

PECULIARITIES OF GROWTH AND FRUITFULNESS OF APPLE CULTIVARS WITH GENETIC RESISTANCE TO DISEASES GROWN UNDER HIGH DENSITY SYSTEM

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Abstract

The researches performed at the Research Station for Fruit Growing Voinești, in the period 2007-2012, had as object of study 13 disease-resistant apple tree cultivars in a high density system, grafted on M 9 rootstock, respectively: 'Ariwa', 'Golden Lasa', 'Goldrush', 'Enterprise', 'Inedit', 'Iris', 'Luca', 'Real', 'Rebra', 'Redix', 'Remar', 'Saturn', 'Voinicel', comparative with the 'Jonathan' cultivar, considered as control. The trees were planted at a distance of 4 x 1 m (2.500 trees/Ha), spindle crown shape. With high production potential remarked the disease-resistant apple cultivars 'Ariwa', 'Remar', 'Inedit' and 'Saturn', which in the years 4 – 6 after planting realized over 29 t/ha. In the same conditions, the apple tree cultivar 'Real', 'Voinicel', 'Luca' and 'Iris' realized between 23,2 t/ha and 25,5 t/ha. The promotion of the high density apple tree system, in which disease-resistant apple tree cultivars are previewed, represents a modality for periodical and rapid replacement of the assortments, leading to the identification of new modern technologies in obtaining productions adapted to the requirements of the European quality standards.

Key words: high density system, disease-resistant cultivars, productivity, fruits quality

INTRODUCTION

The modern apple tree culture systems, with rapid fruit bearing start and short exploitation duration, represent a modality for the periodical and rapid replacement of the assortments, through this being encouraged the introduction of modern technics and ideas in obtaining of productions adapted to the exigences of the European quality standards (Comanescu, 2012).

On the European level, they generalized the use of the reduced vigour graft bearers (M9), with tree sustaining trellis and irrigation system, covering the orchards with an anti-hail net (Eremia, 2007). In the high density fruit trees exploitation in France, Italy, Germany, Spain, Switzerland etc., with densities of 2,500 – 3,000 trees/ha, they obtain remarkable performances, concretized by productions of 40 – 60 t/ha.

The researches performed at the Research Station for Fruit Growing Voinești Dambovită in the period 2007 – 2012, were aimed at the increase of the competency, corresponding to the principles of the enduring development and of the food security, concretized in the promotion of a high density apple tree culture system, in which are previewed elements specific to the

Romanian cultivars, comparative with the foreign ones, which will lead in short time to the increase of the productive performances and economical efficiency, as well as immediate profitability, simultaneously with the implementation at private producers (Petre et al, 2010).

MATERIALS AND METHODS

The researches, conducted in the 2007 – 2012 period, at the Research Station for Fruit Growing Voinești, had in view the establishing of an apple tree assortment, destined to the biological production, cultivated in the ecopedoclimatical conditions of the Voinești area, being studied 13 genetic disease-resistant apple tree cultivars of local and foreign origin, respectively: 'Ariwa', 'Golden Lasa', 'Goldrush', 'Enterprise', 'Inedit', 'Iris', 'Luca', 'Real', 'Rebra', 'Redix', 'Remar', 'Saturn', 'Voinicel', comparative to the cultivar Jonathan, chosen as control. All cultivars were grafted on the rootstock M9.

The trees were planted at the distance of 4 x 1 m (2500 trees/ha), spindle crown shape.

The soil of the experimental plot was fallow on the interval and maintained clean of weeds on the tree row. It is a brown eumezobazic, weakly

preudogleizat, with clayish texture, with a weakly acid pH (5,7–5,9). The content in humus is medium at the surface (2,0–2,9%), medium supplied with nitrogen and weakly supplied with phosphorus and potassium.

Only 6–8 treatments were applied (insecticides).

The other works were performed according to the technology specific to the high density apple tree orchards.

At the apple tree assortment used at setting up the orchard, we followed up the vegetative tree growth, the fruit bearing precocity, the production levels, the fruits quality and other culture aspects, which represent factors to be taken into account at the promotion in culture of the high density system apple tree orchards.

RESULTS AND DISCUSSIONS

The growing vigour in the 6th leaf of the trees, cultivated in the high density system, when the growth potential is well differentiated, shows us that between the apple tree cultivars appear significant differences, regarding the trunk thickness growth, the height and the thickness of the fructiferous fence.

The trunk is one of the elements, which characterizes the tree vigour and it is always analyzed and correlated with a series of other biometrical processes and indices.

The values regarding the trunk thickness, registered in the year 5 from planting, are presented in Table 1.

Table 1. Trunk thickness growth in the year 6 from planting, at the genetic disease-resistant apple tree varieties, cultivated in the high density system (year 2012)

No.	Cultivar/rootstock	Diameter in the 6 th leaf, 2012 (mm)	Medium growth increase (mm)	Trunk section surface in the 6 th leaf, 2012 (cm ²)	Differences ± to control (cm ²)	Significance
1	Jonathan/ M9 (C)	45,69	6,12	16,39	-	-
2	Ariwa/ M9	44,26	4,95	15,38	- 1,01	N
3	Golden Lasa/ M9	56,17	6,10	24,78	+ 8,39	***
4	Goldrush/ M9	38,52	3,95	11,65	- 4,74	000
5	Enterprise/ M9	59,28	6,75	27,60	+ 11,21	***
6	Inedit/ M9	47,70	5,35	17,87	+ 1,48	N
7	Iris/ M9	48,95	5,95	18,82	+ 2,43	**
8	Luca/ M9	58,03	7,35	26,45	+ 10,06	***
9	Real/ M9	44,50	5,30	15,55	- 0,84	N
10	Rebra/ M9	53,33	6,45	22,34	+ 5,95	***
11	Redix/ M9	55,83	7,65	24,48	+ 8,09	***
12	Remar/ M9	56,55	7,80	25,12	+ 8,73	***
13	Saturn/ M9	43,00	5,30	14,52	- 1,87	0
14	Voinicel/ M9	50,00	5,10	20,43	+ 4,04	***

DL 5% = 1,651 cm²; DL 1% = 2,22 cm²; DL 0,1% = 2,97 cm²

Grafted on M9 rootstock, the most vigorous, resistant apple tree cultivars, cultivated in the high density system were: 'Enterprise' (58,28 mm), 'Luca' (58,03 mm), 'Remar' (56,55 mm), 'Golden Lasa' (56,17 mm), 'Redix' (55,83 mm) and 'Rebra' (53,33 mm).

Values of the trunk thickness, comprised between 40 and 50 mm, registered the apple tree cultivars: 'Saturn' (43,00 mm), 'Ariwa' (44,26 mm), 'Real' (44,50 mm), 'Inedit' (47,70 mm), 'Iris' (48,95 mm) and 'Voinicel' (50,00 mm).

Values less than 40 mm registered the cultivar Goldrush (38,52 mm).

At the Jonathan cultivar (control), the trunk diameter in the 6th leaf had an increase of 45,69 mm.

The medium growth increase shows values comprised between 3,95 mm at the 'Goldrush' cultivar and 7,88 mm at the 'Remar' cultivar, both cultivars grafted on M9.

The trunk vigour in the 6th leaf, represented by the trunk section surface, registers extreme values, comprised between 11,65 cm² at the 'Goldrush' cultivar and 27,60 cm² at 'Enterprise'.

The data, statistically analyzed as compared to the Jonathan cultivar, taken as control, point out

very significant positive differences at the cultivars 'Golden Lasa', 'Enterprise', 'Luca', 'Rebra', 'Redix', 'Remar' and 'Voinicel'. Distinctive significant positive differences were assured by the 'Iris' cultivar – and very significant negative differences by the 'Goldrush' cultivar.

Vigour with insignificant differences, as compared to the level of the Jonathan cultivar, have the cultivars 'Ariwa', 'Real' and 'Inedit'.

The tree dimensions and the crown volume registered in the 6th leaf are presents in Table 2. The trees height registers the values comprised between 195 cm at the 'Goldrush' cultivar and 280 cm 'Luca' cultivar. The greatest trees height values are registered at the 'Real', 'Enterprise', 'Rebra', 'Redix', 'Golden Lasa', over 290 cm in height. The Jonathan cultivar riched 210 cm.

The fructiferous fence thickness was comprised between 110 and 165 cm.

The crown volume per tree, in the 6th leaf, oscillated between 1,82 cm/tree at the

'Goldrush' cultivar and 4,12 cm/tree at 'Luca', comparative to Jonathan, where 2,52 cm/tree were registered.

Calculated on the surface unit, the crown volume registers values from 4450 mc/ha at the 'Goldrush' cultivar – to 10300 mc/ha at the 'Luca' cultivar.

Lower values of the crown volume were registered at the cultivars: 'Goldrush' (4450 mc/ha), 'Inedit' (6300 mc/ha) and 'Saturn' (6500 mc/ha). At the other cultivars, the crown volume, calculated on one hectar, approaches the value of 6300 mc, registred at the Jonathan cultivar, taken as control, with insignificant differences at the majority of cultivars. The statistical calculation registers very significant positive differences only at the 'Luca' cultivar, distinctive significant positive difference at the 'Enterprise' cultivar and significant positive differences at 'Golden Lasa', 'Real' and 'Rebra' cultivar, grafted on M9 rootstock.

Table 2. Tree crown dimensions and volume at the studied apple tree cultivars in the 6th leaf (2012)

No.	Cultivar/rootstock	Tree Dimensions (cm)		Crown Volume (cm)			
		Height	Fruits fence thickness	Per tree	Differences ± to control	Significance	Per Ha
1	Jonathan/ M9 (Mt)	210	140	2,52	6.300	-	
2	Ariwa/ M9	240	140	2,94	7.350	+ 1.050	N
3	Golden Lasa/ M9	260	150	3,45	8.625	+ 2.325	*
4	Goldrush/ M9	195	110	1,82	4.450	- 1.850	0
5	Enterprise/ M9	265	160	3,76	9.400	+ 3.100	**
6	Inedit/ M9	210	140	2,52	6.300	0	-
7	Iris/ M9	230	140	2,80	7.000	+ 700	N
8	Luca/ M9	280	165	4,12	10.300	+ 4.00	***
9	Real/ M9	270	140	3,36	8.400	+ 2.100	*
10	Rebra/ M9	265	140	3,29	8.225	+ 1.925	*
11	Redix/ M9	260	136	3,10	7.750	+ 1.450	N
12	Remar/ M9	245	145	3,12	7.800	+ 1.500	N
13	Saturn/ M9	230	130	2,60	6.500	+ 200	N
14	Voinicel/ M9	210	140	2,52	6.300	0	-

DL 5% = 1.729 mc; DL 1% = 2.336 mc; DL 0,1% = 3.117 mc

The productivity of the genetic disease-resistant apple trees, was pointed out by annual registering the apple production at cultivar level.

Among the apple tree cultivars in the apple tree high density system, the 'Iris' cultivar, grafted on M9 rootstock, has the tendency to bear fruits already from the 2nd leaf.

From the year 3 after planting, the 13 apple tree cultivars with genetic resistance to diseases and Jonathan/ M9 realized satisfactory productions, having in view that we used at planting seedling material from the field II of the nursery, without anticipations, as support of the fruit bearing buds differentiation – already from the planting year.

Table 3. Fruits production realized at the apple tree cultivars with genetic resistance to diseases, cultivated in the high density system (2500 trees/ha)

No.	Cultivar/ rootstock	Production obtained in the year (t/ha)				Average of the years 4 – 6 (t/ha)	Differences ± to control	Significance
		3 2009	4 2010	5 2011	6 2012			
1	Jonathan/M9 (C)	3,5	15,8	24,0	21,5	21,4	-	
2	Ariwa/M9	5,5	21,9	42,0	39,0	34,3	+ 12,9	***
3	Golden Lasa/M9	5,5	19,4	29,8	19,5	22,9	+ 1,5	N
4	Goldrush/M9	5,0	20,8	29,5	17,0	22,4	+ 1,0	N
5	Enterprise/M9	1,3	12,5	28,5	31,5	24,2	+ 2,8	**
6	Inedit/M9	6,5	18,5	42,2	26,2	29,0	+ 7,6	***
7	Iris/M9	6,3	20,4	33,0	23,0	25,5	+ 4,1	***
8	Luca/M9	2,8	16,4	35,3	20,0	23,9	+ 2,5	**
9	Real/M9	7,5	18,8	29,3	27,0	25,0	+ 3,6	***
10	Rebra/M9	3,0	10,7	31,0	25,3	22,3	0 0,9	N
11	Redix/M9	2,8	16,6	23,0	21,0	20,2	- 1,2	N
12	Remar/M9	3,8	19,8	32,0	38,0	29,9	+ 8,5	***
13	Saturn/M9	5,8	21,6	42,5	31,5	31,9	+ 10,5	***
14	Voinicel/M9	4,3	18,6	29,8	21,3	23,2	+ 1,8	*

DL 5% = 1,67 t/ha; DL 1% = 2,25 t/ha; DL 0,1% = 3,01 t/ha

From the data presented in Table 3, results that the studied apple tree assortment, the Romanian cultivars, early and productive ones were: 'Real' (7.5 t/ha), 'Inedit' (6.5 t/ha), 'Iris' (6.3 t/ha), 'Remar' (3.8 t/ha).

From the foreign cultivars, we point out, with their productions in the year 3 after planting: 'Saturn' (5.8 t/ha), 'Ariwa' (5.5 t/ha), 'Golden Lasa' (5.5 t/ha), 'Goldrush' (5.0 t/ha).

At Jonathan cultivar, we obtained in the 3rd leaf, 3.5 t/ha.

Analyzing the medium production of the years 4 - 6 from planting, we observe that from the 13 apple tree cultivars with genetic resistance to diseases, cultivated in the high density system, the most productive are the cultivars: 'Ariwa', 'Remar', 'Inedit' and 'Saturn'. at which we obtained over 29 t/ha. Appreciated with high potential are also the apple tree cultivars, which registered medium productions of over 23 t/ha, as follows: 'Real' (25,0 t/ha), 'Voinicel' (23,2 t/ha), 'Luca' (23,9 t/ha), 'Iris' (25,5 t/ha). The Jonathan cultivar, registered as a 3 years average a production of 21,4 t/ha.

The statistically calculated data confirm very significant positive differences, as compared to Jonathan, at the majority of the studied genetic disease-resistant apple tree cultivars.

The studied apple tree cultivars with genetic disease-resistance, cultivated in the high density system, manifested a very good resistance against scab (*Venturia inaequalis*)

and an increased resistance degree against mildew (*Podosphaera leucotricha*), with insignificant values, comprised between 0 and 6.5%.

The medium value of the fruits weight at cultivar level, in the period 2009–2011, shows that the 'Golden Lasa', 'Enterprise', 'Luca', 'Real', 'Rebra', 'Redix', 'Remar' and 'Saturn' cultivars have the potential to assure the suitable fruits size, which shall compete on the market, the fruits framing in the big fruits class – and the other cultivars frame in the medium fruits group.

The tree assortments are in a permanent change, the place of the cultivars, presenting inferior commercial qualities, being taken by the new breded cultivars, which correspond to a higher degree to the consumers' continuously increasing requirements.

The experimented apple tree cultivars, can cover a great part of the consumption season, besides some of the genetic disease-resistant cultivars, multiplied in culture, already known and appreciated on the market by the consumers.

CONCLUSIONS

The growing in the 6th leaf, cultivated in the high density, sistem, represented by the trunk section surface, registers values comprised between, 11,65 cm² at the 'Goldrush' cultivar and 27,60 cm² at 'Enterprise'.

The crown volume, calculated on the surface unit, oscillated between 4450 cm²/ha, at the 'Goldrush' cultivar and 10300 cm²/ha at the Luca cultivar.

The highest production potential on the surface unit was realized in the years 4 - 6 from planting at 'Ariwa', 'Inedit' and 'Saturn', with over 29 t/ha, but also at the 'Real', 'Voinicel', 'Luca' and 'Iris' apple tree cultivars, at which we realize between 23,2 t/ha and 25,5 t/ha.

The genetic disease-resistant apple tree cultivars studied in the high density system, manifested a very good resistance to scab (*Venturia inaequalis*) and an increased resistance degree to mildew (*Podosphaera leucotricha*), with insignificant values, comprised between 0 and 6.5%.

The apple tree cultivars, recently bred at R.S.F.G. Voinești, and also other studied foreign cultivars, cover a great part of the consumption season, besides some genetic disease-resistant cultivars already known and appreciated on the market by the consumers – these framing in differently in the conveyor recommended for the Dâmbovița tree growing region.

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