STUDY OF THE DEVELOPMENT OF *PHASEOLUS VULGARIS* L. IN GREENHOUSE UNDER ELECTROMAGNETIC FIELD

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Abstract. *The study concerning the evolution of beans plants in the electromagnetic field, was carried out in greenhouse conditions, namely in the "House of Vegetation" of University of Agricultural Sciences and Veterinary Medicine Cluj – Napoca, in the experimental year of 2016. The stem lengths, beans and pods production, dry matter content of plants, were recorded, in conditions of irradiation and no irradiation. The process of stems growing, one month after the establishment of culture, in greenhouse conditions, highlights a superior development, statistically ensured at a 0.1% threshold of significance, when plants were placed under electromagnetic field. Two months after sowing, the growth process of beans steams in greenhouse conditions, shows a higher development, statistically ensured at different thresholds of significance when plants were placed under electromagnetic field. In the absence of irradiation, two months after sowing, the length of the stems was of 19.63 and 24.06 cm, respectively. The mean of pods obtained from irradiated plants (5 pieces) is lower, compared with control (6.40 pieces), but the difference is not statistically assured at significance threshold of 5%. The evolution of the average number of beans in the present experiment has an identical trend with that recorded in the production of pods. The bean production records differences, statistically assured at the threshold of 5%, between the quantities of beans obtained from plants placed under the electromagnetic field and from the non-irradiated plants. The dry matter records an average of 16.62% in irradiated plants, while in control it was only of 11.04%, the difference being statistically assured at the threshold of 5%. In the present study, it can be noted that the irradiation influences, in a positive manner, the increasing of the stem length, and dry matter, but to the decrease of the number of pods, and beans' length.*

Key words: *Phaseolus vulgaris L., electromagnetic field, irradiation, greenhouse*

INTRODUCTION

Beans plants belongs to the Phabaceae family, *Phaseolus* L. genus which includes over 200 species of American or Asian origin (also species originating from Africa and Australia), of which about 20 species are cultivated (MUNTEAN ET AL., 2011; BÎLTEANU and BÎRNAURE, 1989; MIHĂILESCU, 1990). *Phaseolus vulgaris* (L.) Savi. (Common beans) is the most widespread species of American origin. Native from Mexico and Argentina (where wild ancestors were found) it has many forms grouped into four main varieties, which are differentiated by the shape of grains ("sphaericus" "ellipticus" "oblongus" "compressus"), and among them many intermediate types, given by a certain percentage of cross-pollination, including the *nanus* variety, namely dwarf beans (BÎLTEANU ET AL., 1991; CEAUȘESCU ET AL., 1984; CHILOM, 2002).

The physical methods used to increase the production of vegetables are based on a series of physical factors for stimulating plant growth and innovative treatment processes aiming the acceleration of plant growth proportional with the production yield (ALADJADJIYAN, 2000, 2007; ALEXANDER AND DOIJDE 1995; DAS AND BHATTACHARYA, 2006). AS BAICU AND SĂVESCU (1986), HOZA (2003), SAMOIL (2007), IMBREA (2007, 2014),

OROIAN (2008) indicate, the environmental friendly way to achieve the objectives mentioned above includes the rational use of chemicals but also the replacement of some of them with appropriate physical treatments.

Organic agriculture promotes sustainable, diversified and balanced production systems, in order to prevent the environmental and harvest pollution. Organic production, as part of the entire crop production, without the use of harmful traditional products, knows a special concern in economically developed countries since several decades ago (OANCEA, 1998). The interest for organic products and production is increasingly growing in our country. Unfortunately, in our country, the areas cultivated in ecological conditions are still very low (SAMOIL, 2007).

MATERIAL AND METHODS

In order to conduct the experiments consisting in testing the low-power electromagnetic field effects in physiological development of dwarf beans (*Phaseolus vulgaris* L. var. *nanus)* in greenhouse conditions, an experimental design was elaborated. The experiment was placed in the Agrobotanical Garden of the University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca.The equipment designed for the application of an electromagnetic field was formed by passive retransmitters equally distributed, sized for a frequency of 900 MHz GSM equal - downlink. The device used to measure the electromagnetic field was a spectrum analyzer Aaron HS6060, with a calibration antenna and specific software. In the greenhouse a microwave generator was used. The biological material in experiments, used in greenhouse and was the dwarf bean, *Phaseolus vulgaris* L. var. *nanus* respectively, Ardeleanca stain.

The following parameters were recorded: stem growth at one month and two months, respectively, after sowing, number of pods, beans' weight, and dry matter. For processing the statistical data, STATISTICA v.8.0 for Windows was used.

RESULTS AND DISCUSSION

The study of the process of steam growth, at one moth from sowing, in greeanhouse environmental conditions, emphasizes a superior development in conditions of irradiation. Thus the average stem length in control was of 5.33 cm, while in irradiated conditions, it was of 15.33 cm, the diference being statistically assured at significance threshold of 0.1% (Table 1). The biggest stem length was noted in irradiated conditions (20 cm), while the smallest (5 cm), in control, not irradiated (Table 1). The coefficients of variation indicate that the averages are very representative (9.76%) in control, and medium representative (14.72%), in experimental group, irradiated (Table 1).

Table 1

The basic statistics of the beans stem length in greenhouse, and significance of differences between them in conditions of lack and presence of irradiation, at one month after plantation 2016 (cm)

Isssue	N	$\bar{X}$ (cm)	±	$s_{\bar{X}}$	s	Min.	Max.	CV(%)	p
Control. not irradiated									
Stem length (cm)	25	5.33***	±	0.08	0.54	5	6.5	9.76	<0.001
Experimental, irradiated									
Stem length (cm)	25	15.33	±	0.71	5.0	13	20	14.72	-

$\bar{X}$ – mean; $s_{\bar{X}}$ – standard error of mean; s – standard deviation; CV – coefficient of variation; p – probability value; *** – very significant (p < 0,001); C – Contro

At two moths from sowing, in the same greenhouse environmental conditions, similarly with results obtained at one month from sowing, the best developments were recorded in conditions of irradiation. The average stem length in control was of 19.63 cm, while in irradiated conditions, the average stem length was of 24.06 cm, the diference being statistically assured at significance threshold of 0.1% (Table 2). The biggest stem length was noted in irradiated conditions (30 cm), while the smallest (5 cm), in control, not irradiated (Table 2). The coefficients of variation indicate that the averages are very representative (6.70%) in control, and medium representative (19.07%), respectively, in experimental group (Table 2).

Table 2

The basic statistics of the beans' stem length in greenhouse, and significance of differences between them, in conditions of lack and presence of irradiation, at two months from seeding 2016 (cm)

Issue	N	$\bar{X}$ (cm)	±	$s_{\bar{X}}$	s	Min.	Max.	CV(%)	p
Control not irradiated									
Stem length (cm)	25	19.63***	±	0.11	1.31	17	21	6.70	<0.001
Experimental, irradiated									
Stem length (cm)	25	24.06	±	0.06	4.58	15	30	19,07	-

$\bar{X}$ – mean; $s_{\bar{X}}$ – standard error of mean; s – standard deviation; CV –coefficient of variation; p – probability value; *** –very significant ($p < 0.001$); C – Control

The pods production recorded the average of 6.40 pieces in control group, not irradiated, and 5 pieces in irradiated environment, but the difference between the averages is not statistically assured at significance threshold of 5% (Table 3). The biggest pod production is reported in lack of irradiation (9 pieces), while the smallest (4 pieces), in irradiated group (Table 3). The coefficients of variation indicate that the average has low representativeness in control group (26.14%), while the value of 20% resulted for experimental group placed in irradiated conditions suggests an average representativeness (Table 3).

Table 3

The basic statistics of the pods production in greenhouse, and significance of differences between them, in conditions of lack and presence of irradiation, 2016 (pieces)

Issue	N	$\bar{X}$ (cm)	±	$s_{\bar{X}}$	s	Min.	Max.	CV(%)	p
Control not irradiated									
Pods production (pieces)	25	6.40ns	±	0.11	1.63	5	9	26.14	0.147
Experimental, irradiated									
Pods production (pieces)	25	5.00	±	0.06	1.00	4	6	20.00	-

$\bar{X}$ – mean; $s_{\bar{X}}$ – standard error of mean; s – standard deviation; CV –coefficient of variation; p – probability value; *** –very significant ($p < 0.001$); C – Control

For the evolution of the average weight of beans may be reported a trend, which is similar to the trend identified in the evolution of the number of pods. Thus the weight of beans recorded the average of 14.70 g in control group, not irradiated, and 10.50 g in irradiated environment, and the difference between the averages is statistically assured at significance threshold of 5% (Table 4). The heaviest bean weighted 17.31 g, while the smallest weighted 7.97 g (Table 4). The first bean belongs to the control group not irradiated, while the second belongs to the group placed in electromagnetic field.

Table 4

The basic statistics of the beans production in greenhouse, and significance of differences between them, in conditions of lack and presence of irradiation, 2016 (g)

Issue	N	$\bar{X}$ (cm)	±	$s_{\bar{X}}$	s	Min.	Max.	CV(%)	p
Control not irradiated									
Beans production (g)	25	14.70*	±	0.53	3.79	8.09	17,31	25.79	0.050
Experimental, irradiated									
Beans production (g)	25	10.50	±	0.23	1.62	7.97	12.35	15.45	

$\bar{X}$ – mean; $s_{\bar{X}}$ – standard error of mean; s – standard deviation; CV –coefficient of variation; p – probability value; *** –very significant ($p < 0.001$); C – Control

The coefficients of variation indicate that the average has low representativeness in control group (25.79%), and average representativeness (15.45%) in experimental group, where plants are placed in electromagnetic field (Table 4).

The bean plants placed in electromagnetic field had bigger content of dry matter, compared to control, not irradiated. Thus the average dry matter reported in control group is of 11.04%, while in irradiated experimantal group it is of 16.62%, and the difference between these averages is atatistically assured at significance threshold of 5% (Table 5).

Table 5

The basic statistics of the beans' dry matter in greenhouse, and significance of differences between them, in conditions of lack and presence of irradiation, 2016

Issue	N	$\bar{X}$ (cm)	±	$s_{\bar{X}}$	s	Min.	Max.	CV(%)	p
Martor, neiradiat/Control not irradiated									
Dry matter (%)	25	11.04**	±	0.51	3.63	7.14	15.66	32.96	0.011
Experimental, iradiat/Experimental, irradiated									
Dry matter (cm)	25	16.62	±	0.18	1.27	15.00	18.51	7.64	-

$\bar{X}$ – mean; $s_{\bar{X}}$ – standard error of mean; s – standard deviation; CV –coefficient of variation; p – probability value; *** –very significant ($p < 0.001$); C – Control

The biggest dry matter, of 18.51%, is reported for the experimental group, where plants are placed in electromagnetic field, while the smalles, of 7.14% in control group, which is not irradiated (Table 5). According to the value of the coefficient of variation (32.96%) reported in control group, results that the average dry matter in conditions of the lack of irradiation is not representative, while the value of the coefficient of variation of 7.64% resulted for experimental group placed in irradiated conditions suggests, in this case, a good representativeness (Table 5).

CONCLUSIONS

The best results concerning stem growth, at one, and respectively two months from sowing, were reported in plants placed in electromagnetic field, under irradiation, when average values of 15.33 cm and 24.06 cm, respectively, were obtained. Concerning pods number, and beans weight, best results were obtained in lack of irradiation, when averages of 6.40 pieces, and 17.70 g, respectively, were obtained.

Except stem growth, basic statistics shows better disperssion distribution in groups placed in electromagnetic field, and, accordingly, lower variability. The averages are representative for majority of analysed parameters, both in control and experimental group. A single exception is noted, and it is represented by the dry matter in control group.

Our study shows that in greenhouse conditions the action of the electromagnetic field stimulates the stem growth and dry matter content of beans, but does not advantage the pods production and beans weight.

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