RESULTS OF RUNNER BEAN (*PHASEOLUS COCCINEUS* L.) YIELD OBTAINED IN INTERCROPPING SYSTEM

REZULTATE DE PRODUCȚIE OBȚINUTE ÎN SISTEM INTERCROPPING LA FASOLEA MARE (*PHASEOLUS COCCINEUS* L.)

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Abstract. *This paper presents the influence of the calendaristic establishment date on the yield (dry seeds) of runner bean (Phaseolus coccineus L.) cultivated in intercropping system, respectively intercropping with common maize, intercropping with sunflower and intercropping with Jerusalem artichoke, in three distinct calendaristic dates of establishment: 1.05, 15.05, 30.05. In order to achieve this goal, we intended to find out in which date the highest yield is obtained, by comparing the variants with each other. The crop establishment was performed by direct sowing in the field. The results revealed significant differences between the studied variants. The date in which the highest yields were achieved was 15.05. The variant which obtained the highest yield was the one where runner bean was interleaved with sunflower.*

Key words: *associated plants, setting up time, common maize, sunflower, Jerusalem artichoke*

Rezumat. *Lucrarea prezintă influența epocii de înființare a culturii asupra cantității de recoltă (boabe uscate) obținută la fasolea mare (Phaseolus coccineus L.) cultivată în sistem intercropping, respectiv intercropping cu porumb comun, intercropping cu floarea soarelui și intercropping cu topinambur legumicol, în trei epoci distincte de înființare a culturii: datele calendaristice 1.05, 15.05 și 30.05. Pentru realizarea scopului propus, ne-am stabilit să aflăm în care epocă și la care variantă se obține cantitatea cea mai mare de producție, prin compararea variantelor între ele. Înființarea culturii a fost realizată prin semănat direct, în câmp. Rezultatele au pus în evidență diferențe semnificative între variantele studiate. Epoca de înființare în care au fost obținute cele mai mari rezultate de producție a fost epoca 15.05. Varianta la care au fost obținute cele mai mari cantități de recoltă a fost varianta în care fasolea mare a fost intercalată cu floarea soarelui.*

Cuvinte cheie: *plante asociate, epoca, porumb comun, floarea soarelui, topinambur legumicol*

INTRODUCTION

Runner bean is a tropical species adapted to the humid highlands. Compared with common bean, it is a thermophilic species that tolerates well

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relatively low temperatures. Starting at 8-12^{0}C, germination occurs, the optimum temperature for growth and development being 16-18^{0}C (Popa, 2010).

Establishment of runner bean crop is one of the most important stages in a culture technology. In principle, it includes operations like: selection, procurement and preparation of biological material, setting the era, the choice of crop system (rows, nests, mixture, plant association), scheme and densities.

Setting up time is conditioned by the cultivation system, runner bean biological peculiarities and the period when the yield should be harvested. The main factors to be taken into account in determining sowing time are climatic conditions, particularly thermal conditions and soil type. As in common bean, setting up scheme is extremely variable, according to tradition and managerial, technical or material possibilities. The main technical element that determines the crop establishment scheme is the trellising method.

Trellising system is a key issue for the success of the crop. In vegetable growing and also in other areas, such as wine growing, trellising system has a very important role on growth, development and crop production. Any trellising system aims to provide a support for the plants so that the goal of yield can be achieved (Branas, 1974; Champagnol, 1984).

The pure culture is simpler, compared to the intercropping/associated system, but fails to clearly modify the environmental conditions of the crop. Instead, intercropping system, although it seems complicated, provides some improvement in microclimate and, also, by ensuring the runner bean suport system by associated / intercropping crops.

Intercropping has been known for thousands of years (Kass, 1978) and it is the system in which, on the same area of the field and at the same time, two or more species are grown (Andrews and Kassam, 1976; Anil *et al.,* 1998; Ofori and Stern, 1987).

The purpose of this paper is to establish the setting up time influence on the amount of crop (dry seeds) obtained from runner bean, grown in intercropping system. To achieve this goal, we set targets to find the best setting up time and the intercropping variant where the highest yields are obtained.

MATERIAL AND METHOD

The research took place in the "Vasile Adamachi" farm of the University of Agricultural Sciences and Veterinary Medicine, in an experimental polygon of the Vegetable Growing department.

The biological material was represented by the local population Coccineus 3 of runner bean, hybrid cultivar Flato F1 of common maize, hybrid cultivar Tristan F1 of sunflower and clone cultivar Topstar of Jerusalem artichoke.

The studied experimental factor was the crop setting up time, with three graduations: dates of 1.05., 15.05. and 30.05, available in three plants arrangeaments, namely intercropping with common maize (*Zea mays* L.) (V_1), intercropping with sunflower (*Helianthus annuus* L.) (V_2) and intercropping with Jerusalem artichoke (*Helianthus tuberosus* L.) (V_3).

The placement of the experimental factor, as well as its graduations, was carried out in sub divided triplicate plots.

On each repetition plot, two rows were placed, spaced at 1.0 m, and between the runner bean plants, on row, there was a distance of 0.4 m. Between associated plants (common maize, sunflower, Jerusalem artichokes) there was a distance of 0.8 m.

Common maize and sunflower sowing, respectively planting Jerusalem artichoke, were made about two weeks before sowing the runner bean. Crop establishment was performed by direct sowing, with three runner bean seeds / nest and two seeds of common maize, respectively two seeds of sunflower / nest. In the time of emergence, two runner bean plants and one plant of common maize or sunflower have been left in each nest. For Jerusalem artichoke two tubers / nest were planted and at emergence only two stems / nest were left.

The experiment was conducted according to technological norms arising from the literature review (Munteanu *et al.,* 1989; Stan *et al.,* 2003; Ruști, 2007; Popa, 2010; Axinte *et al*., 2006). Basic research methods were observation and experiment.

Yield data were processed by the algorithm for ANOVA (analysis of variance) using Fisher's exact test, Student's t test, the least significant difference (LSD) for three levels of confidence: LSD 5% (P = 95%), LSD 1% (P = 99 %) and LSD 0.1% (P = 99.9%) (Săulescu și Săulescu, 1967; Jităreanu, 1999).

RESULTS AND DISCUSSIONS

Runner bean yield results obtained in intercropping with common maize (V_1)

Runner bean yield ranged from 1383 kg/ha to 2498 kg/ha. The highest yield was obtained in 15.05 setting up time, with a value of 2498 kg/ha, registering very significant positive differences compared to the average experience (1966 kg/ha), while the lowest yield was obtained in 01.05 setting up time, highlighted the very significant negative differences from the average. In 30.05 setting up time, yield was within the variation of the experimental mean, respectively 2017 kg/ha (Tab. 1; Fig. 1).

Table 1

Runner bean yield results obtained in intercropping with common maize

No.	Setting up time	Yield (dry seeds)		Yield differences between setting up time and their significance[w]			
		kg/ha	% of the $\bar{x}$	01.05 setting up time	15.05 setting up time	30.05 setting up time	mean ($\bar{x}$)
1.	01.05.2013	1383	70	-	-1115^{ooo}	-634^{ooo}	-583^{ooo}
2.	15.05.2013	2498	127	+1115***	-	+481***	+532***
3.	30.05.2013	2017	103	+634***	-481^{ooo}	-	+51^{NS}
4.	**Mean ($\bar{x}$)**	**1966**	100	+583***	-532^{ooo}	-51^{NS}	**-**

[w]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%= 99,1 (kg/ha); LSD 1%= 164,3 (kg/ha); LSD 0,1%= 306,9 (kg/ha).

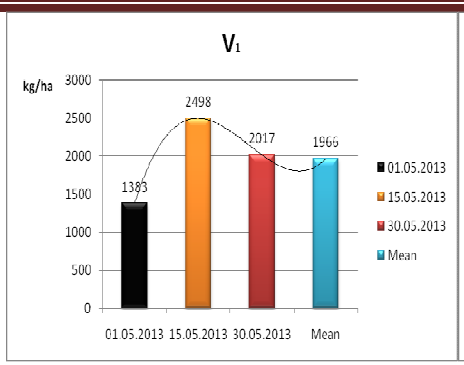

Fig. 1 - Yield graphic representation (V_1)

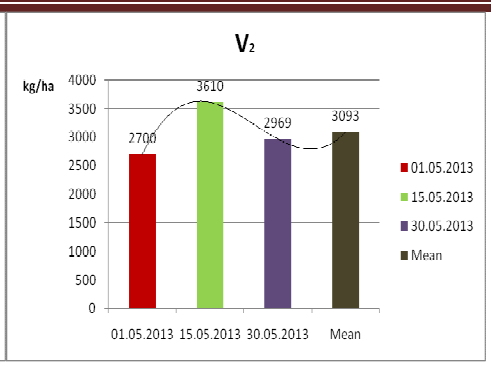

Fig. 2 - Yield graphic representation (V_2)

Runner bean yield results obtained in intercropping with sunflower (V_2)

From the conducted researches, it appears that runner bean yield ranged from 2700 kg/ha to 3610 kg/ha. The highest yield was obtained in 15.05 setting up time, with a value of 3610 kg/ha, registering positive differences significantly distinct from the average experience (3093 kg/ha), while the lowest yield was obtained in 01.05 setting up time, highlighted distinct significant negative differences from the average. In 30.05 setting up time yield was 2969 kg/ha, being within the average experimental variation limits (Tab. 2; Fig. 2).

Table 2

Runner bean yield results obtained in intercropping with sunflower

No.	Setting up time	Yield (dry seeds)		Yield differences between setting up time and their significance[w]			
		kg/ha	% of the $\bar{x}$	01.05 setting up time	15.05 setting up time	30.05 setting up time	mean ($\bar{x}$)
1.	01.05.2013	2700	87	-	-910^{ooo}	-269^{o}	-393^{oo}
2.	15.05.2013	3610	117	$+910^{***}$	-	$+641^{**}$	$+517^{**}$
3.	30.05.2013	2969	96	$+269^{*}$	-641^{oo}	-	-124^{NS}
4.	**Mean ($\bar{x}$)**	**3093**	**100**	$+393^{**}$	-517^{oo}	$+124^{NS}$	**-**

[w]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%= 221,8 (kg/ha); LSD 1%= 367,8 (kg/ha); LSD 0,1%= 686,9 (kg/ha).

Runner bean yield results obtained in intercropping with Jerusalem artichoke (V_3)

From the conducted researches, it appears that runner bean yield ranged from 545 kg/ha to 1065 kg /ha. The highest yield was obtained in 15.05 setting up time, with a value of 1065 kg/ha, registering significantly positive differences from the average experience (789 kg / ha), while the lowest yield was obtained in 01.05 setting up time, being within the average experimental variation limits. In 30.05 setting up time, the yield was 757 kg/ha, within the average experimental variation limits (Tab. 3; Fig. 3).

Table 3

Runner bean yield results obtained in intercropping with Jerusalem artichoke

No.	Setting up time	Yield (dry seeds)		Yield differences between setting up time and their significance[w]			
		kg/ha	% of the $\bar{x}$	01.05 setting up time	15.05 setting up time	30.05 setting up time	mean ($\bar{x}$)
1.	01.05.2013	545	69	-	-520^{oo}	-212^{NS}	-244^{NS}
2.	15.05.2013	1065	135	+520**	-	+308*	+276*
3.	30.05.2013	757	96	+212^{NS}	-308^{o}	-	-32^{NS}
4.	**Mean ($\bar{x}$)**	**789**	100	+244^{NS}	-276^{o}	+32^{NS}	-

[w]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%= 246,3 (kg/ha); LSD 1%= 408,5 (kg/ha); LSD 0,1%= 762,9 (kg/ha).

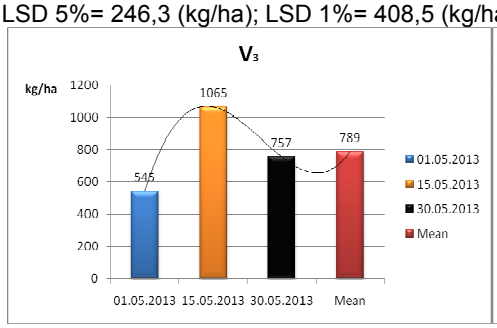

Fig. 3 - Yield graphic representation (V_3)

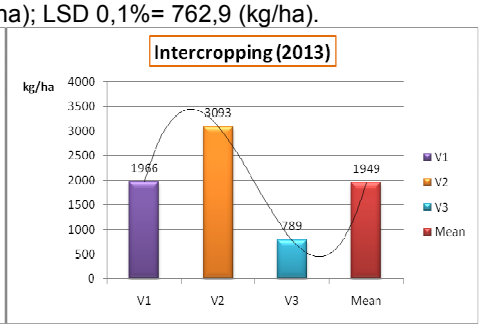

Fig. 4 - Yield graphic representation (intercropping, 2013)

Total experiment

Table 4

Runner bean yield obtained in intercropping (2013)

Variant			Runner bean yield (dry seeds)		Differences from the mean (kg/ha)	Signification[w]
No.	specification		kg/ha	% of the mean		
1	intercropping	V_1	1966	101	+17	NS
2		V_2	3093	159	+144	**
3		V_3	789	40	-1160	oo
Mean ($\bar{x}$)			**1949**	100	-	-

[w]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%= 383,8 (kg/ha); LSD 1%= 636,4 (kg/ha); LSD 0,1%= 1188,6 (kg/ha).

Runner bean yield varied between 789 kg/ha and 3093 kg/ha. The highest yield was obtained in intercropping with sunflower (3093 kg / ha), which recorded positive differences distinct significantly from the average experience (1949 kg/ha), while the lowest yield was obtained in intercropping with Jerusalem

artichoke (789 kg/ha), being highlighted distinct significantly differences from the average negative experience. V_2 variant, intercropping with common maize, registered a yield of 1966 kg/ha, being within the average experimental variation limits (Tab. 4; Fig. 4).

CONCLUSIONS

1. The setting up time in which the highest runner bean yield was obtained was 15.05 in all three variants of intercropping.

2. Comparing the variants to one another, the highest yield was obtained for variant V_2 (intercropping with sunflower), followed by variant V_1 (intercropping with common maize) and V_3 (intercropping with Jerusalem artichoke).

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