), length (LL)

and width (LW) of leaves, petiole length (PeL) flower colour, pod thickness (PT), length (PL) and width (PW), number of pods per plant (NPP), number of grains in a pod (NGP), grain colour, grain length (GL), width and thickness (GT), pod mass and mass of pods/plant (MPP). The qualitative characters were noted based on visual evaluation while the quantitative traits were counted, measured using metric rulers, caliper and weighed using weighing balance. For all agromorphological features, descriptive statistics were calculated, including Analysis of Variance (ANOVA) and Pearson correlation coefficient, adopting the statistical software XLSTAT. Means comparison were performed by Duncan test.

During a period of two years (2018-2019) phenological descriptors were tracked such as: sowing date, sprouting date, date of trifoliate leaves, date of flowering, date of first pod and date of harvest. The planting scheme used was 70 cm between rows and 20 cm between plants in a row. The seeds were sown in the second decade of May. A randomized blocks design with three replications was used.

### Results and discussions

The analysis of climatic condition of 2018-2019 (Tab. 1) showed variation in comparison with the multiannual mean, it was noticed that rainfall was higher in 2019, and the mean monthly temperatures were also higher in 2019 than multiannual temperature while in 2018, the mean temperatures and sum of rainfalls were a bit lower than the multiannual mean.

*Phaseolus vulgaris* has a weakly developed root with *Rhizobium* nodosities. The mean values of plant characteristics are presented in Table 2. The plant height of 'Doina' cultivar varies from

**Table 1.** Climatic conditions during the vegetation period of 2018-2019

Temperatures/rainfall	May	June	July	August
Mean monthly temperatures (°C) 2019	22.5	27	30	29.5
Mean monthly temperatures (°C) 2018	22	25	28	30
Multiannual monthly temperature (°C)	23	26	29	29
Sum of rainfall (mm) 2019	71	92	75	53
Sum of rainfall (mm) 2018	65	83	64	50
Multiannual mean of rainfall (mm)	68	84	65	51

33.1 to 46.3 cm with an average bush diameter of 33.8 cm. The first primary leaves have oval shape and the other leaves are trifoliate with a green medium colour. The length of leaves varies between 18.8-21.2 cm and a mean width of 18.6 cm. The flower colour is white and the pod colour is green, with slight porosity when young and smooth at physiological maturity.

**Table 2.** Mean values of plant characteristics

Plant characteristics	Value $\pm$ Standard deviation
Plant height (cm)	39.6 $\pm$ 6.50
Bush diameter (cm)	33.8 $\pm$ 4.85
Petiol length (cm)	2.4 $\pm$ 0.17
Foliole length (cm)	19.9 $\pm$ 1.49
Foliole width (cm)	18.6 $\pm$ 1.20
Pod length (cm)	12.03 $\pm$ 0.37
Pod width (cm)	1.36 $\pm$ 0.05
Pod thickness (cm)	0.94 $\pm$ 0.15
Number of grains/pod (pcs)	6 $\pm$ 0.57
Grain length (cm)	1.22 $\pm$ 0.1
Grain thickness (cm)	0.76 $\pm$ 0.05
Number of pods/plant (pcs)	26 $\pm$ 2.88
Mass of pods/plant (g)	48.89 $\pm$ 2.95

The average length of pods is 12.03 cm, with a mean width of 1.36 cm and an average thickness of 0.94 cm. Number of pods per plant varies between 23-28 pods, and the number of grains in a pod is

six. The grain is white with a mean length of 1.22 cm, an average diameter of 0.76 cm. The mass of pods/plant has an average value of 48.89 g. The grains are easy to be boiled, are buttery and have a specific aroma. Yield potential is over 3000 kg grains/ha. Due to compact maturation of pods, the variety is suitable for mechanized harvesting and one important characteristic is that pods are easily to unfold. A valuable feature is plant hardiness, due to local genetic resources used in the breeding program. It can be cultivated in organic systems. In Figure 1 are presented crop details of 'Doina' cultivar.

In order to establish a relationship between the main characters a correlation matrix (Pearson) was made (Tab. 3). It can be observed that there is a strong correlation among plant height and bush diameter and also with leaf length and a negative correlation between plant height and mass of pods per plant. Positive correlations are through bush diameter, petiol length, pod weight, grain thickness and number of grains per pod; but also a strong negative correlation amongst bush diameter and mass of pods per plant. Pod mass per plant has a negative correlation with petiol length and with characteristics of pods as grain thickness and width. Petiol length has a strong correlation between grain thickness and pod width and also a negative correlation with number of grains per plant. Pod length is strongly correlated with pod thickness and pod thickness with grain length. Similar studies regarding the correlation of pod length with pod thickness was also found in bean varieties from Turkey (Madakbas and Ergin, 2011).

Number of grains in a pod has a negative correlation with grain thickness and pod width. Number of pods per plant has a strong negative correlation with leaf length. The significant posi-



**Figure 1.** Plant details: a) First true leaves b) Flowers of bean c) Bean pods d) Dry bean pods

**Table 3.** Correlation matrix of main characters

Variable	NPP	LL	PH	MPP	BD	PeL	GT	PW	NGP	LW	PL	PT	GL
NPP	1												
LL	-0.983	1											
PH	-0.850	0.928	1										
MPP	0.752	<b>-0.853</b>	-0.986	1									
BD	-0.658	<b>0.776</b>	<b>0.955</b>	<b>-0.991</b>	1								
PeL	-0.499	0.638	0.879	<b>-0.946</b>	<b>0.981</b>	1							
GT	-0.493	0.636	0.877	<b>-0.944</b>	<b>0.978</b>	<b>0.998</b>	1						
PW	-0.493	0.636	0.877	<b>-0.944</b>	<b>0.978</b>	<b>0.998</b>	<b>1.000</b>	1					
NGP	0.494	-0.601	-0.829	0.893	<b>-0.925</b>	<b>-0.943</b>	<b>-0.917</b>	<b>-0.917</b>	1				
LW	0.000	-0.167	-0.523	0.658	-0.751	-0.866	-0.864	-0.864	<b>0.816</b>	1			
PL	-0.608	0.469	0.106	0.061	-0.193	-0.381	-0.380	-0.380	0.361	0.792	1		
PT	0.757	-0.630	-0.299	0.138	-0.007	0.187	0.196	0.196	-0.132	-0.649	<b>-0.971</b>	1	
GL	-0.864	0.770	0.477	-0.324	0.196	0.000	0.000	0.000	0.000	0.500	0.924	<b>-0.973</b>	1

Note: Values in bold are significant at  $p \leq 0.05$ , according to Duncan test

tive correlation between number of grain per plant and leaf width indicates that these characters are efficient in yield determination. In studies of Okii *et al.* (2014) and Loko *et al.* (2018) similar findings were reported.

As phenological observations are concerned, it was noticed that under conditions of 2018-2019 the sprouting emerged after 13-17 days and the appearance of the first trifoliate leaf was 17-22 days after sowing. The first flowers arose in 43-48 days and first pod in a period of 54 days, in average. The harvest was after 100-110 days after sowing. The phenological characteristics are affected greatly by environmental conditions.

### Conclusions

The researches have been completed so far with obtaining of a new variety of beans that has been registered in the Official Catalogue of Species and Varieties of Cultivated Crops under the name 'Doina'. The variety has a distinct phenotypic expressiveness with a high yield and quality potential.

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