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THE BEHAVIOUR OF SOME APPLE TREE VARIETIES WITH GENETIC DISEASE-RESISTANCE IN THE HIGH DENSITY SYSTEM

Daniel COMĂNESCU, Gheorghe PETRE, Valeria PETRE
Research Station for Fruit Growing Voineşti

Corresponding author email: statiuneavoinesti@gmail.com

Abstract

The researches performed at the Research Station for Fruit Growing Voineşti, in the period 2007-2011, had as object the study of 13 disease-resistant apple tree varieties, cultivated in the high density system, grafted on the graft bearer M 9, respectively: Ariwa, Golden Lasa, Goldrush, Enterprise, Inedit, Iris, Luca, Real, Rebra, Redix, Remar, Saturn, Voinicel, comparative with the Jonathan variety, taken as witness. The trees were planted at a distance of 4 x 1m (2.500 trees/Ha), spindle crown form. With high production potential remarked themselves the disease-resistant apple tree varieties Ariwa, Inedit and Saturn, which in the year 4 and 5 after planting realized over 30 t/Ha. In the same conditions, the apple tree varieties Real, Golden Lasa, Voinicel, Goldrush, Luca, Remar and Iris realized between 24.05 t/Ha and 26.7 t/Ha. The promotion of the high density apple tree system, in which disease-resistant apple tree varieties are previewed, represents a modality for periodical and rapid replacement of the assortments, leading to the identification of new modern technologies in obtaining of productions adapted to the requirements of the European quality standards.

Keywords: *high density system, disease-resistant varieties, productivity, fruits quality*

INTRODUCTION

The modern apple tree culture systems [4], 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. On the European level, they generalized the use of the reduced vigour graft bearers (M9), with tree sustaining and irrigation system, covering the orchardsds with an anti-hail net [2]. In the high density fruit trees exploitaion 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 rersearches performed at the Research Station for Fruit Growing Voineşti in the period 2007 – 2011, were aimed at the increase of the competity [3], 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 [1], in wich are previewed elements specific to the Romanian varieties, comparative with the foreign ones, wich will lead in short time to the increase of the productive performances and to the increase of the economical efficiency, as immediate profitability, simultaneously with the implementation at the private producers.

MATERIAL AND METHODS

The researches were organized at the Research Station for Fruit Growing Voineşti in the spring of the year 2007, by setting up a plantation, in which we followed up the promotion of a high density apple tree system, based on disease-resistant varieties and on the adaptation of specific solutions, which has as effect the early fruit bearing and the permanent fructification on young wood.
The researches, deployed in the perioad 2007 – 2011, had in view the establishing of an apple tree assortement, destined to the biological production, cultivated in the ecopedoclimatical conditions of the Voineşti zone, being studied 13 genetic disease-resistant apple tree varieties of local and foreign origin, respectively: Ariwa, Golden Lasa, Goldrush, Enterprise, Inedit, Iris, Luca, Real, Rebra, Redix, Remar, Saturn, Voinicel, comparative to the variety Ionathan, taken as a witness. All varieties were grafted on the graft bearer M9.

The trees were planted at the distance of de 4 x 1 m (2500 trees/Ha), spindle crown form.
The soil of the experimental lot was fallow on the interval and maintained clean of weeds on the tree row. It is 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.
For pest combat, 6–8 treatments were applied, only with 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 age year 5 of the trees, cultivated in the high density system, when the growth potential is well differentiated, shows us that between the apple tree varieties appear significant differencies, regardig 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.
With values of over 50 mm are inscribed the varieties Golden Lasa (50.07 mm), Luca (50.68 mm), Enterprise (52.53 mm), being the most vigorous in the conditions of grafting on the graft bearer M9.
Values of the trunk thickness, comprised between 40 and 50 mm, registered the apple tree varieties: Inedit (42.35 mm), Iris (43.00 mm), Voinicel (45.30 mm), Rebra (46.88 mm), Redix (48.18 mm), Remar (48.75 mm).
Values lesser than 40 mm registered the varieties: Goldrush (34.57 mm), Saturn (37.70 mm), Real (39.20 mm), Ariwa (39.31 mm).
At the Ionathan variety, taken as witness, the trunk diameter in the year 5 from plantation had an increase of 39.57 mm, framing in the varieties group which had the trunk thickness growth under 40 mm.
The medium growth increase shows values comprised between 4.94 mm at the Goldrush variety and 11.58 mm at the Redix variety, both varieties grafted on the graft bearer M9.
The trunk vigour in the year 5 from planting, represented by the trunk section surface, registers extreme values, comprised between 9.38 cm^2 at the Goldrush variety and 21.66 cm^2 at the Enterprise variety.
The data, statistically processed as compared to the Ionathan variety, taken as witness, point out very significant positive differences at the varieties Golden Lasa, Enterprise, Luca, Rebra, Redix, Remar and Voinicel. Distinctive significant positive differences were assured by the Iris variety – and significant positive differences by the Inedit variety.
Distinctive significant negative differences, as compared to the Ionathan variety, taken as witness, registers the Goldrush variety.
Vigour with unsignificant differences, as compared to the level of the Ionathan variety, have the varieties Ariwa, Real şi Saturn.
The tree dimensions and the crown volume registered in the year 5 presents near values, comparative to those of the year 4 from the tree planting. Thus, the trees height registers 225 cm at the Voinicel variety, 235 cm at the Goldrush variety, 240 cm at the Ariwa and Saturn varieties. The greatest trees height values are registered at the Enterprise (280 cm), Redix (285 cm) varieties and at the Luca and Remar varieties, with 290 cm. The Ionathan variety had the height of 250 cm.
The fructiferous fence thickness was comprised between 130–150 cm at the Inedit, Goldrush, Golden Lasa, Voinicel, Real varieties and values of over 170 cm had the Ariwa, Luca and Enterprise varieties.
The crown volume per tree, in the year 5 from planting, oscillated between 2.73 cm/tree at the Voinicel variety and 4.50 cm/tree at the Enterprise variety, comparative to the Ionathan variety, at which 3.52 cm/tree were registred.
The crown volumue in the year 5 after planting begin to be uniform, following to the trees

cuttings for crown height and thickness limitation. As compared to the Ionathan variety, taken as witness, the differences are unsignificant at the majority of the varieties. The statistical calculation registers significant positive differences only at the Enterprise and Luca varieties, these being considered vigorous varieties, even if grafted on the graft bearer M9.

Calculated on the surface unit, the crown volume registers values from 6825 mc/Ha at the Voinicel variety – to 11250 mc/Ha at the Enterprise variety.

Lesser vaues of the crown volume were registered at the varieties: Goldrush (6925 mc/Ha), Inedit (7475 mc/Ha) and Saturn (7600 mc/Ha). At the other varieties, the crown volume, calculated on one Hectar, approaches the value of 8800 mc/Ha, registred at the Ionathan variety, taken as witness.

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

Among the appple tree varieties cultivated in the apple tree high density system, the Iris variety, grafted on the graft bearer M9, has the tendency to bear fruits already from the year 2 after planting.

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

From the data presented in table 3, rezults that from the studied apple tree assortement, the Romanian varieties, those early and productive, were: Real (7.5 t/Ha), Inedit (6.5 t/Ha), Iris (6.3 t/Ha), Remar (3.8 t/Ha).

From the foreign varieties, 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 the Ionathan/ M9 variety, taken as witness, we obtained in the year 3 after planting 3.5 t/Ha.

In the year 2010, the year 4 from planting, the medium production of the studied apple tree varieties increased over 4 times, as compared to the last year. The productions registered at the apple tree varieties with genetic resistance to diseases, cultivated in the high density system, were comprised between 10.7 t/Ha at the Rebra variety and 21.9 t/Ha at the Ariwa variety.

Among the Romanian varieties, which produced over 18 t/Ha, we point out: Inedit (18.5 t/Ha), Real (18.8 t/Ha), Remar (19.8 t/Ha), Iris (20.4 t/Ha) - and among the foreign ones: Golden Lasa (19.8 t/Ha), Goldrush (20.8 t/Ha), Saturn (21.6 t/Ha) and Ariwa (21.9 t/Ha). The Ionathan variety, taken as witness, registered in the year 4 from planting a production of 15.8 t/Ha.

In the year 2011, the year 5 from planting, the production was almost double, as compared to the former year. In this year the biggest productions were obtained, reaching over 42 t/Ha at the varieties: Ariwa (42.0 t/Ha), Inedit (42.2 t/Ha), Saturn (42.5 t/Ha). At the other varieties, were registered productions comprised between 28.5 t/Ha and 35.3 t/Ha, comparative to the Ionathan variety, taken as witness, at which 24 t/Ha were registered in the year 5 from planting.

Analyzing the medium production of the years 4 and 5 from planting, we observe that from the 13 apple tree varieties with genetic resistance to diseases, cultivated in the high density system, the most productive are the apple tree varieties: Ariwa, Inedit and Saturn, at which we obtained over 30 t/Ha. Appreciated with high potential are also the apple tree varieties, which registred medium productions of over 24 t/Ha, like: Real (24.05 t/Ha), Golden Lasa (24.60 t/Ha), Voinicel (24.2 t/Ha), Goldrush (25.15 t/Ha), Luca (25.85 t/Ha), Remar (25.9 t/Ha), Iris (26.7 t/Ha). The Ionathan variety, taken as witness, registered as a 2 years average a production of 19.9 t/ha.

The statistically calculated data confirm very significant positive differences, as compared to the Ionathan variety, taken as witness, at the majority of the studied genetic disease-resistant apple tree varieties.

The fruits quality, expressed by size, shows us a rather great amplitude, from 150 g at the Ionathan variety, taken as witness, to 190 g at the Rebra and Remar varieties. The fruits of over 170 g were obtained at the majority of the varieties – and smaller ones at the Goldrush (154 g), Inedit (155 g) and Voinicel and Iris varieties with 155 g, the registered differences being due especially to the genetic factors, respectively to the varieties (table 4).

The medium value of the fruits weight at variety level, in the perioad 2009–2011, shows that the Golden Lasa, Enterprise, Luca, Real, Rebra, Redix, Remar and Saturn varieties 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 varieties frame in the medium fruits group.

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

The apple tree varieties, which were study objects, can cover a great part of the consumption season, besides some of the genetis disease-resistant varieties, muliplied in culture, already known and apreciated on the market by the consumers.

In the table 4, we present the genetic disease-resistant apple tree varieties, which were the study object in the period 2007 – 2011 and the modality how they frame in between the valuable varieties, with genetic resistance to diseases, of the present apple tree assortement.

The majority of the presented varieties are suitable to the cultivation in high density orchards, wich will represent the orchards of the future for the apple tree cultivators.

Depending on the fruits maturation and consumption period, the studied apple tree varieties, which remarked themselves by genetic resistance to diseases, productivity and quality of the fruits, frame in differently into the varietal conveyer for the Dâmboviţa tree growing region.

Table 1. Trunk thickness growth in the year 5 from planting, at the genetic disease-resistant apple tree varieties, cultivated in the high density system (year 2011)

Nr.	Variety/ Graft Bearer	Diameter in the year 5, 2011 (mm)	Medium growth inrease (mm)	Trunk section surface in the year 5, 2011 (cm^2)	Differences ± as to Wt (cm^2)	Significance
1	Ionathan/ M9 (Wt)	39.57	7.25	12.29	-	-
2	Ariwa/ M9	39.31	5.97	12.13	- 0.16	N
3	Golden Lasa/ M9	50.07	8.10	19.68	+ 7.39	***
4	Goldrush/ M9	34.57	4.94	9.38	- 2.91	00
5	Enterprise/ M9	52.53	9.10	21.66	+ 9.37	***
6	Inedit/ M9	42.35	6.50	14.08	+ 1.79	*
7	Iris/ M9	43.00	7.69	14.51	+ 2.22	**
8	Luca/ M9	50.68	9.00	20.16	+ 7.87	***
9	Real/ M9	39.20	6.80	12.06	- 0.23	N
10	Rebra/ M9	46.88	8.72	17.25	+ 4.96	***
11	Redix/ M9	48.18	11.58	18.22	+ 5.93	***
12	Remar/ M9	48.75	10.50	18.66	+ 6.37	***
13	Saturn/ M9	37.70	6.61	11.16	- 1.13	N
14	Voinicel/ M9	45.30	7.65	16.11	+ 3.82	***

DL 5% = 1.51 cm^2; DL 1% = 2.10 cm^2; DL 0.1% = 2.91 cm^2

Table 2. Tree crown dimensions and volume at the studied apple tree varieties in the year 5 from planting (2011)

Nr.	Variety/ Graft Bearer	Tree Dimensions (cm)		Crown Volume (cm)			
		Height	Fruits fence thickness	Per tree	Differences ± as to Wt	Signifi-cance	Per Ha
1	Ionathan/ M9 (Mt)	250	160	3.52	-	-	8800
2	Ariwa/ M9	240	170	3.57	+ 0.05	N	8925
3	Golden Lasa/ M9	270	140	3.36	- 0.16	N	8400
4	Goldrush/ M9	235	135	2.77	- 0.75	N	6925
5	Enterprise/ M9	280	180	4.50	+ 0.98	*	11250
6	Inedit/ M9	260	130	2.99	- 0.53	N	7475
7	Iris/ M9	255	160	3.60	+ 0.08	N	9000
8	Luca/ M9	290	170	4.42	+ 0.90	*	11050
9	Real/ M9	270	150	3.60	+ 0.08	N	9000
10	Rebra/ M9	295	160	4.24	+ 0.72	N	10600
11	Redix/ M9	285	150	3.82	+ 0.30	N	9550
12	Remar/ M9	290	155	4.03	+ 0.51	N	10075
13	Saturn/ M9	240	145	3.04	- 0.48	N	7600
14	Voinicel/ M9	225	140	2.73	- 0.79	N	6825

DL 5% = 0.85 mc; DL 1% = 1.18 mc; DL 0.1% = 1.64 mc

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

Nr.	Variety/ Graft bearer	Production obtained in the year (t/Ha)			Average of the years 4 – 5 (t/Ha)	Differences ± as to Wt	Significance
		3 2009	4 2010	5 2011			
1	Ionathan/M9 (Mt)	3.5	15.8	24.0	19.90	-	
2	Ariwa/M9	5.5	21.9	42.0	31.95	+ 12.05	***
3	Golden Lasa/M9	5.5	19.4	29.8	24.60	+ 4.70	***
4	Goldrush/M9	5.0	20.8	29.5	25.15	+ 5.25	***
5	Enterprise/M9	1.3	12.5	28.5	20.50	+ 0.60	N
6	Inedit/M9	6.5	18.5	42.2	30.35	+ 10.45	***
7	Iris/M9	6.3	20.4	33.0	26.70	+ 6.80	***
8	Luca/M9	2.8	16.4	35.3	25.85	+ 5.95	***
9	Real/M9	7.5	18.8	29.3	24.05	+ 4.15	***
10	Rebra/M9	3.0	10.7	31.0	20.85	+ 0.95	N
11	Redix/M9	2.8	16.6	23.0	19.80	- 0.10	N
12	Remar/M9	3.8	19.8	32.0	25.90	+ 6.00	***
13	Saturn/M9	5.8	21.6	42.5	32.05	+ 12.15	***
14	Voinicel/M9	4.3	18.6	29.8	24.20	+ 4.30	***

DL 5% = 1.80 t/Ha; DL 1% = 2.50 t/Ha; DL 0.1% = 3.47 t/Ha

Table 4. Consumption period of the studied apple varieties, framed into the variety conveyor of the genetic disease-resistant apple tree varieties, cultivated in the influence zone of S.C.D.P. Voineşti

Variety	Month/ decade																										
	VII			VIII			IX			X			XI			XII			I			II			III		
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Romus1(Vf)		•	•																								
Romus3(Vf)				•	•																						
Romus4(Vf)						•	•																				
Irisem (Vf)						•	•																				
Real (Vf)							•	•	•	•	•	•															
Prima (Vf)							•	•	•	•	•	•															
Voinea (Vf)								•	•	•	•	•															
Saturn (Vf)								•	•	•	•	•															
Remar (Vf)								•	•	•	•	•															
Golden Lasa (Vf)								•	•	•	•	•															
Pionier (Vf)								•	•	•	•	•	•	•	•												

Voinicel (Vf)								•	•	•	•	•	•	•											
Iris (Vf)								•	•	•	•	•	•	•											
Ciprian (Vf)								•	•	•	•	•	•	•											
Ariwa (Vf)								•	•	•	•	•	•	•	•	•	•	•	•						
Luca (Vf)								•	•	•	•	•	•	•	•	•	•	•	•						
Rebra (Vf)								•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			
Redix (Vf)								•	•	•	•	•	•	•	•	•	•	•	•	•	•	•			
Inedit (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Enterprise (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Florina (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
Goldrush (Vf)									•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

CONCLUSIONS

The values of the trunk diameter increase, registered in the year 5 from planting, are defining for the differentiation on vigour groups of the genetic disease-resistant apple tree varieties, grafted on the graft bearer M9, thus:

- vigorous varieties, with a trunk diameter of over 50 mm: Golden Lasa (50.07 mm), Luca (50.68 mm), Enterprise (52.53 mm);
- medium vigorous varieties, with a trunk diameter between 40 and 50 mm: Inedit (42.35 mm), Iris (43.00 mm), Voinicel (45.30 mm), Rebra (46.88 mm), Redix (48.18 mm), Remar (48.75 mm);
- weakly vigorous varieties, with a trunk diameter smaller than 40 mm: Goldrush (34.57mm), Saturn (37.70mm), Real (39.20mm), Ariwa (39.31mm).

The crown volume, calculated on the surface unit, follows up the same classification of the varieties vigour, the greatest being registered at the Enterprise variety (11.250 cm/Ha) and the smallest at the Voinicel and Goldrush varieties, with 6.825 cm/Ha, respectively 6.925 cm/Ha.

The highest production potential on the surface unit was realized in the years 4 and 5 from planting at the Ariwa, Inedit and Saturn apple tree varieties, with over 30 t/Ha, but also at the Real, Golden Lasa, Voinicel, Goldrush, Luca, Remar and Iris apple tree varieties, at which we realize between 24.05 t/Ha and 26.7 t/Ha. The bigger fruits, which shall resist the competitional pressures on the market, were obtained by the varieties: Golden Lasa, Enterprise, Luca, Real, Rebra, Redix, Remar and Saturn.

The apple tree varieties, recently homologated at S.C.D.P. Voineşti, and also other studied foreign varieties, cover a great part of the consumption season, besides some genetic disease-resistant varieties already known and appreciated on the market by the consumers – these framing in differently in the conveyor recommended for the Dâmboviţa tree growing region.

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