THE INFLUENCE OF DIFFERENT FERTILIZERS ON THE PODS YIELD OF THREE COMMON BEAN CULTIVARS

INFLUENȚA APLICĂRII UNOR FERTILIZANȚI DIFERIȚI ASUPRA PRODUCȚIEI DE PĂSTĂI LA TREI CULTIVARE DE FASOLE PITICĂ

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Abstract. *The paper aim is to evaluate the production capacity of three varieties of dwarf bean - Ferrari, Rocquencourt and Maxidor (C) - under different fertilization conditions: organic-Orgevit-600 kg/ha, chemical-50 kg/ha, with microorganisms-50 kg/ha and the non-fertilized control variant. The experiment was established in the Experimental Field of Vegetable Growing, the University of Agricultural Sciences and Veterinary Medicine Iasi, in the 2016-2017 period. The crop was set up by direct sowing in the field, in three-rows bands, the distance between the bands being 60 cm and between the rows 45 cm. Plant spacing was set at 5 cm, resulting in a density of about 400 thousand plants/ha. The experimental results, under the above mentioned conditions, demonstrate the usefulness of the fertilization of the dwarf bean culture for the pods, the highest yield being obtained by applying chemical and microorganisms fertilization.*
Keywords: *Phaseolus vulgaris* convar. *nanus*, fertilization, productions

Rezumat. *Lucrarea are drept scop evaluarea capacității de producție a trei soiuri de fasole pitică pentru păstăi - Ferrari, Rocquencourt şi Maxidor (Mt) - în condiții de fertilizare diferită: organică-Orgevit 600 kg/ha, chimică-350 kg/ha, cu microorganisme-50 kg/ha şi varianta martor-nefertilizată. Experiența a fost amplasată în câmpul experimental al disciplinei de Legumicultură, din cadrul U.S.A.M.V. Iaşi, în perioada 2016-2017. Cultura a fost înființată prin semănat direct în câmp, în benzi de câte trei rânduri, distanța dintre benzi fiind de 60 cm, iar între rândurile din bandă de 45 cm. Distanța între plante a fost stabilită la 5 cm, rezultând o densitate de aproximativ 400 mii plante/hectar. Rezultatele experimentale, în condițiile menționate, demonstrează utilitatea fertilizării culturii de fasole pitică pentru păstăi, producțiile cele mai ridicate fiind obținute în cazul fertilizării chimice şi cu microorganisme.*
Cuvinte cheie: *Phaseolus vulgaris* convar. *nanus*, fertilizare, producții

INTRODUCTION

Dwarf bean is an important agricultural crop because of its usefulness in the context of a growing global population. The field garden occupies the largest cultivated areas and provides the highest crop yield, both for direct consumption

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and for conservation. The nutritional value of bean pods is determined by the high content of nutrients essential for human nutrition (Stan *et al.*, 2003; Ruşti and Munteanu, 2008; Hnatuszko-Konka *et al.,* 2014; Jayamanohar *et al*., 2018).

The growing of the garden dwarf bean is suitable for the vegetable fields; it is easy to fall into the crops, being an excellent pre-plant for most of the vegetable species. Cultivation of this species contributes to the improvement of the soil structure, as well as to the increase of its nitrogen content due to the symbiosis relation with *Rhizobium* nitrogen fixation bacteria (Mwenda *et al.,* 2018).

Culture is relatively simple, through direct sowing, and includes a small number of maintenance work. Of these technological works, fertilization is extremely important because it influences production in quantitative and qualitative terms, as well as the quality of the environment. The use of chemical fertilizers is preferred by farmers due to the fact that the production is higher and their application is easier. At present, there is an increasing interest in the use of various products that improve yield without adverse effects on plant and environmental quality (Kocira *et al.,* 2018; Michałek *et al*., 2018).

The growing opportunity for high quality products of plant origin is a challenge in modern agriculture. Currently, agricultural production focuses on increasing plant yield and quality, respecting the principles of production safety (Hamburdă *et al.*, 2016; Kocira *et al.,* 2017; Burducea *et al.*, 2018;Caruso *et al.*, 2018; De Sio *et al.*, 2018).

In the realization of corresponding quantitative and qualitative productions, the cultivar chosen also has an important role, which must be well adapted to the environmental conditions specific to the area in which it is used (Teodorescu *et al.*, 2012a; 2012 b).

Starting from the above, this study has proposed a comparative assessment of the effects of chemical fertilization, organic fertilization and application of microorganism products on the production of dwarf bean varieties.

MATERIALS AND MEHODS

The experiment was established in the Experimental Field of Vegetable Growing, the University of Agricultural Sciences and Veterinary Medicine Iasi, in the 2016-2017 period. The experience was carried out a chernozemic soil, medium leachate, medium supplied in nutrients with 3% organic matter (Hamburdă *et al.*, 2016) and pH = 6.5. The weather conditions of the experimental period, shown in table1 (Burducea *et al.*, 2018), were favourable for this species.

The experimental culture protocol was a bifactorial experiment, organized in a split plot design with tree replicates, in which the influence of two experimental factors was studied, namely: Factor A – assortment used - common bean with determined growth, for pods - with three graduations: a1 = Rocquencourt - yellow pods and black seeds, a2 = Ferrari - green pods and white seeds; a3 = Maxidor (Mt) – yellow pods and white seeds; Factor B – crop fertilization variant - with four graduations: b1 = unfertilized variant (control); b2 = application of microorganisms (Micoseeds MB); b3 = chemical fertilization; b4 = organic fertilization (Orgevit).

Table 1

Experimental weather conditions

Month	Sum of precipitations (mm)		Average temperature (°C)	
	Year of experiment		Year of experiment	
	2016	2017	2016	2017
March	24	52	6.4	8
April	56	89	13.5	10.3
May	72	71	15.4	16.5
June	111	47	21.2	21.7
July	12	48	23.1	22
August	52	39	21.3	22.2
September	13	13	18.4	17.4

The fertilizations were carried out in two stages: 1) preparation of the germination bed, ten days prior to the establishment of the crop (starter fertilization) and 2) before flowering (root phase fertilization). 1) 30 kg / ha of Micoseeds MB, 150 kg / ha of ammonium nitrate and 350 kg / ha of Orgevit, and 2) 20 kg / ha of Micoseeds MB, 200 kg / ha NPK complex fertilizer (15: 15:15) and 250 kg / ha respectively, corresponding to the experimental variants. Fertilizers applied to phase fertilization were incorporated into the soil through a manual drill.

The crop was set up in the first decade of May, by sowing directly into the soil, according to the scheme: in three stripes spaced at 45 cm with intervals of 60 cm between the strips, the distance between the plants being 5 cm, resulting in a density of about 400 thousand plants / ha (fig. 1).

Fig. 1 Aspects from experience with garden dwarf bean

During the vegetation period, the care works performed were those recommended by the literature and mainly consisted of weed control, phytosanitary treatments, root phase fertilization (Stan *et al*., 2003). The pods were harvested in three rounds, corresponding to the optimum technological maturity. They were carried outdeterminations of the total harvest quantity, the data being processed by

appropriate statistical and mathematical methods (Săulescu and Săulescu, 1967; Jităreanu, 1999; Leonte and Simioniuc, 2018).

RESULTS AND DISCUSSIONS

The production of pods varied, within the two experimental years, within very wide limits, ranging from 4643.3 kg / ha (Maxidor x unfertilized in 2017) and 7568.0 kg / ha (Rocquencourt x Micoseeds MB in 2016), whereas the average production at the level of the experimental polygon for the two years under study was 6046.2 kg / ha (tab. 2).

Table2

Experimental production results (kg / ha)

No.	Year of experiment	Fertilization variant / Cultivar	Unfertilized (C)	Micoseeds MB	Chemical	Orgevit	Average
1.	2016	Rocquencourt	5718.0	7568.0	7505.3	5895.3	**6671.7**
2.		Ferrari	5341.0	7145.3	7150.3	5604.8	**6310.4**
3.		Maxidor (Mt)	5107.0	6769.0	6680.3	5552.0	**6027.1**
4.	**Average 2016**		**5388,7**	**7160.8**	**7112.0**	**5684.0**	**6336.4**
5.	2017	Rocquencourt	4966.3	6384.3	7418.7	5218.0	**5996.8**
6.		Ferrari	4745.3	6005.3	7092.0	5249.0	**5772.9**
7.		Maxidor (Mt)	4643.3	5629.3	6638.7	5081.0	**5498.1**
8.	**Average 2017**		**4785,0**	**6006.3**	**7049.8**	**5182.7**	**5755.9**
9.	Average 2016-2017	Rocquencourt	5342.1	6976.2	7462.0	5556.7	**6334.2**
10.		Ferrari	5043.2	6575.3	7121.2	5426.9	**6041.6**
11.		Maxidor (Mt)	4875.2	6199.2	6659.5	5316.5	**5762.6**
12.	**Averageyears 2016-2017**		**5086.8**	**6583.6**	**7080.9**	**5433.4**	**6046.2**

At the cultivation level studied, the yields ranged between 5498.1 kg / ha (Maxidor-2017) and 6671.7 kg / ha (Rocquencourt-2016) (tab. 3).

Table3

Comparative analysis of production determined by studied crops

No.	Year of experiment	Cultivar	Yield			Significance of differences
			kg/ha	% of C	differencescompared with C	
1.	2016	Rocquencourt	6671.7	110.70	644.6	*
2.		Ferrari	6310.4	104.70	283.3	-
3.		Maxidor	6027.1	100.00	0	C
DL 5% = 475.9 kg/ha. DL 1% = 789.2 kg/ha. DL 0.1% = 1474.0 kg/ha						
4.	2017	Rocquencourt	5996.8	109,07	498,7	**
5.		Ferrari	5772.9	105,00	274,8	*
6.		Maxidor	5498.1	100,00	0	C
DL 5% = 194.4 kg/ha. DL 1% = 322.4 kg/ha. DL 0.1% = 602.1 kg/ha						
7.	Average 2016-2017	Rocquencourt	6336.7	109,96	573,9	**
8.		Ferrari	6041.9	104,84	279,1	*
9.		Maxidor	5762.8	100,00	0	C
DL 5% = 199.4 kg/ha. DL 1% = 330.7 kg/ha. DL 0.1% = 617.7 kg/ha						

The influence of the variety on the production of pods, on average over the experimental period, revealed distinctly significant yields for Rocquencourt cultivar (573.9 kg / ha) compared to the indicated control (Maxidor variety). Also, the Ferrari cultivar achieved production differences to Maxidor that were statistically significant (279.1 kg / ha).

Depending on the fertilization variant, the yields varied from 4785.0 kg / ha, production obtained in the non-fertilized variant in 2017, to 7160.8 kg / ha, production obtained for Micoseeds MB fertilization in the year 2016. The average of the experimental years revealed productions of 5087.0 kg / ha, recorded in the unfertilized variant and 7084.3 kg / ha, in the fertilized chemical variant (tab. 4).

Table4

The average of the production results determined by the four variants of fertilization

No.	Year of experiment	Fertilization variant	Yield			Significance of differences
			kg/ha	% of C	differencescompared with C	
1.	2016	Unfertilized	5388.7	100.00	0	C
2.		Micoseeds MB	7160.8	132.89	1772.1	***
3.		Chemical	7112.0	131.98	1723.3	***
4.		Organic	5684.1	105.48	295.4	-
DL 5% = 352.6 kg/ha. DL 1% = 483.6 kg/ha. DL 0.1% = 658.3 kg/ha						
5.	2017	Unfertilized	4785.0	100.00	0	C
6.		Micoseeds MB	6006.3	125.52	1221.3	***
7.		Chemical	7049.8	147.33	2264.8	***
8.		Organic	5182.7	108.31	397.7	*
DL 5% = 317.1 kg/ha. DL 1% = 434.9 kg/ha. DL 0.1% = 592.0 kg/ha						
9.	Average 2016-2017	Unfertilized	5087.0	100.00	0	C
10.		Micoseeds MB	6583.8	129.42	1496.8	***
11.		Chemical	7084.3	139.26	1997.3	***
12.		Organic	5433.6	106.81	346.6	**
DL 5% = 244.9 kg/ha. DL 1% = 335.9 kg/ha. DL 0.1% = 457.2 kg/ha						

The analysis of the production results for this factor revealed the production differences registered by the chemically fertilized variants and microorganisms, which, compared to the non-fertilized variant, were positive at a very significant level, while the organically fertilized variant provided differences distinct positive. This proves the usefulness of fertilization of the dwarf bean culture for pods, recommending fertilization with chemical fertilizers and applying microorganisms to obtain high yields.

The interaction between the studied cultivar and the type of fertilization used determined, on average for the two experimental years, large variations in production, starting with 4875.3 kg / ha, a value obtained by the control (which in

our case is the Maxidor variety x unfertilized) and 7471.3 kg / ha, recorded by the Rocquencourt cultivar, to which chemical fertilizers were applied (tab. 5).

Table 5

Comparative results between variety combinations x fertilization (A x B)

Nr. crt.	Year of experiment	A x B	Yield			Significance of differences
			kg/ha	% of C	differences compared with C	
1.	2016	Rocquencourt x unfertilized	5718.0	111.96	611.0	*
2.		Rocquencourt x Micoseeds MB	7568.0	148.19	24610	***
3.		Rocquencourt x chemical	7505.3	146.96	2398.3	***
4.		Rocquencourt x organic	5895.3	15.44	788.3	*
5.		Ferrari x unfertilized	5341.0	104.58	234.0	-
6.		Ferrari x Micoseeds MB	7145.3	139.91	2038.3	***
7.		Ferrari x chemical	7150.3	140.01	2043.3	***
8.		Ferrari x organic	5605.0	109.75	498.0	-
9.		Maxidor x unfertilized	5107.0	100.00	0	C
10.		Maxidor x Micoseeds MB	6769.0	132.54	1662.0	***
11.		Maxidor x chemical	6680.3	130.81	1573.3	***
12.		Maxidor x organic	5552.0	108.71	445.0	-
DL 5% = 610.8 kg/ha. DL 1% = 837.7 kg/ha. DL 0.1% = 1140.2 kg/ha						
1.	2017	Rocquencourt x unfertilized	4966.3	106.96	323.0	-
2.		Rocquencourt x Micoseeds MB	6384.3	137.49	1741.0	***
3.		Rocquencourt x chemical	7418.7	159.77	2775.4	***
4.		Rocquencourt x organic	5218.0	112.38	574.7	*
5.		Ferrari x unfertilized	4745.3	102.20	102.0	-
6.		Ferrari x Micoseeds MB	6005.3	129.33	1362.0	***
7.		Ferrari x chemical	7092.0	152.74	2448.7	***
8.		Ferrari x organic	5249.0	113.04	605.7	*
9.		Maxidor x unfertilized	4643.3	100.00	0	C
10.		Maxidor x Micoseeds MB	5629.3	121.23	986.0	**
11.		Maxidor x chemical	6638.7	142.97	1995.4	***
12.		Maxidor x organic	5081.0	109.43	4377	-
DL 5% = 549.3 kg/ha. DL 1% = 753.3 kg/ha. DL 0.1% = 1025.4 kg/ha						
1.	Average 2016-2017	Rocquencourt x unfertilized	5342.3	109.58	467.0	*
2.		Rocquencourt x Micoseeds MB	6976.3	143.09	2101.0	***
3.		Rocquencourt x chemical	7471.3	153.25	2596.0	***
4.		Rocquencourt x organic	5557.0	113.98	681.7	**
5.		Ferrari x unfertilized	5043.3	103.45	168.0	-
6.		Ferrari x Micoseeds MB	6575.7	134.88	1700.4	***
7.		Ferrari x chemical	7121.7	146.08	2246.4	***
8.		Ferrari x organic	5427.0	111.32	551.7	*
9.		Maxidor x unfertilized	4875.3	100.00	0	C
10.		Maxidor x Micoseeds MB	6199.3	27.16	1324.0	***
11.		Maxidor x chemical	6660.0	136.61	1784.7	***
12.		Maxidor x organic	5316.7	109.05	441.4	*
DL 5% = 294.6 kg/ha. DL 1% = 404.0 kg/ha. DL 0.1% = 549.9 kg/ha						

Very significant positive differences were recorded in six combinations compared to the control variant: Rocquencourt x chemical (2596.0 kg / ha), Ferrari x chemical (2246.4 kg / ha), Rocquencourt x Micoseeds MB (2101.0 kg / ha), Maxidor x chemical (1784.7 kg / ha), Ferrari x Micoseeds MB (1700.4 kg / ha) and Maxidor x Micoseeds MB (1324.0 kg / ha).

As can be seen from the least significant differences calculation, all chemically fertilized and microorganisms variants, regardless of the variety chosen, generated very significant yields compared to the control.

At the same time, Rocquencourt was the only variety that determined productions at statistical level, regardless of the fertilization option we opted for.

CONCLUSIONS

1. Production of pods in the species *Phaseolus vulgaris* convar. *nanus* is influenced by the applied fertilization, the chosen cultivar and the year of production, the biggest differences being highlighted in the fertilization variants.

2. Chemically and microorganisms (Micoseeds MB) fertilized plants generated very significant differences compared to the non-fertilized control (39.26% and 29.42%, respectively), thus these fertilizers can be recomended to obtain high yields.

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