

# EXPERIMENTAL RESULTS ON RUNNER BEAN CULTIVATION (*PHASEOLUS COCCINEUS* L.) IN INTERCROPPING SYSTEM

## REZULTATE EXPERIMENTALE PRIVIND CULTIVAREA FASOLEI MARI (*PHASEOLUS COCCINEUS* L.) ÎN SISTEM INTERCROPPING

HAMBURDĂ Silvia Brîndușa<sup>1</sup>, MUNTEANU N.<sup>1</sup>, STOLERU V.<sup>1</sup>, BUTNARIU Gianina<sup>1</sup>, TELIBAN G. C.<sup>1</sup>, POPA Lorena Diana<sup>1</sup>  
e-mail: silvia\_hamburda@yahoo.com

**Abstract.** *This paper presents the behavior of runner bean (*Phaseolus coccineus* L.) in three intercropping systems, with maize, sunflower and Jerusalem artichoke, compared to a pure culture system (available in three plant display variants - trellis with individual string on a single row, individual string trellis on two rows and synthetic net trellising). The results were evaluated based on the main morphological and phenological plant characteristics, including agro-productivity. The results revealed significant differences between the studied variants, demonstrating the superiority of pure culture growing on synthetic mesh trellis.*

**Key words:** *pure crop, associated crop, trellising system, runner bean yield*

**Rezumat.** *Lucrarea prezintă modul de comportare a fasolei mari (*Phaseolus coccineus* L.) în trei sisteme de intercropping cu porumb, cu floarea soarelui și cu topinambur, în comparație cu sistemul de cultură simplă (în trei variante de dispoziție a plantelor – palisat pe spalier cu sfoară individual într-un singur rând, palisat pe spalier pe sfoară individual pe două rânduri și palisat pe spalier cu plasă sintetică). Rezultatele au fost evaluate pe baza principalelor caracteristici morfologice și fenologice ale plantelor, inclusiv cele de agroproductivitate. Rezultatele au pus în evidență diferențe semnificative între variantele studiate, demonstrând superioritatea variantei de cultivare în cultură pură palisată pe spalier cu plasă sintetică.*

**Cuvinte cheie:** *cultură pură, cultură intercalată, sistem palisare, producție de fasole mare*

## INTRODUCTION

Runner bean (*Phaseolus coccineus* L.) is an herbaceous, annual and out-crossing species, propagated, usually, by seeds, adapted to a relativ cool and humid climate. Such a climate it is not proper for the North – East region of Romania (Popa, 2010). To achieve cost-effective production, it is necessary to diversify the cultivation of this species, through optimization of design and period setting and the use of various support systems, such as runner beans' interleaving with other cultivated species (maize, sunflower, Jerusalem artichoke), whose stem is also supporting bean plants (Hamburdă et al., 2013).

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<sup>1</sup>University of Agricultural Sciences and Veterinary Medicine of Iasi, Romania

Intercropping is based on the management of plant interactions, in order to increase the productivity (Vandermeer, 1989; Wiley, 1979 a, b). The success of intercropping depends on thorough knowledge of the botanical, ecological and technological particularities of associated species, especially habitus, root morphology, requirements for water and nutrients. The purpose of this system is to put the growing crops in the same place throughout the growing season or at least for a period of time (Mousavi and Eskandari, 2011). The plants involved in intercropping may be seeded or planted at the same time or at different times (Ofori and Stern, 1987).

This paper presents the behavior of runner bean in three intercropping systems, with common maize (*Zea mays* L.), sunflower (*Helianthus annuus* L.), and Jerusalem artichoke (*Helianthus tuberosus* L.), compared to a pure culture system (available in three plant display variants - trellis with individual string on a single row, individual string trellis on two rows and synthetic mesh trellising). The need for this research stems from the fact that a standard technology for runner bean crop is not yet developed. Thus, it is an attempt to obtain cost-effective productions, by using different means of trellising and determining the most efficient trellising system.

## MATERIAL AND METHOD

In accordance with the purpose and research objectives, we organized an experience, in 2013, in the Vegetable growing department's experimental field, at "V. Adamachi" farm, U.A.S.V.M. Iași.

The available biological material was the runner bean seeds (C<sub>3</sub> local population), seeds of maize (Flato hybrid), sunflower seeds (Tristan hybrid) and Jerusalem artichoke tubers (Topstar cultivar).

Organization of the experiment was in a randomized blocks device with three repetitions. The studied experimental factor was the trellising system with six graduations, in field conditions:

- V<sub>1</sub> = on individual string trellis with double rows,
- V<sub>2</sub> = on individual string trellis with a single row,
- V<sub>3</sub> = on synthetic net trellis (17 cm mesh) in a single row,
- V<sub>4</sub> = intercropping with common maize,
- V<sub>5</sub> = intercropping with sunflower,
- V<sub>6</sub> = intercropping with Jerusalem artichoke.

Each recurrence plot had a 6 m<sup>2</sup> surface area, which consists of two spaced rows of 1.0 m, ensuring a distance of 0.4 m between runner bean plants. For the pure culture, the system consisted of a reinforced concrete support trellis formed of pillars and a steel wire of about 2 cm on the top thereof.

The establishment of runner bean crop was conducted between 1.05 - 30.05. Sowing maize and sunflower, respectively planting artichokes were made about two weeks before sowing runner bean. Crop establishment was performed by direct seeding, three runner bean seeds/nest and two maize seeds or sunflower seeds/nest. At the time of emergence, there have been left, in each nest, two runner bean plants and one of maize and sunflower plants. Artichokes were planted by two tubers/nest, and at emergence time, only one stem/plant were allowed. Thus, in the case of trellising runner bean plants on maize/sunflower/Jerusalem artichoke, for each repetition, there were 30 nests of runner bean plants and 14 plants of

maize/sunflower/Jerusalem artichoke; in the runner bean mesh and string trellising systems, there were 30 nests of runner bean plants on each repetition.

The experimental culture was conducted according to technical rules arising from the specialized literature consulted (Munteanu et al., 1989, Stan N. et al., 2003, Ruști, 2007; Popa, 2010; Axinte et al., 2006). The culture was performed on well leveled ground; the soil is a cambic chernozem, well-stocked in nutrients, with an organic matter content of 3.2 - 3.4% and a pH of 6.5-6.8. Weather conditions during the growing season (months IV to IX) were characterized by an average temperature of 17.8°C, an average relative humidity of 67% and a rainfall amount of 495.4 mm.

Works were carried out as recommended for common climbing beans (Munteanu et al., 1982; Ruști and Munteanu, 2008; Popa, 2010). The culture was not irrigated.

Basic research methods were the observation and the experiment, in which, for evaluating the performance of studied variants, biometric observations and measurements were conducted on the main morphological and phenological plant features, including agro-productivity. Production results were statistically interpreted according to the specialized literature (Jitoreanu, 1994; Săulescu and Săulescu, 1967).

## RESULTS AND DISCUSSIONS

Between the studied trellising systems, there was no significant differences in the morphological and phenological characterization of the runner bean plants.

Results in terms of morphological characterization: runner bean plant port is voluble; size (height) of the plant is over two meters; plant vigor is high; number of branches per plant is three to four; the foliage color is dark green; flower color is white; seed color is white; pods of widely varying size, with length of 8-17 cm and a width of 1.4 to 2 cm; it is important to point out that the pod's length correlates with the number of seeds/pod, longer pods having a higher number of seeds; seed size, measured by the length of the longest axis, varies between 15 and 22 mm; the number of seed per pod ranges from two to four.

Results in the phenological characterization: emergence is hypogeic, meaning it is achieved only by the epicotil growing above ground, the cotyledon leaves remaining in the soil; period from sowing to emergence was about seven to ten days, the period from emergence to appearance of the first real trifoliate leaves was around five to seven days, the period from emergence to the first flowers was about 32 - 35 days, the period from emergence to the first pods was about 67-70 days, the period from emergence to seed maturation was around 115-122 days and the period from emergence to the end of the vegetation period was around 130-140 days (tab. 1).

*Table 1*

**Phenological characters (number of days)**

Sowing - emergence	Emergence - first real trifoliate leaf	Emergence - first flowers	Emergence - first pods	Emergence - seed maturation	Emergence - end of vegetation
7-10	5-7	32-35	67-70	115-122	130-140

*Results in terms of runner bean production - pure culture*

Following the investigations, it appears that seed production ranged from 2733 kg/ha to 3325 kg/ha. Highest production was obtained in the variant with trellising runner beans on synthetic mesh (3325 kg/ha), which showed distinctly significant positive differences as compared to the mean (3080 kg/ha), while the lowest production variant was obtained on runner bean individual trellising on double rows (2733 kg/ha), a very significant negative differences from the control being highlighted. The second variant (individual string trellis with a single row), achieved yields within the average experimental variation limits (tab. 2).

Table 2

**Results obtained in pure culture of runner bean (year 2013)**

Variant		Yield of runner bean		Differences to mean (kg/ha)	Semnification	
no.	specification	kg/ha	% of the mean			
1	pure culture	V <sub>1</sub>	2733	88,7	-347	ooo
2		V <sub>2</sub>	3182	103,3	+102	NS
3		V <sub>3</sub>	3325	107,9	+245	**
Mean			3080	100	-	-

<sup>w</sup>Significance of differences made by ANOVA (analysis of variance) for experimental factors and interaction of them; NS, \*, \*\*, \*\*\* - indicate nonsignificant and positive significant at p≤0.05, 0.01, 0.001, respectively;

o,oo,ooo - negative significant at p ≤ 0.05, 0.01, 0.001, respectively

LSD 5% = 103,43 (kg/ha)

LSD 1% = 171,15 (kg/ha)

LSD0,1% = 320,34 (kg/ha)

*Results in terms of runner bean production - intercropping*

Following investigations, it appears that seed production ranged from 789 kg/ha and 3093 kg/ha (tab. 3).

Table 3

**Results obtained in intercropping system (year 2013)**

Variant		Runner bean yield		Differences to mean (kg/ha)	Semnification	
no.	specification	kg/ha	% of the mean			
1	intercropping	V <sub>4</sub>	1966	100,8	+16,6	NS
2		V <sub>5</sub>	3093	158,6	+1143,6	***
3		V <sub>6</sub>	789	40,4	-1160,3	ooo
Mean			1949	100	-	-

<sup>w</sup>Significance of differences made by ANOVA (analysis of variance) for experimental factors and interaction of them;

NS, \*, \*\*, \*\*\* - indicate nonsignificant and positive significant at p≤0.05, 0.01, 0.001, respectively;

o,oo,ooo - negative significant at p≤0.05, 0.01, 0.001, respectively

LSD 5% = 271,37 kg/ha

LSD 1% = 449,03 kg/ha

LSD 0,1% = 840,47 kg/ha

Highest yield was obtained when interleaving runner bean with sunflower (3093 kg/ha), which recorded very significant positive differences as compared to the mean (1949 kg/ha), while the lowest yield was obtained in the intercalation of runner bean with Jerusalem artichoke (789 kg/ha), very significant negative differences from the control being highlighted. The third option (intercropping with maize) achieved yields within the average experimental variation limits.

*Results in the production of runner bean - total experience*

Following investigations, it appears that seed yield ranged from 789 kg/ha and 3325 kg/ha. Highest yield was obtained in the variant with trellising runner bean on synthetic mesh (3325 kg/ha), which recorded very significant positive differences as compared to the experimental mean (2515 kg/ha), while the lowest production was obtained when interleaving runner bean with Jerusalem artichoke (789 kg/ha), very significant negative differences from the control being highlighted (Tab. 4).

Table 4

**Yield of runner bean per total experience (year 2013)**

Variant		Runner bean production		Differences to mean (kg/ha)	Semnification	
no.	Specification	kg/ha	% of the mean			
1	pure culture	V <sub>1</sub>	2733	108,6	+218	x
2		V <sub>2</sub>	3182	126,5	+667	xxx
3		V <sub>3</sub>	3325	132,2	+810	xxx
4	intercropping	V <sub>4</sub>	1966	78,1	-549	ooo
5		V <sub>5</sub>	3093	122,9	+578	xxx
6		V <sub>6</sub>	789	31,3	-1726	ooo
Experience mean			2515	100	-	-

<sup>w</sup>Significance of differences made by ANOVA (analysis of variance) for experimental factors and interaction of them;

ns, \*, \*\*, \*\*\* - indicate nonsignificant and positive significant at p≤0.05, 0.01, 0.001, respectively;

o,oo,ooo - negative significant at p≤0.05, 0.01, 0.001, respectively.

LSD 5% = 163,26 kg/ha

LSD 1% = 232,08 kg/ha

LSD0,1% = 336,04 kg/ha

## CONCLUSIONS

1. There were no significant differences in characterization of runner bean plants, regarding plant height, vigour of the plant, pod size, seed size, seed number in a pod, vegetation period.

2. The highest production results were obtained in the pure culture system (3080 kg/ha), in comparison with the intercropped culture (1949 kg/ha).

3 In terms of overall experience production, it ranged from 789 kg/ha (V<sub>6</sub> - intercropping with Jerusalem artichoke) and 3325 kg/ha (V<sub>3</sub> - trellising system on synthetic net).

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