

## VARIABILITY OF TRAITS OF GROWTH – *IN VIVO* AND *IN VITRO* – ON GREENHOUSE CARNATION

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**Abstract.** Several traits of growth on greenhouse carnation were analysed at seven varieties, growing both *in vivo* and *in vitro*. *In vitro* culture, proliferation and root formation were more intense in Pink Sol, Caribe and Tanga than in Pink Sim, Obor and Domingo cultivars. The highest intervarietal variability, under *in vivo* conditions, was recorded for the number of flowers per plant and number of petals per flower, while *in vitro* all analysed characters showed an extremely large span of variability values ( $s\% = 26.5 - 109.1$ ). The heritability in broad sense showed high values for the analysed characters, both *in vivo* ( $H^2 = 0.548 - 0.992$ ) and *in vitro* ( $H^2 = 0.688 - 0.953$ ) conditions. There has been noted a tight positive and negative correlation among a lot of the traits of plants, both *in vivo* and *in vitro*. Correlations among the desirable traits can be used as selection indices, in carnation breeding.

**Key words:** carnation, growth, *in vivo*, *in vitro*, correlations

### INTRODUCTION

As cut flowers, carnations are very popular in Romania where a large diversity of greenhouse cultivars is grown every year. Besides the conventional vegetative multiplication, known and used for a long time in carnation, new *in vitro* methods have been developed lately both for industrial propagation (Pierick, 1987; Pamfil, 1991; Chu, 1992), and breeding purposes (Radojevici et al., 1990; Sestraş et al., 2003).

### MATERIALS AND METHODS

The *in vivo* and *in vitro* peculiarities of seven carnation cultivars were studied at the Horticultural Research Station of Cluj-Napoca, Romania. The evaluation of growing characters, under *in vivo* conditions, was performed in greenhouses at commercial maturity of stems and flowers. Under *in vitro* condition, seven growing characters have been analysed on four weeks old neoplantlets obtained through apical meristem culture on a standard MS medium (Murashige and Skoog, 1962).

### RESULTS AND DISCUSSIONS

As it can be noticed from data presented in table 1, among *in vivo* tested cultivars significant differences have been recorded as far as the plant vigour and flower characters

were concerned. As compared to the mean of experiment (control), it is worth mentioning Caribe cv. for its rather short plants, Pink Sol cv. for its long stems, Tanga and Domingo cvs. for their flowers with an obvious large diameter, Madonna cv. for its tendency of developing more than two flowers/stem, and Domingo, Pink Sol and Pink Sim cvs. for their flowers containing significantly more petals/flower than the other tested cultivars.

Table 1  
Mean values of the main growing and flowers characters in seven greenhouse carnation cultivars

Cultivar	Plant height (cm)	Length of internodes (cm)	No of internodes/plant	No of leaves/stem	No of shoots/plant	Length of stem (cm)	Height of flower bud (cm)	Flower diameter (mm)	No of flowers per plant	No of petals/flower
Pink Sol	76.2	7.0	12.3	16.8	2.5 <sup>(x)</sup>	64.5 <sup>xx</sup>	2.5	71.3	1.7	47.6 <sup>xxx</sup>
Pink Sim	75.3	6.1	13.3 <sup>xx</sup>	17.0	1.7	61.7	2.5	71.4	1.4	43.5 <sup>x</sup>
Obor	75.6	5.9 <sup>o</sup>	13.7 <sup>xxx</sup>	18.1	2.0	58.1	2.4	68.2	1.6	31.7 <sup>ooo</sup>
Caribe	66.8 <sup>oo</sup>	6.3	10.4 <sup>ooo</sup>	15.2	2.0	54.2 <sup>o</sup>	2.7	68.4	1.5	42.6
Madona	70.9	6.6	11.8	17.4	2.2	58.3	2.5	65.1 <sup>ooo</sup>	2.2 <sup>x</sup>	32.1 <sup>ooo</sup>
Tanga	77.2	6.4	11.7	16.6	1.9	61.2	2.6	73.5 <sup>xx</sup>	1.5	39.3 <sup>(o)</sup>
Domingo	74.6	7.4 <sup>xx</sup>	10.8 <sup>oo</sup>	15.2	1.8	58.5	2.6	73.8 <sup>xx</sup>	1.4	51.0 <sup>xxx</sup>
Mean(Ct)	73.8	6.5	12.0	16.6	2.0	59.5	2.5	70.2	1.6	41.1
s%	5.0	7.7	10.1	6.5	13.3	5.5	4.2	4.5	17.3	17.8
DL 5%	4.1	0.6	0.8	1.9	0.6	5.2	0.3	2.5	0.6	1.9
DL 1%	5.5	0.8	1.1	2.6	0.8	6.9	0.4	3.3	0.7	2.6
DL 0.1%	7.1	1.0	1.4	3.3	1.0	9.0	0.5	4.3	1.0	3.4

In *in vitro* culture, the effect of genotypes was obvious and significant for six out of the total seven analysed characters (table 2). Proliferation and root formation are more intense in Pink Sol, Caribe and Tanga than in Pink Sim, Obor and Domingo cvs. The highest intervarietal variability, under *in vivo* conditions, was recorded for the no. of flowers/plant and no. of petals/flower, while *in vitro* all analysed characters showed an extremely large span of variability values (s% = 26.5 - 109.1).

Table 2  
Mean values of the main growing characters „*in vitro*” for seven carnation cultivars

Cultivar	Plant height (cm)	Length of internodes (cm)	No of internodes/plant	No of leaves/stem	No of shoots/plant	No of roots per plantlet	Length of roots (cm)
Pink Sol	8.5 <sup>xx(x)</sup>	1.1	6.3 <sup>xx</sup>	18.5 <sup>x</sup>	0.5	6.7 <sup>xx(x)</sup>	1.3
Pink Sim	3.2	1.0	1.7 <sup>o</sup>	9.6 <sup>oo</sup>	0.1	1.7 <sup>oo</sup>	0.5 <sup>o</sup>
Obor	2.8	0.6	2.0 <sup>o</sup>	7.7 <sup>ooo</sup>	0.1	2.4	0.9
Caribe	7.8 <sup>xx</sup>	0.9	6.3 <sup>xx</sup>	19.2 <sup>x</sup>	2.2 <sup>xx</sup>	5.6 <sup>x</sup>	1.2
Madona	5.4	0.8	4.1	18.6 <sup>x</sup>	1.0	4.6	1.1
Tanga	3.2	0.6	4.3	22.1 <sup>xxx</sup>	0.9	3.1	0.6
Domingo	2.2 <sup>o</sup>	0.6	1.8 <sup>o</sup>	7.5 <sup>ooo</sup>	0.1	2.8	0.9
Mean(Control)	4.7	0.8	3.8	14.7	0.7	3.8	0.9
s%	54.3	26.5	53.4	42.1	109.1	47.7	33.2
DL 5%	2.3	0.4	1.7	3.8	1.0	1.7	0.4
DL 1%	3.0	0.5	2.3	5.1	1.3	2.3	0.5
DL0.1%	3.9	0.7	3.0	6.7	1.7	3.0	0.6

The heritability in broad sense (table 3) showed high values for the analysed characters, both *in vivo* ( $H^2 = 0.548 - 0.992$ ) and *in vitro* ( $H^2 = 0.688 - 0.953$ ) conditions.

The variability for all experiment was higher than intervarietal variability, both *in vivo* conditions ( $s\%=5.4$  for flower diameter and 40.1 for number of internodes/plant), and *in vitro* conditions ( $s\% = 43.9$  for number of internodes/plant and 211.2 for number of shoots/plan).

Table 3

Values of the coefficients of variability ( $s\%$ ) and heritability ( $H^2$ ) for the characters in seven greenhouse carnation cultivars

Traits	Coefficient of variability		Coefficient of heritability in broad sense	
	<i>in vivo</i>	<i>in vitro</i>	<i>in vivo</i>	<i>in vitro</i>
A. Plant height	7.1	91.6	0.877	0.914
B. Length of internodes	12.4	56.4	0.838	0.688
C. No of internodes/plant	40.1	43.9	0.945	0.922
D. No of leaves/stem	13.9	51.3	0.717	0.953
E. No of shoots/plant	33.3	211.2	0.628	0.837
F. Length of stem	12.4	-	0.792	-
G. Height of flower bud	13.3	-	0.548	-
H. Flower diameter	5.4	-	0.931	-
I. No of flowers/plant	11.5	-	0.673	-
J. No of petals/flower	16.7	-	0.992	-
K. No of roots / plantlet	-	65.9	-	0.889
L. Length of roots	-	53.2	-	0.854

The coefficients of correlation among the analysed traits at varieties of greenhouse carnation, studied *in vivo* and *in vitro*, are presented in table 4.

Table 4

Coefficients of correlation among the analysed traits at seven varieties of greenhouse carnation (A-J: technical mature plants, in greenhouse; A-E, K-L: *in vitro*, plantlets of four week old)

	A	B	C	D	E	F	G	H	I	J	K
A	—	0.088	0.582	0.426	-0.056	0.803	-0.540	0.609	-0.260	0.122	—
B	0.756	—	-0.564	-0.550	0.259	0.226	0.299	0.407	0.042	0.691	—
C	0.918	0.531	—	0.877	0.877	-0.005	-0.903	-0.127	0.039	-0.430	—
D	0.625	0.323	0.841	—	0.242	0.357	-0.907	-0.435	0.463	-0.738	—
E	0.631	0.194	0.754	0.710	—	0.308	-0.219	-0.372	0.622	-0.091	—
F	—	—	—	—	—	—	-0.440	0.458	-0.018	0.282	—
G	—	—	—	—	—	—	—	0.280	-0.332	0.478	—
H	—	—	—	—	—	—	—	—	-0.768	0.735	—
I	—	—	—	—	—	—	—	—	—	-0.586	—
J	—	—	—	—	—	—	—	—	—	—	—
K	0.775	0.321	0.681	0.303	0.477	—	—	—	—	—	—
L	0.947	0.575	0.926	0.656	0.586	—	—	—	—	—	0.873

There were identified strong correlations, positive or negative, among many traits of plant, both in greenhouse, at mature plants, and *in vitro*, at plantlets. *In vivo* conditions, the strong positive correlation has been identified between the plant height – length of stem (0.803), number of internodes per plant – number of leaves per stem (0.877), number of internodes per plant – number of shoots per plant (0.877), number of internodes per plant – plant height (0.918), and *in vitro* between length of roots - plant height (0.947), length of roots – number of internodes per plant (0.926), length of roots – number of roots per plantlets (0.873). Also, *in vivo*, strong negative correlation has been identified between the number of internodes per plant – height of flower bud (-0.903), number of leaves per stem – height of flower bud (-0.907), number of leaves per stem – number of petals per flower (-0.738), flower diameter – number of flowers per plant (-0.768).

## CONCLUSIONS

There have been noticed significant differences, both under *in vivo* and *in vitro* conditions, among the tested carnation cultivars concerning their growing characteristics. The variability (s%) of analysed characters *in vivo* was high and very high (s% > 20) while *in vitro* the tested cultivars showed a low or medium variability (s% = 4.2 - 17.8) of these characters. Varieties that presented favourable characteristics can be recommended for being cultivated on large areas and for being included in the Official Catalogue of Plants.

The rather high values of heritability in broad sense, suggest fair possibilities of efficient phenotypic selection for the analysed characters. Thus, by using the better cultivars as genitors in hybridisation it can be possible to obtain descendents with positive traits, in which is possible a good background of selection.

There has been noted a tight positive and negative correlation among a lot of the traits of plants, both *in vivo* and *in vitro*. Correlations among the desirable traits can be used as selection indices, in carnation breeding.

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## REZUMAT

### VARIABILITATEA UNOR CARACTERISTICI ALE CREȘTERII LA GAROAFELE DE SERĂ, ÎN CONDIȚII *IN VIVO* ȘI *IN VITRO*

Diferite caracteristici ale creșterii plantelor au fost studiate la șapte soiuri de garoafe de seră, în condiții *in vivo* și *in vitro*. Procesele de proliferare și formare a rădăcinilor au fost mult mai intense, în condiții *in vitro*, la soiurile Pink Sol, Caribe și Tanga decât la Pink Sim, Obor și Domingo. Cea mai ridicată variabilitate interspecifică în condiții *in vivo* s-a înregistrat pentru numărul de flori pe plantă și numărul de petale din floare, în timp ce în condiții *in vitro* toate caracterele analizate au prezentat o largă variabilitate. Heritabilitatea în sens larg a avut valori ridicate pentru toate elementele analizate, atât *in vivo* ( $H^2 = 0,548 - 0,992$ ) cât și *in vitro* ( $H^2 = 0,688 - 0,953$ ). Au fost identificate corelații strânse, pozitive sau negative, între diferite caracteristici ale plantelor, atât *in vivo* cât și *in vitro*, unele putând fi utilizate în ameliorarea garoafelor, ca indici de selecție.