Drought Effects to the Dry Bean Local Population Productivity

Eliza TEODORESCU[1)], Neculai MUNTEANU[1)] and Costel VÎNĂTORU[2)]

[1)] Faculty of Horticulture, "Ion Ionescu de la Brad" University of Agricultural Sciences and Veterinary Medicine, Nº 3, Mihail Sadoveanu Alley, 700490, Iaşi, Romania, Corresponding author: neicu_eliza@yahoo.com
[2)] Vegetable Research and Development Station, Nº 23, Mesteacănului Street, 120024, Buzău, Romania

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Abstract

The study presents the main characteristics of 10 local bean population (*Phaseolus vulgaris* L. convar. *nanus*). Considering the total opposite weather conditions in 2011 and 2012, growing bean allowed their evaluation in drought conditions. High temperatures and relative low air humidity determined a 76.61% yield diminuation at V_7 in 2012 comparative to 2011. The 13.52% yield diminuation from an year to another registered at V_1 corroborated with a 0.25 drought susceptibility index (DSI), recommands using this provenience in drought breeding works for this species.

Keywords: dry bean, drought, *Phaseolus vulgaris* L. convar. *nanus*, breeding, germplasm collection, local population

INTRODUCTION

In 2011, in Romania there were 24105 ha cultivated with bean. This surface represents 28.9% from the surface intended for bean culture in the European Union (FAO). In 2012, the surface cultivated with bean in Romania, increased with 1302 ha, and the percentage reached 30%.

Yield level obtained in Romania in 2011 (0.89 t/ha) represented half of the Europen Union average (1.71 t/ha), and in 2012 yield decreased with 232 kg and represented only 40% from mean yield of the European Union.

In the same geographical area, yield obtained in countries affected by drought in those two years shows that the quality of the bean biological material must be improved. Drought resistance represents the main breeding objective at bean (Emam *et al*., 2010) and it is determined by the ecological demands of this plant (Porch, 2006).

In this sense, there was initiated a breeding program at this species concretized in collecting and growing many local populations from all parts of the country.

The researches had the purpose to identify the proveniences with qualities that correspond to the main breeding objectives to this species, namely: obtaining new productive bean varieties, early, with white color seeds, resistant/tolerant to the main diseases and pests, resistant to the weather conditions of 2012, especially to low atmospheric humidity.

MATERIALS AND METHODS

There were selected 10 proveniences with determined growth from the V.R.D.S. Buzău germplasm collection that contains over 150 bean proveniences. The biological material studied presents threads and it also presents characteristics that can be used at the breeding works for this species.

The biological material was cultivated in open field, according to the technology recommended by the specialty literature (Ruşti and Munteanu, 2008). During the experiment were made many mensurations according to the U.P.O.V. guide, in order to determine distinctness, uniformity and stability of the bean plants (TG 12/9). In order to establish the intensity or the gradation of different characteristics was consulted the *Color scales for identification characters of common bean* (Genchev and Kiryakov, 2005).

The experiment was organized according to the randomized blocks method with 3 repetitions. In order to analise the results we used analysis of variance, multiple comparison method (Duncan`s test) and the analysis of data from several year experiments on the same location.

Weather conditions in 2012 were characterized by a high level of temperatures corroborated with a low level of precipitations (Fig. 1).

RESULTS AND DISCUSSIONS

Half of the studied variants present elliptic shaped seeds (V_1, V_3, V_6, V_7 and V_8). At V_2, V_4, V_9 and V_{10} we can observe reiniform seeds with a higher or lower degree of curvature, and V_5 has circular to elliptic seeds.

Most variants presented an only seed color: white (V_7, V_8 and V_{10}), black (V_1), red (V_9) and beige (V_2).

Distribution of the secondary color compared with main color at V_3 and V_6 was made up by straks, at V_5 by patches, and at V_4 by half of grain (Fig. 2).

V_5 and V_6 variants had different shapes, but presented same colors. Secondary color distribution (red) is different: in stranks at V_6 and in patches at V_5 (Fig. 3).

In 2011, seeds length varied between 1.72 cm at V_2 and 1.13 at V_1. In the following year length of ell seeds decreased, except V_5 where was registered an 0.05 cm increase (Tab. 1).

Fig. 1. Level of temperatures and precipitation in 2012 (www.accuweather.com)

Fig. 2. Color and shape of seeds in longitudinal and transverse section (V_9, V_4, V_3, V_8, V_1, V_{10} and V_2)

Fig. 3. Comparisson between shape and color distribution at V_6 and V_5

Tab. 1 Main characteristics of the seeds

Variants	Shape in longitudinal section	Seed`s color	Seeds dimensions (cm)						Main weight of seed (g)	
			Length		Thickness		Width			
			2011	2012	2011	2012	2011	2012	2011	2012
V_1	elliptic	black	1.13 g	1.05 f	0.50 f	0.50 d	0.62 bc	0.62 a	0.25 f	0.25 e
V_2	kidney	beige	1.72 a	1.67 a	0.83 b	0.83 a	0.65 b	0.63 a	0.56 b	0.54 a
V_3	elliptic	beige and brown	1.21 ef	1.15 e	0.66 e	0.64 c	0.51 f	0.53 b	0.29 ef	0.28 cde
V_4	kidney	black and white	1.36 d	1.27 d	0.47 f	0.47 d	0.61 cd	0.60 a	0.30 e	0.25 de
V_5	circular to elliptic	beige and red	1.22 e	1.27 d	0.91 a	0.86 a	0.70 a	0.64 a	0.51 c	0.44 b
V_6	elliptic	beige and red	1.42 c	1.38 c	0.94 a	0.85 a	0.71 a	0.63 a	0.65 a	0.48 ab
V_7	elliptic	white	1.34 d	1.30 d	0.71 d	0.67 bc	0.56 e	0.53 b	0.40 d	0.34 c
V_8	elliptic	white	1.16 fg	1.15 e	0.71 d	0.69 b	0.56 e	0.53 b	0.32 e	0.29 cde
V_9	kidney	red	1.62 b	1.37 c	0.81 b	0.72 b	0.59 de	0.52 b	0.51 c	0.32 cd
V_{10}	kidney	white	1.66 b	1.56 b	0.78 c	0.69 b	0.64 bc	0.62 a	0.59 b	0.43 b
Mean			1.38	1.32	0.73	0.69	0.61	0.58	0.44	0.36

Note: Different letters between cultivars denote significant differences (Duncan test, $p < 0.05$).

In 2011, seeds thickness varied between 0.47 cm at V_4 and 0.94 cm at V_6. In 2012, seeds had the same thickness or a 0,09 cm decrease (V_6, V_9 and V_{10}).

The highest value of seeds width was registered in 2011 at V_6 (0.71 cm), and the lowest value was registered at V_3 (0.51 cm).

The lowest value of a seed mean weight was registered and maintained during those 2 years at V_1 (Tab. 1), this way it determined significant negative differences than the mean of the experiment. The highest values of a seed mean weight were registered in 2011 at V_6 (0.65g), and in 2012 at V_2 (0.54 g). The highest values of seeds mean weight, considering the 2 years of culture, was observed at V_6 (0.56 g). In what it concerns V_6, the variance analisys showed that the interaction between years and variants determined a distinct significant difference than the mean of the experiment.

The highest values of the number of seeds/pod (Tab. 2) were registered in 2011 at V_4 (7.00), and in 2012 at V_1 (6.33). In 2012, at V_8 was registered the most pronounced decrease of the mean number of seeds/pod comparing to the value obtained in 2011 (2.67); V_8 was followed by V_{10} (1.33). The interaction between variants and culture years determined significant differences at V_1 (1.55), V_4 (1.55) and V_{10} (-1.62). Studies made by Ruști and Munteanu in 2008 show that the mean number of seeds/pod for dry bean is included within 5 and 10 according to the pods length. From this point of view the mean value obtained in 2011 (5.37) is situated within normal limits, while the mean value obtained in 2012 (4.53) is inferior to this interval.

In what it concerns the mean number of pods/plant, the highest values and and also significant differences comparring to mean value of the experience were registered during both culture years at V_1 (2011 – 59.00; 2012 – 54.00). In 2011 were registered distinct and verry distinct significant differences, according to the mean value, V_6 (-11.47) și V_8 (-17.47). In 2012 the lowest value and significant difference than the mean value, was registered at V_7 (12.00). In what

Tab. 2 Main characteristics of the pods

Variants	N° of seeds/ pod		N° of pods/plant		MMB (g)	
	2011	2012	2011	2012	2011	2012
V_1	6.67 ab	6.33 a	59.00 a	54.00 a	248.61	247.26
V_2	4.67 cd	3.67 cde	38.33 c	22.67 cd	564.07	538.99
V_3	5.67 abc	5.00 abc	46.00 b	35.67 b	286.04	281.72
V_4	7.00 a	6.00 a	38.00 c	16.33 d	300.43	254.50
V_5	4.00 d	3.67 cde	47.33 b	32.00 bc	512.52	440.46
V_6	6.00 abc	5.67 ab	27.00 de	14.67 d	647.11	482.72
V_7	5.33 bcd	5.00 abc	40.67 bc	12.00 d	401.27	339.30
V_8	5.67 abc	3.00 de	21.00 e	17.00 d	319.20	290.75
V_9	4.67 cd	4.33 bcd	31.00 d	23.33 cd	511.41	318.90
V_{10}	4.00 d	2.67 e	36.33 c	18.33 d	588.92	430.91
Mean	5.37	4.53	38.47	24.60	437.96	362.55

Note: Different letters between cultivars denote significant differences (Duncan test, $p < 0.05$).

Tab. 3 Main productivity characteristics

Variants	Mean yield seeds (g/plant)		Difference of yield 2011-2012		DSI
	2011	2012	g/plant	%	
V_1	97.79	84.56	13.23	13.52	0.25
V_2	100.91	44.80	56.11	55.61	1.03
V_3	74.56	50.24	24.32	32.62	0.60
V_4	79.91	24.94	54.97	68.79	1.27
V_5	97.04	51.68	45.36	46.74	0.86
V_6	104.83	40.12	64.71	61.73	1.14
V_7	87.03	20.36	66.67	76.61	1.41
V_8	37.98	14.83	23.16	60.96	1.13
V_9	73.98	32.24	41.74	56.42	1.04
V_{10}	85.59	21.07	64.52	75.39	1.39
Mean	83.96	38.48	45.48	54.17	–

it concerns V_7, there was also observed the most pronounced decrease of the number of pods/ plant number in 2012 than 2011 (28.67). The interaction between variants and culture years determined significant negative differences at V_8 and distinct significant positive at V_1.

MMB values are situated in normal limits (Ruști and Munteanu, 2008). V_9 manifested a pronounced sensibility to 2012 weather conditions, there was observed a 37.64% MMB decrease than the one obtained in 2011. Widely MMB decreases were registered as well at V_{10} (26.83 %) and V_6 (25.4%).

Highest yield values in 2011 (Tab. 3) were registered at V_6 (104.83 g seeds/plant) and V_2 (100.91 g seeds/plant), and the lowest value was registered at V_8 (37.98 g seeds/plant). V8 variant maintained a lower level in 2012 (14.83 g seeds/plant). Same year V_1 had the highest production (84.56 g seeds/plant).

V_7 presented a higher sensibility in what it concerns 2012 weather conditions because yield level had a 76.61% decrease than lats year level (87.03 g seeds/plant), reaching close to the minimum of V_8 (14.83 g seeds/plant).

V_1 was less influenced by 2012 weather conditions, because the yield decreased only with 13.23 g seeds/plant, which represents 13.52% from 2011 yield (97.79 g seeds/plant). At V_3 there was registered a 32.62% decrease, rest of the variants having losts bigger than 50%.

Drought susceptibility index (DSI) confirms that V_1 was less affected by 2012 weather conditions (Beebe, 2013), and V_7 presents the highest drought susceptibility (1.41).

CONCLUSION

In 2011 at V_6 were registered the highest values in what it concerns yield (104.83 g seeds/plant), width (0.71 cm), thickness (0.94 cm) and seeds weight (0.65 g).

V_1 was the most resistant local population in 2012 weather conditions, because at this variant there was registered the highest number of seeds in pod (6.33), the highest number of pods per plant (54), and the mean seed weight (0.25 g) did not registered a decrement comparing to 2011.

Weather conditions of 2012 negatively influenced the mean seeds weight at V_9, number of seeds in pod at V_8 and number of pods per plant V_7.

2012 conditions determined a 13.87 decrease of the mean number of pods/plant and a 54.17% decrease of plants yield comparing to 2011.

Even if V_7 and V_8 have white seeds and there are preffered by consumers, low yield values and high DSI values do not recommend their introduction into culture.

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