THE SELECTION OF ROOTSTOCKS, THE CREATION OF NEW CULTIVARS AND SIGNIFICANT CHANGES IN THE ALMOND ASSORTMENT

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Abstract

Research regarding almond culture started in 1975 and had three directions: a). selection of new rootstocks with a preliminary stage in the nursery (1978-1979) and another rone in the orchard (1979-1991); b). introducing more productive cultivars to improve the assortment; c). breeding Romanian cultivars better adapted to the ecological conditions of the area. Over 100 cultivars and hybrids were studied between 1979 and 1994 in 5 field trials and in 1983 the following cultivars were introduced: Texas, Sudak, Ardechoise, Bruantinne, Mary Dupuy, Pomorie and Retsou. The newly introduced cultivars showed a yield increase of 71.9% in the 1987-2005 period versus 1975-1982. Out of the selections in two field trials, established in 1994 and 1999, the following cultivars were registered: Ana, Sandi, Viola, April and Sabina. By introducing the five commercial cultivars, the yield increase in the future may surpass 81% compared to the 1987-2005 period.

Key words: diallel, reciprocal, recurrent.

INTRODUCTION

After the 1979 tree census, when the almond tree did not register under “other species”, the Bihor County now holds the top spot in the country, having 15.000 trees. (Popescu, M. and col., 1982).

The systematic research regarding the culture of the almond began in 1975, focusing on 3 main objectives:

- selection of new rootstocks, adapted to conditions like heavy soils, which are specific to the culture zone of the Bihor fruit-growing district. In our country (Bordeianu T., Cociu V. and col., 1976), 24 cultivars grafted on peach tree, almond and cherry plum rootstocks were studied at Mărculeşti.

The cultivars reacted differently, being grouped into two classes: with good affinity and with weak affinity.

During 1978-1979 a study in the nursery (Şcheau V., 1992) was performed on 26 rootstocks on which two cultivars were grafted: Texas and Ferragnes.

The orchard phase ensued between 1979 and 1991 (Şcheau V., 1992, Şcheau V. and col., 1996):

- the introduction of new cultivars, more productive and better adapted to the ecological conditions of the Bihor culture zone (Şcheau V. and col.,

1987, Şcheau V., 1989, Şcheau V. and col., 1994, Şcheau V. and col., 1997, Şcheau V. and col., 1997).
- the creation of new, more productive cultivars than the introduced ones, through studying in field trials the elites selected from hybrid fields (Gâtea M. and col., 2004), ratifying the most valuable ones (Şcheau V. and col., 2006) and introducing them in the area's assortment.

MATERIAL AND METHODS

For the selection of new rootstocks, a linearly placed experiment, in the nursery stage the focus was on: M.M.B., sprouting, production of STAS saplings, taking to grafting and resistance to wintering, the diameter and height of grafted trees and the production of STAS trees per ha; as for the orchard stage: the phases of fructification, the percentage of floriferous buds frozen in the critical years of the culture, the surface of trunk section, the production of fruit and kernels per ha and the fruit's physicochemical characteristics.

In order to introduce new cultivars, 5 comparative field trials were studied, having 89 cultivars and hybrids set linearly, with 12 trees per variant.

In each experiment, the following were surveyed: the phases of fructification, the percentage of floriferous buds harmed by low temperatures during winter, the surface of trunk section, the fructiferous formations per linear meter of framework, production of fruit and core per ha and the fruit's physicochemical characteristics (the indices of size, weight, breaking output, the percentage of double kernels, proteinic and fat substances).

In order to create new cultivars, simple, double, complex, reciprocal, diallel, recurrent and even interspecific hybridizations were used.

Thus 245 combinations were performed, pollinating 350.921 flowers, obtaining 14.725 hybrid fruits and over 6.000 hybrids in three distinct fields. The hybrid seed was planted in flower pots in spring and in the month of May it was planted in the hybrid field, at a distance of 4/1 m.

After the fourth year since plantation, hybrid studies were carried out for 3-5 years on two hybrid fields of 649 and 1.274 descendants from 11 respectively 28 combinations, focusing on 10 quantitative features (abundance of blooming, period of blooming, productivity, weight of a fruit, weight of 50 kernels, peeling output, percentage of double kernels, aspect and shape of the kernel, sensitiveness to disease and pests, hybrids with sweet, semi-sweet and bitter fruit) and on two qualitative features (fat substances and proteinic substances), establishing their manner of transmission to offspring, as well as the potentially exceptional genitors.

Based on the observations and determinations made in the hybrid field, 48 respectively 56 elites were selected, which were grafted on almond trees and were planted in 1994 and 1999 linearly, with 5 trees per variant in comparative field trials. The reference in the experiment was the established cultivar Primorski. The observations and determinations were the same as in the comparative field trials.

The data gathered after all the experiments were statistically processed using the method of the variance analysis.

RESULTS AND DISCUSSION

For all the experiments, given the multitude of data, the production of fruit and especially the production of kernels were taken into account as main indicators.

Table 1 presents the production of fruit for the Texas and Ferragnes cultivars, grafted on various generative rootstocks.

Taking into account the critical years as well, 1985 with a -20.5º C temperature on January 8th, and 1987 with -22.5º C on January 13th, the highest average fruit production was recorded for the cultivars grafted on the Băneasa 2-6 rootstock, that is 920,9kg/ha for the Ferragnes cultivar and 1142,9kg/ha for Texas, values that were statistically very significant.

Table 2 presents the production of kernels for the cultivars and hybrids in the five comparative field trials.

In the first comparative field trial, the following were notable: Ardechoise with 420,2kg/ha, Bruantinne with 458,8kg/ha, Sudak with 486,3kg/ha, Mărculeşti 2/1 with 540,9kg/ha and Texas with 589,3kg/ha kernels, all of which are statistically very significant.

From the second comparative field trial, Mary Dupuy stood out, with 581,9kg/ha kernels, statistically very significant

From the third one, the following distinguished themselves: H (219-486) 2 with 711,6kg/ha, H (219-189) 1 with 749,9kg/ha, both hybrids being French patents, impossible to multiply, but used in the hybridization works, Pomorie with 761,0kg/ha and Retsou with 1005,6kg/ha kernels, all of them being statistically very significant.

In the forth one, B1 Mandula is notable, with 508,1kg/ha, while in the last one H 1/16/73 with 727,8kg/ha kernels.

Table 3 presents the production of kernels for the selected elites in field trials.

Table 1

Production of fruit from Texas and Ferragnes on various generative rootstocks

Nr.crt.	Rootstock	Cultivar	Average production 1983-1991 (kg/ha)	Relative production (%)	±d (kg/ha)	Significance
1.	Yellow cherry plum	A	373,2	65,4	-197,2	0
2.		B	647,3	95,3	93,9	
3.	Red cherry plum	A	407,3	71,4	-163,1	0
4.		B	473,1	69,7	-206,1	0
5.	**Cherry plum average**	**A**	**390,2**	**68,4**	-180,2	**0**
6.		**B**	**560,2**	**82,5**	-119,0	
7	Buburuz	A	520,5	91,3	-49,9	
8		B	1052,7	157,1	+373,5	***
9	D'Agen	A	644,0	112,9	+73,6	
10		B	727,5	107,0	+47,3	
11	De Bistrița	A	642,3	112,6	+71,9	
12		B	1005,0	148,0	+325,8	***
13	**Plum average**	**A**	**602,3**	**105,6**	**+31,9**	
14		**B**	**928,1**	**136,6**	**+248,9**	**
15	De Balc	A	834,0	146,2	+263,6	**
16		B	560,9	82,6	-118,3	
17	Oradea – 1	A	702,8	123,2	+132,4	
18		B	897,6	132,2	+218,4	**
19	**Peach tree average**	**A**	**768,4**	**134,7**	**+198,0**	*
20		**B**	**729,3**	**107,4**	**+50,1**	
21	**Apricot tree**	**A**	**416,9**	**73,1**	**-153,5**	
22		**B**	**377,3**	**65,1**	**-301,9**	**000**
23	**Fenzliana Almond**	**A**	**582,5**	**102,1**	**+12,2**	
24		**B**	**676,1**	**99,5**	**-3,1**	
25	Bitter almond type 1	A	711,4	124,7	+140,0	
26		B	782,4	115,2	+103,2	
27	Bitter almond type 2	A	494,7	86,7	-75,7	
28		B	619,7	91,2	-59,5	
29	Bitter almond type 3	A	439,9	77,1	-130,5	
30		B	591,3	87,1	-87,9	
31	**Bitter almond average**	**A**	**548,7**	**96,2**	**-21,7**	
32		**B**	**664,5**	**97,8**	**-14,7**	
33	Sweet almond type 1	A	711,3	124,7	+140,9	
34		B	751,8	110,7	+72,6	
35	Sweet almond type 2	A	554,4	97,2	-15,9	
36		B	744,4	109,6	-65,2	
37	**Sweet almond average**	**A**	**632,9**	**1110**	**+62,5**	
38		**B**	**748,1**	**110,1**	**+68,9**	
39	I.C.A.R. – 1	A	641,9	112,5	+71,5	
40		B	666,6	98,1	-12,6	
41	**Băneasa 2-6**	**A**	**920,9**	**161,4**	**+350,5**	***
42		**B**	**1142,9**	**168,3**	**+463,7**	***
43	Băneasa 4-21	A	642,0	109,4	+53,6	
44		B	878,2	129,3	+199,0	*
45	Tohani 17/10	A	562,2	98,6	-8,2	
46		B	689,7	101,5	+10,5	
47	Tohani S 3/7	A	653,6	114,6	+83,2	
48		B	747,6	110,1	+68,4	
49	Tohani 3/18	A	505,0	88,5	-65,4	
50		B	610,9	89,9	-68,3	
51	Timpurii 135829	A	506,8	88,8	-63,6	
52		B	655,5	96,5	-23,6	
53	Valea Scheii	A	534,8	93,8	-35,6	
54		B	685,2	100,9	+6,0	
55	Valea Teancului 2740	A	623,6	109,3	+53,2	
56		B	798,6	117,6	+119,4	
57	Dabkov	A	521,0	91,3	-49,4	
58		B	671,4	98,9	-7,8	
59	Dușistâi	A	788,9	138,3	+218,5	*
60		B	619,6	91,2	-59,6	
61	Budatétény	A	575,6	100,9	+5,2	
62		B	836,3	123,	+157,1	*
63	**Cultivars and hybrids average**	**A**	**621,5**	**109,4**	**+51,1**	
64		**B**	**750,2**	**110,0**	**+71,0**	
65	**Rootstocks average**	**A**	**570,4**	**100,0**	**0**	
66		**B**	**679,2**	**100,0**	**0**	

A = Ferragnes DL 5% = 156,4 B = Texas DL 1% = 208,0 DL 0.1% = 251,9

Table 2

The production of kernels at almond breeds and hybrids from C.C.C. at S.C.D.P. Oradea

Breed	Avg 1979-1982 kg/ha	Breed	Avg 1982-1985 kg/ha	Breed	Avg 1983-1991 kg/ha	Breed	Avg 1988-1994 kg/ha	Sel. elites	Avg 1988-1994 kg/ha
1 Texas	2 583,3 ***	3 Mary Dupuy	4 581,9 ***	5 Retsou	6 1005,6 ***	7 B1 Mandula	8 508,1 ***	9 H 1/10/73	10 727,8 ***
Mărculeşti 2/1	540,9 ***	H 1/9 – 1 fa	435,4 **	Pomorie	761,0 ***	Szigetosepi 55	457,0 ***	H 4/24/73	597,3 ***
Sudak	486,3 ***	Drake	388,9*	H (219-189)1	749,9 ***	H III	456,9 ***	H 1/5/73	587,2 **
Bruantinne	485,8 ***	Cacahuet	336,9	H (219-486)2	711,6 ***	H 716/4	431,3 **	H 9/57/73	552,3 *
Ardechoise	420,2 ***	Mt. (avg)	284,6	Primorski	630,6 ***	H 139/6 Mandula	395,4	H 2/42/73	536,6
Nikitsky 62	354,6	Crâmsky	283,8	H (61-269)7	565,9	Mt. (avg)	371,7	H 1/2/73	534,9
Preanâi	311,5	Dusistâi 133298	275,0	Thompson	538,9	B3 Mandula	357,2	H 2/13/73	516.1
Saucaret	308,5	Mărculeşti 18/51	236,8	Belle D'Aurons	517,5	Szigetosepi 92	336,5 *	H 2/59/73	502,1
Mt. (avg)	253,1	Băneasa 4-21	234,8	H (219-189)6	516,3	Szigetosepi 58	320,3 **	H 8/52/73	488,9
Crâmsky	285,7	Exinograd	182,5*	H 772	431,2	H 1	319,8 **	Mt. (avg)	475,4
Nikitsky Pozduo	274,0	Prinţesa	170,7*	Nessebar	4302	H 1/2	309,6 **	H 6/26/73	459,9
Y.X.L.	244,4	Mărculeşti 2/1	153,5 ***	Mt. (avg)	411,8	H V	299,8 ***	H 6/31/73	451,0
Primorski	235,1	Languedoc	135,2 ***	Cristonorto	389,5	H IV	268,8 ***	H 5/38/73	449,7º
Lovrin 18	222,2º			Tliono	384,8			H 2/18/73	405,8º
Ferragnes	221,9º			Peanâi	365,2			H 5/35/73	400,9 ºº
Mărculeşti 23/54	210,9º			Nikitski 62	364,0			H 5/39/73	385,9 ºº
Tohani 17	207,0 ººº			H 5/1	363,3			H 2/26/73	374,0 ºº
Burbank	168,2 ººº			H 2/9	349,3			H 8/46/73	369,7 ººº
Mari de stepă	138,1 ººº			Mărculeşti	345,2			H 10/53/73	354,3 ººº
Hattes	136,3 ººº			Tetenyi Boterno	297,9			H 6/30/73	338,3 ººº
Mollesse	20,2 ººº			Ferragnes	282,1				
				Ferraduel	260,9				
				Tardy Non-pareille	173,3 ºº				
				H(44-189)132	133,8 ºº				

Planted DL5%=61,9 DL1%=84,6 DL0.1%=114,8 | Planted 1975 5/6m | DL5%=83,3 DL1%=116,9 DL0.1%=164,9 | Planted 1978 5/6m | DL5%=156,9 DL1%=212,6 DL0.1%=284,2 | Planted 1980 5/3m | DL5%=34,6 DL1%=18,7 DL0.1%=68,7 | Plt. in 1984 5/3m | DL5%=73,3 DL1%=98,3 DL0.1%=118,8

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Table 3

Kernel production for the almond elites selected at S.C.D.P. Oradea

Nr. crt.	Elite	Average production 1998-2003 (kg/ha)	Elite	Average production 2003-2006 (kg/ha)
1	H 4/2205/84	887,2***	H 4/1451/82	1043,8 ***
2	H 3/1344/82	823,7***	H 1/2025/84	982,7 ***
3	H 1/2043//84	762,4***	H 14/851/81	930,5 ***
4	H 1/2033/84	740,2***	H 9/1464/82	899,7 ***
5	H 1/2021/84	678,4***	H 23/1501/82	770,2 ***
6	H 19/1532/84	671,2***	H 5/786/81	732,6 ***
7	H 4/1464/82	616,5***	H 16/1939/84	719,2 ***
8	H 16/1919/84	614,1**	H 16/1974/84	701,3 ***
9	H 1/2022/84	571,2***	H 5/785/81	699,3 ***
10	H 4/1222/82	524,7**	H 6/2253/84	692,5 ***
11	H 33/2240/84	513,1**	H 23/2003/84	691,2 ***
12	H 26/961/82	503,0*	H 1/2012/84	664,7 ***
13	H 1/2012/84	497,5*	H 24/719/82	624,0 ***
14	H 5/142/82	439,1	H 31/1426/81	614,4 ***
15	**Primorski (Mt.)**	**432,9**	**Primorski (Mt.)**	**432,4** ***
16	H 3/1378/82	421,1	H 46/1008/82	570,4 ***
17	H 14/1183/82	407,6	H 3/1421/81	561,0 ***
18	H 4/1459/82	380,1°°	H 16/1606/84	527,6 **
19	H 3/1346/82	358,6°	H 16/1816/84	518,2 **
20	H 1/2057/84	344,7°°	H 16/1730/84	488,2
21	H 16/1685/84	335,6°°°	H 16/1986/84	486,5
22	H 1/2212/84	326,1°°°	H 16/1816/84	466,2
23	H 15/2221/84	322,1°°	H 8/1365/82	456,9
24	H 16/1994/84	305,1°°°	H 16/1919/84	440,5
25	H 24/2131/84	302,4°°°	H 46/985/82	436,4
26	H 16/1711/84	301,4°°°	H 16/1838/84	419,2
27	H 2/1298/82	271,7°°°	H 16/1992/84	409,2
28	H 21/738/81	261,4°°°	H 8/1358/82	408,8
29	H 3/1348/82	253,0°°°	H 1/2006/84	407,5
30	H 16/1657/84	250,3°°	H 16/1828/84	402,2
31	H 9/2283/84	248,7°°°	H 16/1744/84	379,0
32	H 16/1984/84	244,2°°°	H 23/2113/84	349,7 °
33	H 16/1986/84	240,8°°°	H 31/1175/82	342,6 °°
34	H 16/1959/84	240,3°°°	H 4/1465/82	338,7 °°
35	H 16/1864/84	234,0°°°	H 24/811/81	329,1°°
36	H 33/2217/84	232,1°°	H 12/2148/84	315,2°°°
37	H 15/2217/84	221,2°°°	H 16/1698/84	315,1°°°
38	H 16/1721/84	220,4°°°	H 11/719/81	303,1°°°
39	H 5/1420/82	216,5°°°	H 31/1223/82	298,4°°°
40	H 5/1425/82	215,8°°°	H 30/1125/82	295,7°°°
41	H 3/1385/82	196,8°°°	H 23/950/81	283,8°°°
42	H 16/1951/84	196,6°°°	H 23/2104/84	286,2°°°
43	H 1/2075/84	184,3°°°	H 16/1718/84	262,5°°°
44	H 3/1365/82	171,3°°°	H 16/1617/84	254,5°°°
45	H 8/1508/82	167,2°°°	H 8/951/81	223,3°°°
46	H 1/2011/84	143,6°°°	H 24/818/81	218,5°°°
47	H 3/1370/82	111,5°°°	H 19/912/81	215,4°°°
48	H 12/2145/84	110,4°°°	H 23/2076/84	210,8°°°
49	H 14/1212/82	104,4°°°	H 24/794/81	206,9°°°
50			H 15/2224/84	204,2°°°
51			H 19/916/81	194,3°°°
52			H 31/1178/82	178,1°°°
53			H 16/1610/84	166,6°°°
54			H 23/1508/82	165,7°°°
55			H 16/1979/84	161,2°°°
56			H 46/953/82	147,8°°°
57			H 8/930/81	120,5°°°
Planted in 1994 at 5/3 m	DL5%=56,2 DL1%= 74,6 DL0.1%=96,0	Planted in 1999 at 5/4 m	DL5%=62,2 DL1%=82,7 DL0.1%=107,6	

In view of the multitude of data taken into account, the following stood out in the first micro-culture: H 16/1919/84 with 614,1 kg/ha, H 1/2033/84 with 740,2 kg/ha, H 1/2043/84 with 762,4 kg/ha, H 3/1344/82 with 823,7 kg/ha and h 4/2205/84 with 887,2 kg/ha of kernels, all of which are statistically very significant and were ratified in 2006.

In the second comparative field trial, the following distinguished themselves: H 14/851/81 with 930,5 kg/ha, H 1/2025/84 with 982,7 kg/ha and H 4/1451/82 with 1043,8 kg/ha kernels, all of them being statistically very significant and enrolled for testing.

Table 4 presents the evolution of the almond assortment at S.C.D.P. Oradea. If during 1975-1982 the Primorski, Nikitski 62, Crâmski, Preanâi and Burbank cultivars were bred in our own nursery, with an average production of 316,9 kg/ha kernels, in 1983 other cultivars were introduced for breeding, such as Texas, Sudak, Mărculeşti 2/1, Ardechoise and Bruantinne, and the production of the new arrivals was 492,6 kg/ha kernels, representing an increase of 55,4%.

Table 4

The evolution of the almond assortment at S.C.D.P. Oradea

Nr crt	1975-1982			1983-1986		1987-2005		Perspective	
	Assort-ment		Kernel prod. kg/ha	Assort-ment	Kernel prod. kg/ha	Assort-ment	Kernel prod. kg/ha	Assort-ment	Kernel prod. kg/ha
1	Primorski		432,9	Primorski	432,9	Primorski	432,9	Primorski	432,9
2	Nikitski 62		359,3	Texas	589,3	Texas	589,3	H3/1344/82 (Ana)	823,7
3	Crâmsky		285,7	Mărculeşti 2/1	540,9	Mărculeşti 2/1	540,9	H1/2033/84 (Viola)	740,2
4	Preanâi		338,3	Sudak	486,3	Sudak	486,3	H4/2205/84 (Sandi)	887,2
5	Burbank		168,2	Ardechoise	420,2	Ardechoise	420,2	H1/2043/84 (Sabina)	762,1
6				Bruantinne	485,8	Bruantinne	485,8	H16/1919/84 (April)	614,1
7						Mary Dupuy	581,5	H14/851/81	930,5
8						Pomorie	761,0	H4/1451/82	1043,8
9						Retsou	1005,6	H1/2025/84	982,7
10	Avg	Kg/ha	316,9		492,6		544,8		801,9
11		%	100,0		155,4		171,9		253,0

In 1987 another three new cultivars are introduced in the assortment of the zone, Mary Dupuy, Pomorie and Retsou and a production of 544,8 kg/ha of kernels is attained, thus a 71.9% increase compared to the period between 1975 and 1982 or a 16,5% increase compared to the period between 1983 and 1986.

The perspective for the year 2006, because of the introduction of five cultivars and three Romanian hybrids, is that the average production be 801,9 kg/ha kernels, an increase of 81,1% compared to the 1987-2005 period.

CONCLUSIONS

In 1992 the generative rootstock for almond Băneasa 2-6 was ratified under the name Felix, which in 2006 was reenlisted in the Official List of crop plant breeds in Romania.

Also in 1992 the Mărculeşti 2/1 cultivar was homologated, and in 2006 the following breeds were ratified: April, Viola, Sabina, Ana and Sandi, the last five being in the phase of patent granting.

In the year 2006 the next hybrids were enrolled for testing in the I.S.T.I.S. net: H 4/1451/82, H 1/2025/84 and H 14/851/81.

Compared to the 1987-2005 period, using the Felix rootstock and the new Romanian cultivars can ensure kernel production increases of over 81%.

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