

THE BEHAVIOR OF A RUNNER BEAN ASSORTMENT FOR PODS (*PHASEOLUS COCCINEUS* L.) IN POLYETHYLENE TUNNELS, IN A CROP ESTABLISHED BY DIRECT SOWING

COMPORTAREA ÎN SPAȚII PROTEJATE A UNUI SORTIMENT DE FASOLE MARE (*PHASEOLUS COCCINEUS* L.) PENTRU PĂSTĂI, ÎN CULTURĂ ÎNFIINȚATĂ PRIN SEMĂNAT DIRECT

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Abstract. The paper is focused on the study of agroproductive behavior of a runner bean for pods assortment, in polyethylene tunnel conditions. The trial was conducted in the experimental polygon of the Vegetable Growing discipline, belonging to the Faculty of Horticulture from Iasi. The culture was established in 2014, by direct sowing, in nests, two plants in nest, being established three different densities through the experimental protocol: 20, 25 and 33 thousand nests/ha. The research sought to determine the total yield at four indeterminate cultivars of runner bean (Lady Di, Desiree, Polestar and White Apollo), the control variant being represented by the Desiree cultivar, considered classic in the home country (UK), established at a density of 25 thousands nests/ha. Within the bifactorial experience, the highest total production was obtained by the Polestar cultivar, sown at the distance of 50 cm between nests per row (density of 20 thousands nests/ha).

Key words: runner bean for pods, planting distances, polyethylene tunnel.

Rezumat. Lucrarea se axează pe studiul comportamentului agroproductiv al unui sortiment de fasole mare pentru păstăi, în condiții de solar. Experiența a fost derulată în poligonul experimental al disciplinei de Legumicultură, aparținând Facultății de Horticultură din Iași. Cultura a fost înființată în anul 2014, prin semănat direct, în cuiburi, câte două plante la cuib, fiind stabilite prin protocolul experimental trei densități diferite: 20, 25 și 33 mii cuiburi/ha. Cercetările au urmărit determinarea producției totale la patru cultivare urcătoare de fasole mare (Lady Di, Desiree, Polestar și White Apollo), varianta martor fiind reprezentată de cultivarul Desiree, considerat clasic în țara de origine (Marea Britanie), înființat la o densitate de 25 mii cuiburi/ha. În cadrul experienței bifactoriale, producția totală cea mai ridicată a fost obținută de cultivarul Polestar, semănat la distanța de 50 cm între cuiburi pe rând (densitatea de 20 mii cuiburi/ha).

Cuvinte cheie: fasole mare pentru păstăi, distanțe de plantare, solar.

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INTRODUCTION

The runner bean (*Phaseolus coccineus* L.) is a well-known species in Romania, with food and ornamental utilities, but occupies relatively small areas, being especially common in the gardens of the rural population (Munteanu, 1985). This species is grown especially for its dry and green beans, are less known the forms from which pods are used (Munteanu, 2005; Munteanu *et al.*, 2007; Popa *et al.*, 2008; Popa, 2010; Hamburdă *et al.*, 2014). The growth of runner bean for pods in protected areas is not known in Romania, although the results from other countries recommend this culture system (Klaus, 2013). Researches focused on this theme were held worldwide, in UK, Netherlands, France etc., but in Romania there were no concerns in this regard (Phillips, 1993).

The assortment for pods, used at European level, comprising, in general, improved climbing cultivars, but also improved cultivars or local populations with determined growth, for these being required a support system (<http://www.marshalls-seeds.co.uk/>, <http://www.thompson-morgan.com/>, <http://www.tozerseeds.com/eu/en/>).

Knowing the need to diversify the vegetables assortment, as well as some technological characteristics of this culture (Munteanu, 1985; Hidalgo *et al.*, 1986), our research aimed assessing the cultivation possibilities of the runner bean for pods in polyethylene tunnels, in Romania conditions, establishing as main objectives the study of cultivar and density influence on the crop and yield.

MATERIAL AND METHOD

The researches were organized in the experimental conditions of Didactic Station of USAMV Iasi, Horticultural Farm, in 2014. The experience was established in a covered polyethylene tunnel, with the dimensions of 40 x 10 x 3.5 m, on a chernozem cambic soil type, medium stocked in nutrients, with 3% organic matter and pH = 6.5.

The biological material used was represented by four cultivars of runner bean for pods, stringless, from UK: Lady Di, Desiree, Polestar and White Apollo (table 1).

Table 1

Runner bean assortment used in the experience

No.	Cultivar	Provenance	Flowers color	Seeds color	Presence/absence of thread in pods
1.	Lady Di	U.K.	red	purple with black arabesque	stringless
2.	Desiree	U.K.	white	white	stringless
3.	Polestar	U.K.	red	purple with black arabesque	stringless
4.	White Apollo	U.K.	white	white	stringless

The experience was of bifactorial type, organized in a device of subdivided plots, with three repetitions. The experimental factors were:

- A factor – the used assortment, with four graduations: a_1 = Lady Di; a_2 = Desiree; a_3 = Polestar; a_4 = White Apollo; as the control graduation was considered a_2 (Desiree cultivar).

- B factor – culture density, expressed by three graduations: $b_1 = 33000$ nests/ha (100 x 30 cm); $b_2 = 25000$ nests/ha (100 x 40 cm); $b_3 = 20000$ nests/ha (100 x 50 cm); as control density was the 25000 nests/ha.

The culture was established on 20 May, in nests of three seeds/nest, after emergence were kept only two plants/nest. The sowing was done in equidistant rows, spaced at 100 cm, the distances between nests per row being of 30, 40, and 50 cm. The support system consisted of a plastic net, with a mesh of 15 x 15 cm and the width of 1.7 m, placed at 30 cm from the ground. The net has been stretched over the rows, immediately after plant emergence (Fig. 1).



Fig. 1 – Aspects from the runner bean for pods experience, in polyethylene tunnel, from USAMV Iasi
a – aspect from polytunnel culture, b – ento pollination with bumblebees (original photo)

During the vegetation season, the maintenance work consisted in manual and mechanical weeding, phytosanitary treatments, root and foliar fertilizations, drip irrigation, trellising and pinching plants (Popa, 2010; Stan *et al.*, 2003). Also, in the polyethylene tunnel was placed a hive of bumblebees for flower pollination, the *Phaseolus coccineus* L. species being allogam (Kendall and Smith, 1976; Munteanu, 1985; Munteanu, 2005). The pods harvesting in order to determine yield was performed at 7-8 days intervals between harvests.

During the experience, were made determinations of the total harvest quantity, the data being processed by appropriate statistical – mathematical methods (Săulescu and Săulescu, 1967; Jităreanu, 1999).

RESULTS AND DISCUSSION

The total yield of pods, within the study assortment, has ranged, in 2014, between 6591 kg/ha (Desiree x 33000 nests/ha) and 20726 kg/ha (Polestar x 20000 nests/ha), while the control variant (Desiree x 25000 nests/ha) has achieved 7533 kg/ha (Table 2).

The statistical analysis (Table 3) for the total yield shows that the yield differences or the yield variance between cultivars is due to their characteristics, as demonstrated by the fact that the value of F ratio (sv^2/se^2) calculated is 167.17 compared with $F_{\text{theoretical}}$, of 4.76, at a degree of confidence of 95%. Also, the Fischer test shows that the total yield is determined significantly distinct and by

the variation of the cultivation densities, $F_{\text{calculated}}=28.09$ compared with $F_{\text{theoretical}}=3.63$.

Table 2

Results of runner bean assortment yields for the studied densities (kg/ha)

No.	Cultivar	33000 nests/ha	25000 nests/ha	20000 nests/ha	Average
1.	Lady Di	14043	14381	17964	15463
2.	Desiree	6591	7533	11272	8465
3.	Polestar	16694	17763	20726	18394
4.	White Apollo	7422	7533	10314	8423
	Average	11187	11803	15069	12686

The Fischer test, for the cultivar x density factors interaction, demonstrates that the yield differences compared to the control haven't any significance and is due, mainly, to the experimental error ($F_{\text{calculated}} = 0.26 < F_{\text{theoretical}} = 2.74$).

Table 3

The variance analysis for the bifactorial experience

Variance source	SP	GL	S ²	F _{calculated}	F _{theoretical}
Large plots	695630900	11			
Repetitions	873472	2			
A factor	686543900	3	228848000,0	167,17	4,76
Error (a)	8213504	6	1368917,0		
Small plots	832771100	35			
B factor	104455200	2	52227590,0	28,09	3,63
A x B	2936320	6	489386,7	0,26	2,74
Error	29748740	16	1859296,0		

SP = sum of squared deviations; GL = degrees of freedom; S² = variance; F = factor

In the studied cultivars, the total yield ranged between 8423 kg/ha (White Apollo) and 18394 kg/ha (Polestar), the value recorded by the control cultivar (Desiree) being of 8465 kg/ha (Table 4).

Table 4

The comparative analysis of the total yield determined by the studied cultivars

No.	Cultivar	Yield			Difference significances
		kg/ha	% to C	Differences to the C	
1.	Lady Di	15463	182.67	6998	xxx
2.	Desiree (C)	8465	100.00	0	
3.	Polestar	18394	217.30	9929	xxx
4.	White Apollo	8423	99.51	- 42	-

DL 5% = 1351.3 kg/ha, DL 1% = 2046.2 kg/ha, DL 0.1% = 3287.2 kg/ha

The yield differences obtained when comparing to the control (Desiree cultivar – 8465 kg/ha) have recorded very significant degree of confidence in the case of Lady Di (15463 kg/ha) and Polestar (18394 kg/ha) cultivars.

Although the studied assortment was reduced, however there was a very high variability of yield, the lowest yield being extremely close to the control (White Apollo cultivar – 99.51%), the highest, however, representing 217.3% (Polestar cultivar). This aspect presents a particular importance in the improvement

field of this species, and could use some technological links with impact on improving the productive capacity, such as distances, establishing epochs etc.

Regarding the analysis of the yield results, on average for each of the three cultivation densities, compared with the control variant (the density of 25 thousands nests/ha), the 20 thousands nests/ha density has achieved a total yield of 15069 kg/ha, representing a yield increase of 27.68%, that can be recommended in culture, because the plants thus have a space of light and nutrition efficiently distributed (Table 5).

Table 5

The average of yield results determined by the three studied densities

No	Density (nests/ha)	Yield			Difference significances
		kg/ha	% to C	Differences to the C	
1.	33000	11187	94.79	-616	-
2.	25000 (C)	11803	100.00	0	
3.	20000	15069	127.68	3266	xxx

DL 5% = 1180.1 kg/ha, DL 1% = 1625.5 kg/ha, DL 0.1% = 2237.8 kg/ha

The yield differences recorded at a density of 20 thousands nests/ha (3266 kg/ha) were ensured at a very significant level when compared to the control of 25 thousands nests/ha (11803 kg/ha).

The 33 thousands nests/ha density presented yield values beneath control variant, the negative differences were not statistically ensured (-616 kg/ha).

Table 6

Comparative results between the cultivar x distance between rows combinations (A x B)

No.	A x B	Production			Difference significances
		kg/ha	% to C	Differences to the C	
1.	a1b1	14043	186.42	6510	xxx
2.	a1b2	14381	190.91	6848	xxx
3.	a1b3	17964	238.47	10431	xxx
4.	a2b1	6590	87.49	-943	-
5.	a2b2 (C)	7533	100.00	0	
6.	a2b3	11271	149.63	3738	xx
7.	a3b1	16694	221.61	9161	xxx
8.	a3b2	17763	235.80	10230	xxx
9.	a3b3	20726	275.14	13193	xxx
10.	a4b1	7422	98.53	-111	-
11.	a4b2	7533	100	0	-
12.	a4b3	10314	136.92	2781	x

DL 5% = 2348.6 kg/ha, DL 1% = 3330.8 kg/ha, DL 0.1% = 4829.4 kg/ha

Combination between cultivar x density has generated production results which ranged from 6590 kg/ha (Desiree x 33 thousands nests/ha) to 20726 kg/ha (Polestar x 25 thousands nests/ha), under a control of 7533 kg/ha (Desiree x 25 thousands nests/ha), the differences being very significant for six combinations compared to the control (table 6).

CONCLUSIONS

1. Analyzing the results obtained due to the cultivar influence, it may be noted that the highest yields, compared to the control (Desiree – 8465 kg/ha), were achieved at the Polestar and Lady Di cultivars (18394 kg/ha, respectively 15463 kg/ha), the obtained increases were statistically ensured as significant.

2. The comparative analysis of the three experimented densities showed that the highest yield increase (27.68%), when comparing to the control (25 thousands nests/ha) was recorded at the density of 20 thousands nests/ha, this may be recommended for growing runner bean for pods in protected areas, in order to improve the light and nutrition space.

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