

## PHENOTIPYCAL VARIABILITY OF THREE IMPORTANT CHARACTERS AT *ECHINACEA* GENUS

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**Abstract.** This study aimed to determine the phenotypycal variability between fourteen cultivars of *Echinacea* sp. during three experimental years 2005-2007. The experimental data presents the development of stems length and the number of stems because of the medicinal importance of *Echinacea* sp. and we analyzed also the diameter of the capitulum in order to determine the ornamental potential of *Echinacea* sp. cultivars. According to the results, all cultivars are very stable and their phenotypycal variations do not interfere with the climatic conditions. *Echinacea simulata* and one of *Echinacea purpurea* cultivars showed a very good ornamental potential. The best medicinal potential was proved by some *E. purpurea* cultivars only. These results may be useful in the breeding improvement of *Echinacea* sp. for medicinal and ornamental use.

### INTRODUCTION

Belonging to the composite family (Asteraceae), *Echinacea* is a perennial, herbaceous plant native from eastern North America. A detailed morphological classification of *Echinacea* was provided by McGregor (1968) and recently revised by Binns et. al. (2002). In this report McGregor's (1968) taxonomy is followed.

Three species, *E. angustifolia* DC, *E. pallida* (Nutt.) and *E. purpurea* (L.) Moench, show potential pharmacological activity (Bauer et al. 1988; Bauer and Wagner 1991 cited from Luping Qu et. al. 2005). In addition to its possible medicinal uses, *Echinacea* has obvious ornamental potential. *E. purpurea*, the only species for which ornamental cultivars have been bred, is both productive and profitable as a field grown species for cut flower (Starman et al. 1995).

It is interesting to note that the cultivars of *E. purpurea* which are generally grown as source materials for herbal extracts were actually developed for ornamental purposes (McKeown 1999). Commercial field plantings of the other species in the genus have been sown from generally unimproved, wild seed (McKeown 1999).

The goal of this investigation was to the variability of the number and lenght of individual stems and of capitulum diameter in order to establish the medicinal and ornamental potential of *Echinacea* cultivars that are in UASVM Cluj Napoca collection field in order to use them for breeding purposes.

## MATERIAL AND METHOD

The plants used were three years old, obtained from seeds, as presented in table 1:

Table 1

Seeds sources for *Echinacea* sp.

Variant	Cultivar	Provider	Origin	Viable seeds	Type
V 1	<i>E. purpurea</i>	UASVM <sup>1</sup>	Cluj Napoca, Romania	65%	Crop
V 2	<i>E. purpurea</i>	Botanical Garden	Bydgoszcz, Poland	80%	Crop
V 3	<i>E. purpurea</i>	NCRPIS, USDA <sup>2</sup>	Arkansas, United States	93%	Wild
V 4	<i>E. purpurea</i>	USM, HPM <sup>3</sup>	Lodz, Poland	80%	Crop
V 5	<i>E. purpurea</i>	Botanical Garden	Tg. Mures, Romania	70%	Crop
V 6	<i>E. purpurea</i>	RKV Rt. <sup>4</sup>	Rede, Hungary	60%	Crop
V 7	<i>E. purpurea</i> „Magnus”	SS <sup>5</sup>	Holland	60%	Hybrid
V 8	<i>E. angustifolia</i>	NCRPIS, USDA <sup>2</sup>	Oklahoma, United States	88%	Wild
V 9	<i>E. angustifolia</i>	Botanical Garden	Tg. Mures, Romania	55%	Crop
V 10	<i>E. pallida</i>	Botanical Garden	Tg. Mures, Romania	50%	Crop
V 11	<i>E. pallida</i>	NCRPIS, USDA <sup>2</sup>	Iowa, United States	53%	Wild
V 12	<i>E. atrorubens</i>	NCRPIS, USDA <sup>2</sup>	Oklahoma, United States	93%	Wild
V 13	<i>E. simulata</i>	NCRPIS, USDA <sup>2</sup>	Missouri, United States	81%	Wild
V 14	<i>E. hybrid</i> *	NCRPIS, USDA <sup>2</sup>	Missouri, United States	66%	Hybrid

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<sup>2</sup> North Central Regional Plant Introduction Station, United States Department for Agriculture

<sup>3</sup> Universitas Studiorum Medicorum, Hortus Plantarum Medicinarum

<sup>4</sup> Redei Kertimag Vetomagkereskedelmi Rt.

<sup>5</sup> Syngenta Seeds

\* Putative parents: *E. paradoxa* and *E. simulata*. Plants were frequent with yellow flowers. Very few cones present, possibly due to poaching. This population was reported in 1937 and is not likely to have any introductions (source: <http://sun.ars-grin.gov/cgi-bin/npgs/html/sites>).

The collection field was set in the springtime of 2005 in the Botanical Garden, UASVM, Cluj Napoca. Each cultivar has at least four shrubs in the third year of vegetation. The measurements of number of stems and the length of stems and capitulum diameter started on 15 August every year until the end of month. There were numbered all the stems and were measured ten stems and ten capitulums for each shrub. Choosing these particularly three characters is important to cover the importance of all cultivars from the field collection, in order to be used as medicinal plants or/and for their ornamental value.

ANOVA was computed for a series of experiments. Because in 2005 not all the *Echinacea* plants got flowers or stems, the statistical interpretation for those two characteristics is only for 2006 and 2007. For number of stems we used a mathematic trick and we have worked with  $x' = \sqrt{1+x}$  (Ardelean et al. 2005).

## RESULTS AND DISCUSSIONS

The results of statistical interpretation show that the length of stems it not depending of the year of experiment, suggesting that the cultivars are very stable regarding the phenotypical expression (as it can be seen in table 2). The data reveal that *E. purpurea*, provided from the Botanical Garden, Bydgoszcz, Poland has the largest length of stems comparing with *E. purpurea*, Cluj Napoca cultivar, considered as control. *E. purpurea* (V5) and *E. purpurea* „Magnus” (V7) showed also significant differences compared to control, being higher with 22-23 cm. The smallest plants were found in *E. angustifolia* (V8).

All the other cultivars from the experiment are identical with control concerning the length of stems, which means they have the same yield biomass value if only this character is considered.

Table 2

Synthesis concerning *Echinacea* stem length – measurements performed at Cluj Napoca, 2006-2007

Variant	Cultivar	Length of stem (mm)	% of stem length	± d (mm)	Difference signification (E)	Difference signification (I)
V 1	<i>E. purpurea</i> (Cluj)(Wt.)	479,03	100,00	-	-	-
V 2	<i>E. purpurea</i> (Bydgoszcz)	754,14	157,43	275,11	***	ns
V 3	<i>E. purpurea</i> (Arkansas)	520,50	108,66	41,47	ns	ns
V 4	<i>E. purpurea</i> (Lodz)	588,87	122,93	109,85	ns	ns
V 5	<i>E. purpurea</i> (Tg. Mures)	699,71	146,07	220,69	**	ns
V 6	<i>E. purpurea</i> (Rede)	605,88	126,48	126,85	ns	ns
V 7	<i>E. purpurea</i> „Magnus”	712,13	148,66	233,10	**	ns
V 8	<i>E. angustifolia</i> (Oklahoma)	258,76	54,02	-220,27	0	ns
V 9	<i>E. angustifolia</i> (Tg. Mures)	372,64	77,79	-106,39	ns	ns
V 10	<i>E. pallida</i> (Tg. Mures)	381,05	79,55	-97,97	ns	ns
V 11	<i>E. pallida</i> (Iowa)	404,30	84,40	-74,73	ns	ns
V 12	<i>E. atropurpurea</i> (Oklahoma)	598,15	124,87	119,13	ns	ns
V 13	<i>E. simulata</i> (Missouri)	351,06	73,29	-127,96	ns	ns
V 14	<i>E. hybrid</i> (Missouri)	525,25	109,65	46,22	ns	ns
SD 5%					142,08	301,97
SD 1%					188,48	420,80
SD 0.1%					243,46	589,95

The best ornamental potential from the cultivars used in this report was noted in *E. simulata* which presented the largest diameter both when comparison was made based on  $s^2_E$  and when it was based on  $s^2_{(V \times Y)}$ . Most likely the diameter of capitulum at *E. simulata* plants will be 37 mm every year (as it seen in table 3). A good ornamental potential is for *E. purpurea* „Magnus” which is a commercial hybrid provided by Syngenta, Holland. The diameter of capitulum is larger both compared to  $s^2_E$  and to  $s^2_{(V \times Y)}$ . The cultivars *E. purpurea* (V4), *E. purpurea* (V5), *E. purpurea* (V7) and *E. hybrid* (V14) had capitulum of 26 mm diameter, at a significant difference compared to *E. purpurea* Cluj Napoca.

All other cultivars from the experiment are identical with the control concerning the diameter of capitulum, which means they have the same ornamental value considering only this character.

Table 3

Synthesis concerning *Echinacea* capitulum diameter - measurements performed at Cluj Napoca, 2006-2007

Variant	Cultivar	Capitulum diameter (mm)	% of capitulum diameter	± d	Difference signification (E)	Difference signification (I)
V 1	<i>E. purpurea</i> (Cluj)(Wt.)	21,16	100,00	-	-	-
V 2	<i>E. purpurea</i> (Bydgoszcz)	24,12	113,99	2,96	ns	ns
V 3	<i>E. purpurea</i> (Arkansas)	22,84	107,98	1,69	ns	ns
V 4	<i>E. purpurea</i> (Lodz)	26,38	124,67	5,22	*	ns
V 5	<i>E. purpurea</i> (Tg. Mures)	26,65	125,97	5,50	*	ns
V 6	<i>E. purpurea</i> „Magnus”	28,63	135,30	7,47	**	(*)
V 7	<i>E. purpurea</i> (Rede)	26,84	126,88	5,69	*	ns
V 8	<i>E. angustifolia</i> (Oklahoma)	24,31	114,92	3,16	ns	ns
V 9	<i>E. angustifolia</i> (Tg. Mures)	21,00	99,26	-0,16	ns	ns
V 10	<i>E. pallida</i> (Tg. Mures)	20,17	95,32	-0,99	ns	ns
V 11	<i>E. pallida</i> (Iowa)	22,07	104,33	0,92	ns	ns
V 12	<i>E. atropurpurea</i> (Oklahoma)	21,50	101,62	0,34	ns	ns
V 13	<i>E. simulata</i> (Missouri)	37,22	175,92	16,06	***	**(*)
V 14	<i>E. hybrid</i> (Missouri)	26,94	127,33	5,78	*	ns

SD 5%	4,77	8,54
SD 1%	6,33	11,90
SD 0.1%	8,18	16,69

On inspecting the number of stems, the best cultivar is *E. purpurea* (V3) which presents at least three stems/shrub every year. That demonstrates a good adaptability and productivity of this cultivar as compared to control. *E. purpurea* (V4), *E. purpurea* (V5) and *E. purpurea* (V6) show good performances concerning the number of stems as well. All other cultivars from the experiment are identical with control if this character is considered only.

Table 4

Synthesis concerning *Echinacea* number of stems/shrub - measurements performed at Cluj Napoca, 2005-2007

Variant	Cultivar	Lenght of stem (mm)	% of stem lenght	± d (mm)	Difference signification (E)	Difference signification (I)
V 1	<i>E. purpurea</i> (Cluj)(Wt.)	2,10	100,00	-	-	-
V 2	<i>E. purpurea</i> (Bydgoszcz)	2,33	111,31	0,24	ns	ns
V 3	<i>E. purpurea</i> (Arkansas)	3,01	143,75	0,92	***	*
V 4	<i>E. purpurea</i> (Lodz)	2,69	128,36	0,59	*	ns
V 5	<i>E. purpurea</i> (Tg. Mures)	2,56	122,25	0,47	(*)	ns
V 6	<i>E. purpurea</i> (Rede)	2,61	124,48	0,51	*	ns
V 7	<i>E. purpurea</i> „Magnus”	2,43	115,75	0,33	ns	ns
V 8	<i>E. angustifolia</i> (Oklahoma)	1,80	85,83	-0,30	ns	ns
V 9	<i>E. angustifolia</i> (Tg. Mures)	2,10	100,38	0,01	ns	ns
V 10	<i>E. pallida</i> (Tg. Mures)	1,89	90,19	-0,21	ns	ns
V 11	<i>E. pallida</i> (Iowa)	2,01	95,73	-0,09	ns	ns
V 12	<i>E. atropurpurea</i> (Oklahoma)	2,16	103,21	0,07	ns	ns
V 13	<i>E. simulata</i> (Missouri)	1,91	91,21	-0,18	ns	ns
V 14	<i>E. hybrid</i> (Missouri)	2,03	96,96	-0,06	ns	ns
					SD 5%	0,49
					SD 1%	0,65
					SD 0.1%	0,84
						0,82
						1,10
						1,47

## CONCLUSIONS

1. During this study it was confirmed that *E. purpurea* cultivars has a great medicinal and ornamental value.
2. The best ornamental potential of the cultivars used in this study was shown by *E. simulata* which presented the largest diameter of capitulum.
3. The data of the experiment show that *E. simulata* cultivar can be used in breeding *Echinacea* genus for ornamental purposes with good chances of success.
4. Knowing the phenotypic variability of characters of interest in breeding is useful for breeders to select the right cultivars and to improve their qualities.

## BIBLIOGRAPHY

1. Ardelean, M., R., Sestras, Mirela, Cordea, 2005, Tehnica experimentală horticolă, Editura AcademicPres, Cluj-Napoca, 61-67
2. Binns, S.B., J., Baum, T., Arnason, 2002, A taxonomic revision of *Echinacea* (Asteraceae: Heliantheae), Systematic Botany, 27(3): pp. 610-632
3. Luping, Q., Y., Chen, X., Wang, R., Scalzo, Jeanine, Davis, 2005, Patterns of Variation in Alkamides and Cichoric Acid in Roots and Aboveground Parts of *Echinacea purpurea* (L.) Moench, HortScience, 40(5):1239-1242.

4. McGregor, R.L., 1968, The taxonomy of the genus *Echinacea* (Compositae), The Univ. Kansas Sci. Bul. 48(4):113-142
5. McKeown, K.A., 1999, A review of the taxonomy of the genus *Echinacea*, p. 482–489. In: J. Janick (ed.), Perspectives on new crops and new uses. ASHS Press, Alexandria, VA.
6. Starman , T., T. Cerny, A. MacKenzie, 1995, Productivity and profitability of some field-grown specialty cut flowers, HortScience 30 (6):1217-1220
7. [www.usda.gov](http://www.usda.gov)