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Studies concerning the influence of genotype and planting density on fruit number and yield per plant at some paprika pepper cultivars grown in solarium type

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ABSTRACT

After the discovery of America, pepper was brought to Europe (1493) and spread to the southern (Italy, France) in the XVI-th century, and in the Balkan Peninsula in the XVII-th century. In Romania has grown from XIX-th century.
The experiment developed during year 2011 at the Didactic and Research Base of the Faculty of Horticulture and Forestry.
The biological material was represented by Délibáb F1, Sláger F1, Bolero F1, SJN 5 and SJD 5, hungarian paprika varieties.
The experiment has been set up after the model of polifactorial experiences, with three repetitions.
Hybrids Sláger and Délibáb achieved most fruits/plant and increases of 14-50% than the other genotypes. Should be noted that in case of planting paprika pepper in solarium at densities between 3,33 – 4,16 plants/m2 is registered a yield/plant between 1,20 kg (Bolero F1) to 2,37 kg (SJD 5).

Keywords : paprika pepper, yield per plant, culture in solarium

Introduction
Pepper is native to Central and South America, where he was known and cultivated since ancient times and is considered as one of the oldest plants taken in culture. After the discovery of America, pepper was brought to Europe (1493) and spread to the southern (Italy, France) in the XVI-th century, and in the Balkan Peninsula in the XVII-th century. In Romania has grown from XIX-th century (Indrea *et al.*, 2007)

From the fruits of the pepper varieties created for the production of paprika, paprika is obtained, which is part of the most widespread and popular spices, being used in a wide range of dishes. Some varieties of peppers with small, sharp and erect fruits are used as ornamental plants (Berar & Poşta, 2006).

In Hungary, paprika pepper qualities which are marketed are: delikatess, edelsuss (sweet), halbsuss (sweetish), rosen and spicy (Ursu, Berar & Poşta, 2012).

Regarding the content in vitamin C, pepper occupies first place between the cultivated vegetables. The high content in vitamin C was demonstrated at the early 1930, by doctor and biochemist Szent-Györgyi Adalbert, which after analysis performed to paprika, discovers ascorbic acid (Márkus & Kapitány, 2001).

Until now, there is a growing trend of local varieties, which are important genetic sources used in work, to improve pepper (Berar, 1998).

Material and Method
The experiment developed during year 2011 at the Didactic and Research Base of the Faculty of Horticulture and Forestry, from B.U.A.S.V.M. Timişoara. The biological material used in the experiment was represented by Délibáb F_1, Sláger F_1, Bolero F_1, SJN 5 and SJD 5, hungarian paprika varieties.

The location of the experiment has been set up after the model of polifactorial experiences, with three repetitions, namely:

-factor A (cultivar) with 5 graduations:

a_1 – Délibáb F_1;

a_2 – Sláger F_1;

a_3 – Bolero F_1;

a_4 – SJD 5;

a_5 – SJN 5.

-factor B (planting scheme) with 4 graduations:

b_1 – 80+40×20 cm → 8,33 plants/m^2;

b_2 – 80+40×30 cm → 5,55 plants/m^2;

b_3 – 80+40×40 cm → 4,16 plants/m^2;

b_4 – 80+40×50 cm → 3, 33 plants/m^2.

The observations have been made using the current observation techniques, experimental data processing has been performed using statistical and mathematical methods and those data regarding the production were calculated and interpreted on the basis of analysis of variance (Ciulcă, 2002).

Results and Discussions
Productivity or production potential as fundamental trait of every plant – seen not only in terms of biology but also in economic way – should be analyzed and known thoroughly in all its aspects (Berar & Poşta, 2005). Acknowledges of this are absolutely necessary in order to apply optimal solutions both in creation activity of new forms or hybrids, which refers to the improvement of plants, and in the activity of technological specialists that have the duty to cultivate them and to provide them with conditions that permit full expression of potential production (Savatti *et al.,* 2004).

Regarding the effect of genotype on the number of fruits/plant from table 1 is observed that hybrids and cultivars taken in study presented mean values of this character between 52,31 at Bolero and 103,80 at Sláger, with a variation amplitude of

51,49. Therefore, hybrids Sláger and Délibáb achieved most fruits/plant and significant increases of 14-50% than the rest of genotypes. Fruit number at hybrid Bolero and variety SJN 5 was significantly lower than the other genotypes.

Table 1
Genotype effect on fruit number/plant at paprika pepper

Genotype	Fruit number/ plant		Relative values (%)	Difference/ Significance
Sláger - Délibáb	103,80	97,30	106,68	6,50*
Bolero - Délibáb	52,31	97,30	53,76	-44,99^{000}
SJD 5 - Délibáb	89,46	97,30	91,94	-7,84^{00}
SJN 5 - Délibáb	55,75	97,30	57,30	-41,55^{000}
Bolero - Sláger	52,31	103,80	50,39	-51,49^{000}
SJD 5 - Sláger	89,46	103,80	86,18	-14,34^{000}
SJN 5 - Sláger	55,75	103,80	53,71	-48,05^{000}
SJD 5 – Bolero	89,46	52,31	171,02	37,15***
SJN 5 - Bolero	55,75	52,31	106,58	3,44
SJN 5 – SJD 5	55,75	89,46	62,32	-33,71^{000}

$DL_{5\%}$=4,54 $DL_{1\%}$=6,37 $DL_{0,1\%}$=9,01

Regarding the unilateral effect of planting schemes (table 2), fruit number presented a variation amplitude of 29,70 with values between 66,24 at planting scheme 80/40x20 cm and 95,94 in case of planting scheme 80/40x50, in conditions of a mean variability of 16,84%. Overall it is observed that reducing the plant density by increasing the distance per row, determined significant increases of fruit number/plant, with average increases of about 16% for each 10 cm extra space between plants on row.

Table 2
Density effect on fruit number/plant at paprika pepper

Planting scheme (cm)	Fruit number/ plant		Relative values (%)	Difference/ Significance
80/40x30 – 80/40x20	71,57	66,24	108,05	5,33*
80/40x40 – 80/40x20	85,16	66,24	128,56	18,92***
80/40x50 – 80/40x20	95,94	66,24	144,84	29,70***
80/40x40 – 80/40x30	85,16	71,57	118,99	13,59***
80/40x50 – 80/40x30	95,94	71,57	134,05	24,37***
80/40x50 – 80/40x40	95,94	85,16	112,66	10,78***

$DL_{5\%}$=4,82 $DL_{1\%}$=6,43 $DL_{0,1\%}$=8,42

From point of view, the influence of different densities on mean fruit number for each genotype (table 3, fig. 1) is noted that the highest variation amplitudes registered at variety SJD 5 (57,05) and hybrid Sláger (35,07) while in case of hybrid Bolero the amplitude was considerable lower (17,32).

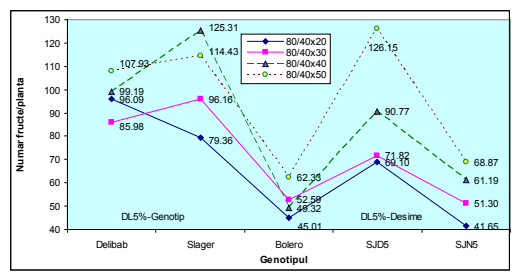

Fig. 1 Fruit number/plant for different genotypes and densities at paprika pepper

Table 3 Genotype and density effect on fruit number/plant at paprika pepper

Genotype	Planting scheme (cm)				$\bar{x} \pm s_{\bar{x}}$	$S_{\%}$
	80/40x20	80/40x30	80/40x40	80/40x50		
Délibáb	yz96,09a	z85,98b	xy99,19b	x107,93b	97,30±2,38	9,79
Sláger	u79,36b	z96,16a	x125,31a	y114,43b	103,80±4,96	19,12
Bolero	y45,01d	xy52,59d	y49,32d	x62,33c	52,31±1,90	14,53
SJD 5	z69,10c	z71,82c	y90,77b	x126,15a	89,46±5,93	26,51
SJN 5	z41,65d	yz51,30d	xy61,19c	x68,87c	55,75±2,77	19,88
$\bar{x} \pm s_{\bar{x}}$	66,24±4,83	71,57±4,18	85,16±6,34	95,94±6,02	79,73±2,96	
$S_{\%}$	32,59	26,11	33,32	28,06	33,21	

-Genotypes $DL_{5\%}$=10,17 $DL_{1\%}$=13,54 $DL_{0,1\%}$=17,63 (a,b,c), -Densities $DL_{5\%}$=10,77 $DL_{1\%}$=14,38 $DL_{0,1\%}$=18,83 (x,y,z)

Under the conditions of the planting scheme 80/40x20 (table 3) genotypes taken in study achieved values of fruit weight with limits between 41,65 at SJN 5 and 96,09 at Délibáb due to a high interpopulational variability (32,59%). Hybrid Délibáb has registered in this growing conditions values of this character significantly higher compared to the other genotypes with increases between 17 and 56%. Hybrid Sláger manifested a fruit number significantly superior to hybrid Bolero and varieties SJN 5 and SJD 5.

Amid the increase of the nutrition space according to planting scheme 80/40x30 cm, genotypes taken in study achieved fruit weight values with limits ranged between 51,30 at SJN 5 and 96,16 at Sláger, amid a high variability (26,16%), but lower than the previous density. Hybrid Sláger achieved at this density significant increases of fruit number/plant between 12-46% compared to the rest of the genotypes.

In case of planting scheme 80/40x40 cm, studied genotypes manifested a amplitude of fruit number ranged between 49,32 at Bolero and 125,31 at Sláger. Hybrid Sláger registered significant increases of fruit numbers with values of 24% from variety SJN 5 to 84% from variety SJD 5.

Mean values of fruit number/plant registered by the studied genotypes amid the planting scheme 80/40x50 cm ranged between 62,33 in case of hybrid Bolero and 126,15 at variety SJD 5, amid a high variability (28,06%). For this planting scheme hybrid Délibáb and Sláger registered a significantly higher fruit number/plant than variety SJN 5 and hybrid Bolero.

Table 4 Genotype effect on yield/plant at paprika pepper

Genotype	Yield/Plant (kg)		Relative values (%)	Difference/ Significance
Sláger - Délibáb	1,76	1,69	104,14	0,07
Bolero - Délibáb	1,32	1,69	78,11	-0,37^{00}
SJD 5 - Délibáb	1,80	1,69	106,51	0,11
SJN 5 - Délibáb	1,44	1,69	85,21	-0,25^{0}
Bolero - Sláger	1,32	1,76	75,00	-0,44^{00}
SJD 5 - Sláger	1,80	1,76	102,27	0,04
SJN 5 - Sláger	1,44	1,76	81,82	-0,32^{0}

SJD 5 – Bolero	1,80	1,32	136,36	0,48***
SJN 5 - Bolero	1,44	1,32	109,09	0,12
SJN 5 – SJD 5	1,44	1,80	80,00	-0,36^{00}

$DL_{5\%}$=0,23 kg $DL_{1\%}$=0,33kg $DL_{0,1\%}$=0,46 kg

Regarding the effect of studied genotypes on yield/plant at paprika pepper (table 4) genotypes presented a mean variability (13,16%) of this character at a amplitude of 0,48 kg, with limits between 1,32 kg at Bolero until 1,80 kg at SJD 5. Therefore hybrid Bolero and variety SJN 5 manifested a mean yield/plant potential significantly lower compared to the rest of the genotypes, registering differences of 15-36%.

Table 5
Density effect on yield/plant at paprika pepper

Planting scheme (cm)	Yield/Plant (kg)		Relative values (%)	Difference/ Significance
80/40x30 – 80/40x20	1,35	1,38	97,83	-0,03
80/40x40 – 80/40x20	1,77	1,38	128,26	0,39***
80/40x50 – 80/40x20	1,90	1,38	137,68	0,52***
80/40x40 – 80/40x30	1,77	1,35	131,11	0,42***
80/40x50 – 80/40x30	1,90	1,35	140,74	0,55***
80/40x50 – 80/40x40	1,90	1,77	107,34	0,13

$DL_{5\%}$=0,15 kg $DL_{1\%}$=0,20 kg $DL_{0,1\%}$=0,26 kg

Concerning the density effect on yield/plant, from Table 5 is observed a amplitude of 0,55 kg amid a mean variability of 17,30%. Production potential for the first two planting schemes does not present significant deviations, is observed only a minor reduction of approximately 2%, in case of increasing the distance between plants per row from 20 to 30 cm. By using the planting schemes 80/40x40 cm and 80/40x50 cm, yield/plant registered significant increases of 28-40%, compared to planting schemes 80/40x20 cm and 80/40x30 cm.

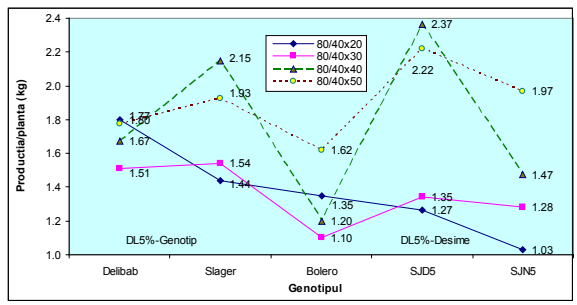

Fig. 2 Yield/plant for different genotypes and densities at paprika pepper

From point of view of the genotype influence on plant productivity for different densities (table 6, fig. 2) is noted that the highest variation amplitude registered at planting scheme 80/40x40 cm while at the planting scheme 80/40x30 cm the genotype effect was reduced.

Table 6
Genotype and density effect on yield/plant at paprika pepper

Genotype	Planting scheme (cm)				$\bar{x} \pm s_{\bar{x}}$	$S_{\%}$
	80/40x20	80/40x30	80/40x40	80/40x50		
Délibáb	x1,80a	x1,51a	x1,67b	x1,77b	1,69±0,06	14,64
Sláger	y1,44b	y1,54a	x2,15a	x1,93ab	1,76±0,11	24,41
Bolero	xy1,35bc	y1,10b	y1,20c	x1,62b	1,32±0,07	21,88
SJD 5	y1,27bc	y1,35ab	x2,37a	x2,22a	1,80±0,14	31,01
SJN 5	z1,03c	yz1,28ab	y1,47bc	x1,97ab	1,44±0,10	28,87
$\bar{x} \pm s_{\bar{x}}$	1,38±0,08	1,35±0,06	1,77±0,11	1,90±0,08	1,60±0,08	
$S_{\%}$	24,91	19,03	27,43	19,05	27,28	

-Genotypes $DL_{5\%}$=0,36 kg $DL_{1\%}$=0,47 kg $DL_{0,1\%}$=0,62 kg (a,b,c)

-Densities $DL_{5\%}$=0,33 kg $DL_{1\%}$=0,44 kg $DL_{0,1\%}$=0,57 kg (x,y,z)

In density conditions for planting scheme 80/40x20 cm (table 6) the genotypes taken in study achieved a yield/plant with limits between 1,03 kg at SJN 5 and 1,80 kg at Délibáb, amid a high interpopulational variability (24,91%). Hybrid Délibáb registered significant yield increases with values between 20 and 40% compared to the other genotypes.

Mean yield/plant values registered by the five genotypes amid the planting scheme 80/40x30 cm ranged between 1,10 kg in case of hybrid Bolero and 1,54 kg at Sláger amid a relatively high variability (19,03%) but lower than the previous density.

Studied genotypes for planting scheme 80/40x40 cm achieved yield/plant values with limits ranging from 1,20 kg at Bolero and 2,37 kg at SJD 5, amid a high variability (27,43%) superior to the other densities. Variety SJD 5 and hybrid Sláger achieved significant yield increases ranged between 28 – 97% compared to the other genotypes.

According to planting scheme 80/40x50 cm studied genotypes manifested a yield/plant ranging between 1,62 kg at hybrid Bolero and 2,22 kg at variety SJD 5 amid a mean variability of 19,05%.

Conclusions

According to the experimental obtained results concerning the genotype and density effects on fruit number and yield per plant to some paprika pepper varieties cultivated in solarium type, can be drawn the following conclusions:

1. Hybrids Sláger and Délibáb achieved most fruits/plant and significant increases of 14-50% than the rest of genotypes;
2. Reducing the plant density by increasing the distance per row, determined significant increases of fruit number/plant, with average increases of about 16% for each 10 cm extra space between plants on row;
3 By using the planting schemes 80/40x40 cm and 80/40x50 cm, yield/plant registered significant increases of 28-40%, compared to planting schemes 80/40x20 cm and 80/40x30 cm;
4. Should be noted that in case of planting paprika pepper in solarium at densities between 3,33 – 4,16 plants/m^2 is registered a yield/plant between 1,20 kg (Bolero) to 2,37 kg (SJD 5);
5. In case of planting paprika pepper in solarium we recommend hybrids Délibáb and Sláger and the planting schemes 80/40x20 cm and 80/40x30 cm.

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