STUDIES CONCERNING THE YIELD/M^2 OF SOME PAPRIKA PEPPER VARIETIES CULTIVATED IN SOLARIUM

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ABSTRACT
History of pepper culture begins with 3000 – 4000 years ago, in Peru, in the ancient Inca Empire. The fruits of bell/chilli pepper are consumed at technical or physiological maturity, fresh or processed. Some varieties with small, sharp and erect fruits are used as ornamental plants. In Europe, the main producing countries are Spain, Italy, Hungary, Romania and Serbia.
In Romania, pepper was cultivated from the 19th century. The first fruits were set up around Timisoara (Cenadul Mare, Tomnatic, Lovrin), around year 1923.
The experiment developed during the year 2011, at the Didactic and Research Base of the Faculty of Horticulture and Forestry, from B.U.A.S.V.M. Timisoara.
The biological material used in the trials was represented by 5 cultivars (hybrids and lines): Délibáb F_1, Sláger F_1, Bolero F_1, SJD 5 and SJN 5. The experience was set up according to the monofactorial method with randomised blocks and four replicates.
Hybrid Délibáb obtained the highest yield for the planting scheme 80/40x20 cm, with yield increases between 18% from Bolero and 38% from SJN 5. The yield/m^2, registered a gradual decrease by reducing the plant density per row from 20 to 30, 40, 50 cm, to all five genotypes.

Keywords: paprika (*Capsicum annuum* L.), culture in solarium, yield/m^2, planting scheme

INTRODUCTION

Over the time, in the weather conditions of the Carpathian region, the cultivation of paprika spread, providing livelihood for many householders generations (MARKUS & KAPITANY, 2001).
In Romania, paprika was introduced in the 19th century by Bulgarian vegetable growers. The first paprika fruits (*Capsicum annuum* L.) were grown around Timisoara (Cenadul Mare, Tomnatic, Lovrin), around year 1923.
The importance of pepper culture lies in the nutritional value of the fruits, through the high content in vitamin C (150-300 mg/100 g) and carotenoids (1,8-4,5 mg/100 g), also the vitamins B_1, B_2 and P (INDREA ET. AL., 2009).
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 Albert, which after analysis performed to the paprika, discovers ascorbic acid. He mentions that paprika pepper has the highest content in C vitamin at the end of ripening (MARKUS & KAPITANY, 2001).
Paprika powder is used in seasoning and colouring different meat products. It is used in big quantities for colouring and seasoning different products, in the canning industry (BALÁZS, 1994).

MATERIAL AND METHOD

The experiment was performed during 2011 at the Didactic and Research Base of the Faculty of Horticulture and Forestry, from B.U.A.S.V.M. Timisoara.
The biological material used in the experiment was represented by Délibáb F_1, Sláger F_1, Bolero F_1, SJD 5 and SJN 5 hungarian paprika varieties.
The location of the experiment has been made after the model of polifactorial experiences, with four 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 (CIULCA, 2002).

RESULTS

The productive potential or production capacity means the maximum level of biomass useful from economic point of view that a genotype can achieve in optimal conditions of growth and development (nutrition, water, climate) and in an environment free of diseases and pests (SAVATTI ET AL., 2004).
Due to the influence of different planting schemes on the productivity of the area unit of each genotype (*Table 1*), it is noted that the highest variation amplitudes (8.63 kg) were registered at hybrid Délibáb, while in the case of variety SJN 5, the amplitude was significantly lower (2.84 kg).

Table 1. The effect of genotype and density on yield/m^2 in paprika pepper

Genotype	Planting distance				$\bar{x} \pm s_{\bar{x}}$	S%
	80/40x20 cm	**80/40x30 cm**	**80/40x40 cm**	**80/40x50 cm**		
Délibáb	x14.52a	y7.80a	yz6.80b	z5.79bc	8.73±0.89	40.70
Sláger	x11.84bc	y8.31a	y9.00a	z6.58abc	8.93±0.50	22.52
Bolero	x11.94b	y6.14b	y5.41c	y5.41c	7.22±0.72	40.08
SJD 5	x10.57cd	y7.50a	x9.51a	y7.37a	8.73±0.40	18.15
SJN 5	x9.07d	y7.57a	z6.23bc	yz6.91ab	7.44±0.28	15.23
$\bar{x} \pm s_{\bar{x}}$	11.59±0.46	7.46±0.18	7.39±0.37	6.41±0.18	8.21±0.27	
S%	17.62	11.02	22.59	12.41	29.84	

-Genotypes $DL_{5\%}$ = 1.33 kg $DL_{1\%}$ = 1.78 kg $DL_{0,1\%}$ = 2.32 kg (a,b,c)
-Planting distance $DL_{5\%}$ = 1.32 kg $DL_{1\%}$ = 1.75 kg $DL_{0,1\%}$=2.29 kg (x,y,z)
Source: Ursu (2011) Didactic and Research Base of the Faculty of Horticulture and Forestry

The average values of fruit weight/m^2 achieved by the five genotypes at the planting scheme 80/40x20 cm (*Table 2*), ranged between 9.07 kg in the case of variety SJN 5 and 14.52 kg at hybrid Délibáb, due to a medium intergenotypic variability (17.62%).

Table 2. The effect of genotype on yield/m^2 in paprika planted in different densities

Genotype x 80/40x20 cm	Production/m^2 (kg)		Relative values (%)	Difference/ Significance
Sláger – Délibáb	11.84	14.52	81.52	-2.68^{000}
Bolero – Délibáb	11.94	14.52	82.22	-2.58^{000}
SJD 5 – Délibáb	10.57	14.52	72.80	-3.95^{000}
SJN 5 – Délibáb	9.07	14.52	62.48	-5.45^{000}
Bolero – Sláger	11.94	11.84	100.83	0.10
SJD 5 – Sláger	10.57	11.84	89.27	-1.27
SJN 5 – Sláger	9.07	11.84	76.62	-2.77^{000}
SJD 5 – Bolero	10.57	11.94	88.53	-1.37^{0}
SJN 5 – Bolero	9.07	11.94	75.98	-2.87^{000}
SJN 5 – SJD 5	9.07	10.57	85.83	-1.50^{0}
Genotype x 80/40x30 cm	Production/m^2 (kg)		Relative values (%)	Difference/ Significance
Sláger – Délibáb	8.31	7.80	106.54	0.51
Bolero – Délibáb	6.14	7.80	78.65	-1.67^{0}
SJD 5 – Délibáb	7.50	7.80	96.12	-0.30
SJN 5 – Délibáb	7.57	7.80	97.01	-0.23
Bolero – Sláger	6.14	8.31	73.83	-2.18^{00}
SJD 5 – Sláger	7.50	8.31	90.22	-0.81
SJN 5 – Sláger	7.57	8.31	91.06	-0.74
SJD 5 – Bolero	7.50	6.14	122.10	1.36*
SJN 5 – Bolero	7.57	6.14	123.24	1.43*
SJN 5 – SJD 5	7.57	7.50	100.89	0.07
Genotype x 80/40x40 cm	Production/m^2 (kg)		Relative values (%)	Difference/ Significance
Sláger – Délibáb	9.00	6.80	132.35	2.20**
Bolero – Délibáb	5.41	6.80	79.59	-1.39^{0}
SJD 5 – Délibáb	9.51	6.80	139.78	2.71***
SJN 5 – Délibáb	6.23	6.80	91.54	-0.58
Bolero – Sláger	5.41	9.00	60.13	-3.59^{000}
SJD 5 – Sláger	9.51	9.00	105.61	0.51
SJN 5 – Sláger	6.23	9.00	69.17	-2.78^{000}
SJD 5 – Bolero	9.51	5.41	175.69	4.10***
SJN 5 – Bolero	6.23	5.41	115.06	0.82
SJN 5 – SJD 5	6.23	9.51	65.46	-3.29^{000}
Genotype x 80/40x50 cm	Production/m^2 (kg)		Relative values (%)	Difference/ Significance
Sláger - Délibáb	6.58	5.79	113.64	0.79
Bolero - Délibáb	5.41	5.79	93.44	-0.38
SJD 5 - Délibáb	7.37	5.79	127.20	1.58*
SJN 5 - Délibáb	6.91	5.79	119.34	1.12
Bolero - Sláger	5.41	6.58	82.22	-1.17
SJD 5 - Sláger	7.37	6.58	111.93	0.79
SJN 5 - Sláger	6.91	6.58	105.02	0.33
SJD 5 – Bolero	7.37	5.41	136.14	1.96**
SJN 5 - Bolero	6.91	5.41	127.73	1.50*
SJN 5 – SJD 5	6.91	7.37	93.76	-0.46

$DL_{5\%}$ = 1.33 kg $DL_{1\%}$ = 1.78 kg $DL_{0,1\%}$ = 2.32 kg

Source: Ursu (2011) Didactic and Research Base of the Faculty of Horticulture and Forestry

In those culture conditions, the hybrid Délibáb realized average production values significantly higher compared to those of other genotypes, with differences between 18% compared to Bolero and 38% compared to SJN 5. Also, variety SJN 5 showed at this density yields significantly lower than those of the hybrids Sláger and Bolero.
Under the conditions of the planting scheme 80/40x30 cm the studied genotypes achieved values of production/m^2 limited between 6.14 kg at Bolero and 8.31 kg at Sláger, due to a medium variability of 11.02%, lower compared to other densities.
The yield/m^2 values of the five genotypes studied under the conditions of an 80/40x40 cm nutrition space were between 5.41 kg in case of hybrid Bolero and 9.51 kg at variety SJD 5, due to a high variability (22.59%), superior to the other density categories. At this density, hybrid Sláger and variety SJD 5 achieved mean values of fruit weight/m^2 being significantly superior compared to the other genotypes, with differences between 25% and 39%. Productivity of the hybrid Délibáb was significantly higher than that of the hybrid Bolero, under the conditions of this planting scheme.
Due to the appropriate nutrition space of the planting scheme 80/40x50 cm, the mean values of yield/m^2, registered by the five genotypes were between 5.41 kg in the case of hybrid Bolero and 7.37 kg at SJD 5, due to a medium interpopulational variability (12.41%). Under this condition variety SJD 5 achieved mean values of fruit weight/m^2 being significantly higher than those of hybrids Délibáb and Bolero, with differences between 27% and 36%. Also, variety SJN 5 under the conditions of the planting scheme 80/40x50 cm, registered an increase in production of 1.50 kg, comparing to hybrid Bolero.
Considering the effect of different planting schemes on fruit weight/m^2 for each genotype (*Table 3*), it is observed that the highest amplitude of this character (8.73 kg) was manifested at hybrid Délibáb, associated to a variability of 40.70%. Therefore, increasing the nutrition space to this genotype, by modifying the distance per row from 20 to 30, 40, 50 cm, significantly influenced the yield variability, causing a progressive and statistically assured decrease by 46-60%. Reducing the plant density from 80/40x30 cm to 80/40x50 cm has been associated with a decrease of yield by 2.01 kg.
Yield/m^2 values of hybrid Sláger at different densities submitted a medium variability (22.52%), at amplitude between 6.58 kg for scheme 80/40x30 cm and 11.84 kg for scheme 80/40x20 cm. Also, in the case of this hybrid it was observed that by modifying the nutrition space, fruit weight/m^2 was gradually reduced by increasing the nutrition space. Thereby, using the planting scheme of 80/40x20 cm at this hybrid has allowed an increase in yield between 24% and 45%, compared to the other planting schemes.
At hybrid Bolero, fruit weight per area unit was between 5.41 kg for the planting schemes 80/40x20 cm and 80/40x30 cm, and respectively 11.94 kg for scheme of 80/40x20 cm, due to a high variability (40.08%). Therefore, under the conditions of the highest density (80/40x20 cm), this hybrid achieved a significantly superior yield compared to other densities, associated with increases of 50-55%. Modifying the distance between plants in the row from 30 to 40-50 cm resulted in an insignificant decrease of 0.73 kg of the yield.
In the case of variety SJD 5, the capacity of yield/m^2 values were between 7.37 kg for the scheme of 80/40x50 cm and 10.57 kg for the scheme of 80/40x20 cm, due to a mean variability (18.15%), inferior to the genotypes previously presented. At variety SJD5, modifying the nutrition space had a major effect on the variability of this character, causing the appearance of some significant differences. Thereby, reducing the plant density by increasing the distance in the row from 20 to 30 cm caused a very significant decrease by approximately 29% in fruit weight of the variety concerned. Under the conditions of using the planting scheme of 80/40x40, the yield of this variety was significantly higher towards the planting schemes 80/40x30 and 80/40x50.

Table 3. The effect of density on yield/m^2 in different paprika pepper genotypes

Planting distance x Délibáb	Yield/m^2 (kg)		Relative values (%)	Difference/ Significance
80/40x30 – 80/40x20	7.80	14.52	53.72	-6.72^{000}
80/40x40 – 80/40x20	6.80	14.52	46.83	-7.72^{000}
80/40x50 – 80/40x20	5.79	14.52	39.88	-8.73^{000}
80/40x40 – 80/40x30	6.80	7.80	87.18	-1.00
80/40x50 – 80/40x30	5.79	7.80	74.23	-2.01^{00}
80/40x50 – 80/40x40	5.79	6.80	85.15	-1.01
Planting distance x Sláger	Yield/m^2 (kg)		Relative values (%)	Difference/ Significance
80/40x30 – 80/40x20	8.31	11.84	70.19	-3.53^{000}
80/40x40 – 80/40x20	9.00	11.84	76.01	-2.84^{000}
80/40x50 – 80/40x20	6.58	11.84	55.57	-5.26^{000}
80/40x40 – 80/40x30	9.00	8.31	108.30	0.69
80/40x50 – 80/40x30	6.58	8.31	79.18	-1.73^{0}
80/40x50 – 80/40x40	6.58	9.00	73.11	-2.42^{000}
Planting distance x Bolero	Yield/m^2 (kg)		Relative values (%)	Difference/ Significance
80/40x30 – 80/40x20	6.14	11.94	51.42	-5.80^{000}
80/40x40 – 80/40x20	5.41	11.94	45.31	-6.53^{000}
80/40x50 – 80/40x20	5.41	11.94	45.31	-6.53^{000}
80/40x40 – 80/40x30	5.41	6.14	88.11	-0.73
80/40x50 – 80/40x30	5.41	6.14	88.11	-0.73
80/40x50 – 80/40x40	5.41	5.41	100.00	0.00
Planting distance x SJD 5	Yield/m^2 (kg)		Relative values (%)	Difference/ Significance
80/40x30 – 80/40x20	7.50	10.57	70.96	-3.07^{000}
80/40x40 – 80/40x20	9.51	10.57	89.97	-1.06
80/40x50 – 80/40x20	7.37	10.57	69.73	-3.20^{000}
80/40x40 – 80/40x30	9.51	7.50	126.80	2.01**
80/40x50 – 80/40x30	7.37	7.50	98.27	-0.13
80/40x50 – 80/40x40	7.37	9.51	77.50	-2.14^{00}
Planting distance x SJN 5	Yield/m^2 (kg)		Relative values (%)	Difference/ Significance
80/40x30 – 80/40x20	7.57	9.07	83.46	-1.50^{0}
80/40x40 – 80/40x20	6.23	9.07	68.69	-2.84^{000}
80/40x50 – 80/40x20	6.91	9.07	76.19	-2.16^{00}
80/40x40 – 80/40x30	6.23	7.57	82.30	-1.34^{0}
80/40x50 – 80/40x30	6.91	7.57	91.28	-0.66
80/40x50 – 80/40x40	6.91	6.23	110.91	0.68

$DL_{5\%}$=1.32 kg $DL_{1\%}$=1.75 kg $DL_{0,1\%}$=2.29 kg

Source: Ursu (2011) Didactic and Research Base of the Faculty of Horticulture and Forestry

Variety SJN 5 achieved due to different densities amplitude of yield/m^2 of 2.84 kg, associated to a middle variability (15.23%), with limits from 6.23 kg for density of 80/40x40 cm up to 9.07 kg, in conditions of the density 80/40x20 cm. Therefore, the variety concerned, reacted to a lesser extent towards the plant density variation, noting a significant decrease of yield, as the distance between plants per row increases.

CONCLUSIONS

According to the experimental obtained results concerning the genotype and density effects on yield/m^2 of some paprika varieties cultivated in solarium type, we can make the following conclusions:

- under the aspect of the influence of different schemes, we observe that the highest variation amplitudes (8.63 kg) were registered at hybrid Délibáb, while in the case of variety SJN 5, the amplitude was significantly lower (2.84 kg);
- modifying the distance between plants in the row from 20 to 30, 40 or 50 cm, determined a gradual decrease in the yield/m^2;
- we recommend the planting scheme 80/40x20 cm, and the protected cultivation system of paprika hybrids Délibáb F_1, Sláger F_1 and Bolero F_1.

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