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# GROWTH AND FRUITING POTENTIAL OF SOME APPLE VARIETIES WITH GENETIC RESISTANCE TO DISEASE, GROWN IN HIGH DENSITY SYSTEM

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***Abstract***

*The research conducted at the Research and Development Station for Fruit Growing Voinesti in the period 2014-2016 highlights the growth potential of apple varieties with genetic resistance to diseases such as: 'Ariwa', 'Golden Lasa', 'Goldrush', 'Enterprise', 'Inedit', 'Iris', 'Luca', 'Real', 'Rebra', 'Redix', 'Remar', 'Saturn', 'Voinicel', all grafted on the M9 dwarfing rootstock. Orchard is defined as high density system with 2,500 trees/ha. The growth vigor of the ten years old trees, when the growth potential is well defined, indicates that between apple varieties with genetic resistance to the diseases under study, were significant differences noticed in the thickness of the trunk, size of the trees and crown volume. The production potential of apple varieties ranged from 28 to 44 t/ha in trees aged of 8-10 years. Most varieties yield over 30 t/ha, considered as apple varieties with high production potential. The level of costs for phytosanitary treatments in apple varieties with genetic resistance to disease is lower with more than 55% compared to the sensitive varieties like 'Jonathan', 'Golden Delicious', 'Starkrimson'.*

***Key words****: Vf resistance, productivity, economic efficiency, environment.*

## INTRODUCTION

Apple's assortment has seen a significant change over the last decades, with varieties dedicated to meet growing consumer demands (Petre et al., 2005). A special situation is the promotion of apple varieties with genetic resistance to diseases, which for the new plantations are the key to the efficient economic technology with immediate effect by the total or partial elimination of the fungicide treatments (Comanescu et al., 2012).

The gradual change of the assortment through the promotion of varieties of apple with genetic resistance to diseases depends on certain characteristics that they can exhibit (Comanescu, 2002). The superiority of new varieties should mainly address the requirements of the producer, oriented to economic efficiency, vigour of growth, high production potential, fruit appearance, consumption period, as well as the taste of the consumer (Petre et al., 2014, 2015).

The important advances made in the research of apple varieties with genetic resistance to diseases at RDSFG Voineşti allowed study of 13 scab resistant varieties behaviour in the orchard, with 'Jonathan', as sensitive to diseases control variety.

## MATERIALS AND METHODS

The research was organized in an apple orchard belonging to RDSFG Voineşti, Experimental Base no. 1, between 2014 and 2016, and highlights the potential for growing and fruiting of the apple varieties with genetic resistance to diseases, representing the main factor in obtaining of an adapted production to the requirements of European quality standards. We have studied 13 varieties with genetic resistance to diseases, namely 'Ariwa', 'Golden Lasa', 'Goldrush', 'Enterprise', 'Inedit', 'Iris', 'Luca', 'Real', 'Rebra', 'Redix', 'Remar', 'Saturn', 'Voinicel' compared to sensitive apple variety 'Jonathan'. All apple varieties were grafted on M 9 rootstocks. The trees were planted in 2007 at a distance of 4 x 1m (2,500 trees / ha), trained as slender spindle (Figure 1).

Figure 1. Experimental field with scab resistant varieties trained as slender spindle

Observations and determinations have been made regarding the growth vigour expressed in in trunk thickness and tree crown size, production record, and average fruit weight.

The orchard's soil is brown eumesobasic, pseudogley, with a pH ranged between 5.7 - 5.9. Humus content is medium in the upper part (2.0 - 2.9%), medium supplied with nitrogen and poorly supplied in phosphorus and potassium.

The climatic conditions were favourable for growing and fruiting of trees, characterized by an average annual temperature higher than $1.9^0$C, with an annual precipitation amount of 755 mm.

In the orchard, natural grass was maintained mowed between the rows and clean along the tree rows. To control pests 6 to 8 treatments were applied only with insecticides.

## RESULTS AND DISCUSSIONS

### Trees Growth

The vegetative growth of trees is determined by a number of biological factors such as variety, rootstock, disease and pest resistance, but also technological: fruit load, optimal provision of technological measures, as well as nutrition and water conditions necessary for the development of the physiological processes.

The vigour of apple varieties trees with genetic resistance to diseases is manifested in quantitative terms by the annually volume of vegetative growth, trunk size, height and size of the tree crown. These parameters are depending on the vigour of the varieties, corroborated with the degree of fertility of the soil, planting distance etc.

According to the diameter of the tree trunk, 10 years after planting, the scab resistance apple varieties grown in a high density system and grafted on the M9 rootstock rank as follows (Table 1):

- vigorous varieties with trunk diameters above 80 mm: 'Luca' (96.18 mm), 'Golden Lasa' (80.40 mm), 'Enterprise' (87.90 mm), 'Rebra' (81.62 mm), 'Redix' (87.23 mm), 'Remar' (85.90 mm);
- medium vigorous varieties, with trunk diameters between 65-80 mm: 'Iris' (67.35 mm), 'Inedit' (70.50 mm), 'Voinicel' (67.60 mm), 'Real' (67.50 mm), 'Ariwa' (68.03 mm);
- low vigour varieties with trunk diameters below 65 mm: 'Saturn' (62.39 mm), 'Goldrush' (55.44 mm).

Table 1. Vegetative growth of apple varieties trees cultivated in high density system (2,500 trees / ha)

| No | Variety / M9 | Diameter (mm) | | Tree size (cm) | | Crown volume | | Dif. |
|---|---|---|---|---|---|---|---|---|
| | | value | Average growth increase | Height | Thickness of the fruiting fence | mc/tree | mc/ha | ± control |
| 1 | Ionathan (control) | 66.38 | 5.79 | 245 | 130 | 2.53 | 6,325 | - |
| 2 | Golden Lasa | 80.40 | 7.17 | 240 | 140 | 2.66 | 6,650 | +325 |
| 3 | Ariwa | 68,03 | 6.35 | 250 | 135 | 2.70 | 6,750 | +425 |
| 4 | Goldrush | 55.44 | 4.74 | 230 | 120 | 2.16 | 5,400 | -925 |
| 5 | Enterprise | 87.90 | 6.57 | 270 | 150 | 3.30 | 8,250 | +1,925 |
| 6 | Inedit | 70.50 | 6.20 | 230 | 120 | 2.16 | 5,400 | -925 |
| 7 | Iris | 67.35 | 6.50 | 205 | 135 | 2.09 | 5,225 | -1,100 |
| 8 | Luca | 96.18 | 8.59 | 270 | 145 | 3.19 | 7,975 | +1,650 |
| 9 | Real | 67.50 | 6.60 | 250 | 130 | 2.60 | 6,500 | +175 |
| 10 | Rebra | 81.62 | 7.43 | 275 | 140 | 3.15 | 7,875 | +1,550 |
| 11 | Redix | 87.23 | 7.53 | 270 | 140 | 3.08 | 7,700 | +1,375 |
| 12 | Remar | 85.90 | 7.80 | 260 | 135 | 2.83 | 7,075 | +750 |
| 13 | Saturn | 62.39 | 4.43 | 230 | 130 | 2.34 | 5,850 | -475 |
| 14 | Voinicel | 67.60 | 5.30 | 230 | 130 | 2.34 | 5,850 | -475 |

The average growth of the trunk, in the 10th year since planting, exceeded 7 mm in the varieties: 'Golden Lasa', 'Luca', 'Rebra', 'Redix' and 'Remar', and below 7 mm varieties such as 'Inedit', 'Iris', 'Ariwa', 'Enterprise', 'Saturn', 'Real', 'Voinicel' and 'Goldrush', which recorded an increase in growth between 4.43 - 6.60 mm.

The tree crown volume provides the skeleton to support the branches, leaves and fruits. Depending on the type of orchard, crown volume differs, both at the tree level and at the surface unit level. Through its structure, the crown's volume must ensure that the light penetrates all the tree elements, a prerequisite for maintaining its garnish with fruit branches to produce as much productive volume as possible.

The volume of the crown depends on the size of the trees, which is influenced to a large extent by the vigour of the variety. Based on the vigour of the trees, the crown volume was calculated at the tree level and at surface unit.

Regarding the crown volume recorded in the 10th year of planting at the tree level, it oscillated with quite large variation between varieties, from 2.09 cm / tree to 'Iris', 'Goldrush' and 'Inedit' variety 2.16 cm / tree, up to 3.30 cm / tree in the 'Enterprise' variety. Larger volumes were remarked at 'Enterprise', 'Luca', 'Ariwa', 'Real', 'Golden Lasa', 'Rebra', 'Remar', 'Redix', with the crown volume on the tree of more than 2.5 cubic meters.

The volume of the crown calculated on the surface unit follows the same grading of varietal vigour, given by the planting density of 2500 trees/ha for all varieties. Thus, the largest crown was recorded in the 'Enterprise' variety - 8,250 mc / ha and the lowest in 'Iris' varieties with 5,225 and 'Goldrush' with Inedit 5,400 mc / ha respectively.

Lower values of the crown volume at the surface unit were also recorded for the apple varieties 'Saturn' and 'Voinicel' with values of 5,850 mc / ha.

In terms of vegetative growth, small and medium-sized varieties are suitable for high-density orchards at 4 x 1 m planting distances with 2,500 trees / ha.

**Trees Productivity**

One of the main goal of the research is the evaluation of apples production capacity, a very strong reason for new modern orchards.

The high productive potential associated with the superior quality of fruit expresses the highest degree of genetically-resembled ability of scab apple varieties in the ecological conditions of the area in which they are grown.

The productivity of apple varieties with genetic disease resistance, which is the subject of this study, is a complex, genetically determined hereditary base from which it originates, but is influenced by the interaction between the variety and the climatic conditions of the area of culture. Other factors contributing to the mapping of this attribute of genetically resistant apple varieties are related to the precocity of the fruit, the type of fructification, the applied technology, the resistance to diseases and pests, the compatibility to grafting and pollination, the density of planting and the rootstock used.

For the correct analysis of the harvest quantity, it was envisaged to record the fruit production each year and to determine the level of production, the self-regulation or the intermittent fructification trend.

The annual record of apple production at the variety level shows that there are differences in production levels.

For the appreciation of the productivity of the varieties, the production recorded in the 8-10 years from planting was taken into account (Table 2).

The yield obtained in the 8th - 10th years from planting show the outstanding performance of the apple-high-density system, which can be expanded into well-established fruit-growing areas, only with the most productive varieties, which give quality fruit adapted to market demands.

In the 8th leaf, the largest productions were recorded for the varieties 'Real', 'Remar', 'Iris', 'Luca', ranging from 38.8 to 46.8 t/ha. Most varieties recorded over 30 t/ha, including Jonathan.

In the 9th year after planting, the highest yields were obtained from 'Ariwa', 'Iris', 'Real', 'Remar' and 'Saturn', ranging from 34 to 38 t/ha. The other varieties recorded yields ranging from 24.7 to 29.5 t/ha, compared to the Jonathan, which was recorded 22.5 t / ha.

Table 2: Production of apple varieties with genetic resistance to diseases, cultivated in a high density system (2,500 trees / ha), in the 8-10 years leaf

| No | Variety | Yield (t/ha) | | | | Dif. ± Control |
|---|---|---|---|---|---|---|
| | | 8th year / 2014 | 9th year / 2015 | 10th year / 2016 | Average | |
| 1 | Ionathan (control) | 30.3 | 22.5 | 24.3 | 25.7 | - |
| 2 | Golden Lasa | 31.3 | 29.0 | 29.8 | 30.0 | + 4.3 |
| 3 | Ariwa | 30,3 | 34.0 | 28.5 | 30.9 | + 5.2 |
| 4 | Goldrush | 36.8 | 24.7 | 28.8 | 30.1 | + 4.4 |
| 5 | Enterprise | 36.5 | 38.2 | 28.5 | 34.4 | + 8.7 |
| 6 | Inedit | 35.6 | 28.7 | 30.3 | 31.5 | + 5.8 |
| 7 | Iris | 46.8 | 38.2 | 48.3 | 44.4 | + 18.7 |
| 8 | Luca | 39.5 | 25.2 | 24.5 | 29.7 | + 4.0 |
| 9 | Real | 38.8 | 35.5 | 29.3 | 34.5 | + 8.8 |
| 10 | Rebra | 28.0 | 25.7 | 30.6 | 28.1 | + 2.4 |
| 11 | Redix | 29.3 | 29.5 | 28.3 | 29.0 | + 3.3 |
| 12 | Remar | 43.5 | 38.5 | 40.3 | 40.8 | + 15.1 |
| 13 | Saturn | 32.8 | 37.2 | 29.3 | 33.1 | + 7.4 |
| 14 | Voinicel | 33.6 | 28.5 | 29.3 | 30.5 | + 4.8 |

In the year 2016 (10th year after planting), the largest production was recorded in the varieties 'Golden Lasa', 'Real', 'Rebra', 'Saturn', 'Voinicel', 'Inedit', 'Iris', 'Remar' ranging from 29.3 to 48.3 t/ha. In the other varieties, yields ranging from 24.5 to 28.8 t/ha were recorded, compared to the variety Jonathan, which was registered in 10th year of planting 24.3 t/ha.

Analysing the average of the yields obtained in the three years of study, the yields of the varieties: 'Real' (34.5 t/ha), 'Saturn' (33.1 t/ha), 'Enterprise' (34.4 t/ha), 'Remar' (40.8 t/ha) and 'Iris' (44.4 t/ha). Most varieties have produced over 30 t/ha, being included as branded varieties with high production potential.

**Production quality**

Apples for fresh consumption or for processing must be healthy, ripen for commercial or consumption purposes and to have organoleptic properties specific to the variety. In order to sell apples at higher prices, they must be at market-standardized levels and maintain their quality after harvesting and during storage and delivery time.

The quality of the fruits is a genetic trait influenced by the variety, the degree of maturation, the action of the environmental factors, as well as of the technological factors. The effects of the interaction of these factors materialize by obtaining fruits with special qualities or they can be negatively influenced.

Low-vigour vegetative rootstocks significantly contribute to the enhancement of apple quality if the varieties grown under appropriate ecological conditions and some technological performance measures are applied.

**Fruit Quality Parameters**

Average weight and size are important elements in assessing the commercial quality of fruits. These are characteristics of the variety and can be influenced to a greater or lesser extent by the amount of production, the age of the tree, the applied crop technology and the climatic conditions of the year.

The interest in obtaining large fruit with high commercial value is one of the major objectives in the pomological appreciation of the variety. It is known that in European standards, apple size is far superior to that obtained in Romania. Under these circumstances, we must be demanding to choose varieties to promote them in commercial crops and to apply appropriate technology to achieve this goal.

The size of the fruit, combined with an intense and uniform colour (red or golden type) and a symmetrical shape, gives the fruit the appearance and attractiveness required. The study of apple varieties with genetic resistance to diseases grown in high density system reveals a genetic variability in fruit size. A fruit size variability among the varieties studied was found.

It is appreciated that an average fruit size of 170 - 180 g is appropriate for a modern apple variety. Most apple varieties in the study have a fruit size that corresponds to and competes with modern varieties, to the extent that varieties of genetic scab resistance grown in a high density system are promoted in culture in order to

obtain some organic production, increasingly demanded by consumers.

The size of the fruit in the 9th year after planting had fairly large amplitude, from 140 g to 'Ariwa', 'Inedit', 'Saturn', to 180 g in the 'Real' variety. Fruit over 160 g were obtained in the varieties 'Enterprise', 'Luca', 'Rebra', 'Redix', 'Remar' and smaller in the varieties 'Goldrush', 'Inedit', 'Iris', 'Ariwa', 'Golden Lasa', 'Saturn' and 'Voinicel', with 140 - 155 g; the differences are due to the genetic factors, respectively the varieties (Table 3).

Table 3: Fruits quality parameters, from apple scab resistant varieties at the harvest date (2015 - 2016)

| No | Variety | Fruit weight (g) | | Flesh firmness (kgf/cm$^2$) | | Dry substance (%) | |
|---|---|---|---|---|---|---|---|
| | | 2015 | 2016 | 2015 | 2016 | 2015 | 2016 |
| 1 | Ionathan | 145 | 148 | 7.6 | 8.2 | 14.2 | 14.6 |
| 2 | Golden Lasa | 145 | 165 | 10.6 | 10.2 | 13.8 | 15.8 |
| 3 | Ariwa | 140 | 155 | 10.2 | 10.5 | 13.8 | 15.2 |
| 4 | Goldrush | 145 | 148 | 11.4 | 10.8 | 14.1 | 15.0 |
| 5 | Enterprise | 175 | 165 | 9.8 | 10.7 | 14.0 | 15.9 |
| 6 | Inedit | 140 | 158 | 7.4 | 8.2 | 14.2 | 16.0 |
| 7 | Iris | 145 | 153 | 7.8 | 7.2 | 13.8 | 13.6 |
| 8 | Luca | 160 | 162 | 10.8 | 8.7 | 15.2 | 15.7 |
| 9 | Real | 180 | 175 | 9.6 | 10.2 | 13.5 | 13.0 |
| 10 | Rebra/M9 | 170 | 171 | 9.1 | 8.1 | 14.1 | 13.4 |
| 11 | Redix | 175 | 165 | 10.2 | 8.6 | 14.1 | 15.5 |
| 12 | Remar | 165 | 172 | 8.8 | 8.6 | 14.0 | 13.8 |
| 13 | Saturn | 140 | 160 | 9.4 | 9.0 | 15.4 | 15.5 |
| 14 | Voinicel | 145 | 155 | 7.0 | 7.5 | 14.2 | 14.7 |

In the 10th leaf, the fruit biomass oscillated from 148 grams at the 'Goldrush' variety (figure 2) and 175 grams at the 'Real' variety. Fruit with biomass over 160 g was obtained in most of the varieties with genetic resistance to the diseases studied: 'Golden Lasa', 'Enterprise', 'Redix' with 165 g, 'Rebra', 'Remar', 'Real' with biomass fruits ranging from 171 to 175 g. The smallest fruits were recorded in the 'Goldrush', 'Iris' and 'Voinicel' varieties with biomass ranging from 148 to 155g.

Figure 2. 'Goldrush' fruit size in overloaded trees

The average value of fruit variety at the level of the variety shows that the varieties 'Enterprise', 'Luca', 'Real', 'Rebra', 'Redix' and 'Remar' have the potential to ensure the large size of the fruit to compete on the market, and the other varieties fall into the middle fruit size group.

The firmness of the fruit pulp is considered to be appropriate when it is compact, crisp or fine, with uniform colouring. A poor firmness is considered to be inappropriate, and is generally found in over-ripen fruits. Also, a rough, coarse consistency with glassy areas is considered negative.

Under the conditions of 2015, the firmness of the fruit pulp at harvest time ranged from 7.0 kgf/cm$^2$ to the 'Voinicel' variety and 11.4 kgf/cm$^2$ in the 'Goldrush' variety.

From the data recorded in 2015, it appears that there are varieties producing firm fruit such as: 'Goldrush', 'Ariwa', 'Golden Lasa', 'Enterprise', 'Luca', 'Real', 'Rebra', 'Saturn', 'Redix' and 'Remar', with average penetration resistance of 8.60 kgf/cm$^2$ and 11.4 kgf/cm$^2$ and varieties such as 'Voinicel', 'Inedit', 'Iris' and 'Jonathan' as control, whose average fruit penetration resistance is much lower than 7 - 7.8 kgf/cm$^2$.

In 2016 the firmness of the pulp was between 7.2 kgf/cm$^2$ in the 'Iris' variety and 10.8 kgf/cm$^2$ in the 'Goldrush' variety.

The dry matter content of apple varieties with genetic resistance to disease in the years 2015-2016 was 13.0 - 13.5% for 'Real' apple variety, being the earliest variety with a dry matter content of 13,4 - 16,0%. For the other varieties, dry matter content accumulated according to the variety and the ripening period of the fruits.

**Varietal conveyer of scab apple varieties**

Studies and research undertaken at RDSFG Voineşti presents for apple growers, especially for those who promote modern apple culture systems, a group of varieties with different maturation ages covering a long period of consumption with apples of resistant varieties.

Now, the basic range includes the varieties with genetic resistance to diseases: 'Romus1', 'Romus 3', 'Romus 4', 'Prima', 'Pionier', 'Voinea', 'Ciprian', 'Florina' which are propagated in the fruit trees nurseries in the country. Some of the varieties mentioned, even if they currently meet the requirements of fruit resistance, productivity and quality, can be replaced as new varieties become more valuable, both in terms of production and quality of fruit.

The apple varieties that have been studied can cover much better the consumer season, along with some genetically scab resistant varieties already known and appreciated on the market by consumers.

Table 4 indicate scab apple varieties that were the subject of the study during the period 2014 - 2016 and the way they fit among the valuable varieties with genetic resistance to diseases from the current apple assortment.

Most of the varieties presented are suitable for growing in high-density orchards that will represent future orchards for apple growers.

Depending on the period of maturation and consumption of fruits, the apple varieties studied, which have been distinguished by genetic resistance to disease, productivity and quality of fruit, fall differently in the variety conveyor for Dâmboviţa fruit area.

Thus, according to the varieties of apple 'Romus 1', 'Romus 3', 'Romus 4', 'Irisem', the 'Real' variety can be introduced, thanks to appetizing fruits, ripen in the last decade of August - first decade of September.

The varieties of apple such as 'Saturn', 'Remar', 'Golden Lasa' fall between the varieties 'Voinea' and 'Pionier' with the goal of replacing 'Voinea' variety by 'Remar' because of his superior qualities, taste and fruit coloring.

Table 4: The apple varieties consumption period, in the frame of the scab resistant apple varietal conveyer, cultivated in the Voinesti area

| 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) | | | | | | | | | | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • | • |

Also for autumn fresh consumption, the 'Iris' and 'Voinicel' varieties can be up-scaled, and multiplied along with the 'Pionier' variety, which should be replaced.
The 'Ariwa', 'Luca', 'Rebra' and 'Redix' varieties fill up the consumption period that extends until January and February.
The varieties 'Inedit', 'Enterprise' and 'Goldrush' exceed Florina's consumption period.

**Economic and environmental impact by promoting scab resistant apple varieties**

Apple's cultivar assortment is very dynamic due to a competitive market. Is very important to stay economic efficient and therefore, total or partial elimination of the fungicide treatments has a significant role in it.
It can be appreciated that the orientation towards apple varieties with genetic resistance to diseases will gradually be imposed also in high density orchards, not only for the economic efficiency, but also for obtaining ecological productions.
By promoting the cultivation of apple varieties with genetic resistance to diseases adapted to the ecological conditions in our country, we increase the quantity of apples on the market with low pesticide levels, with beneficial influences on the consumers and the environment too.
Due to the reduction of the number of phytosanitary treatments and the quantities of pesticides, the costs are reduced by more than 55%.
The research and development center for fruit growing in Voinesti has been and remains the promoter of the disease-resistant assortment and the high-density apple-tree system in our country.
The economic and environmental effects are highlighted by the costs of phytosanitary treatments per one hectare of orchard.
From the data presented in Table 5, it results that between the two cultivated varieties there are significant differences in the total number of warnings requested during the vegetation period, the quantities of pesticides, the consumption of diesel fuel and the related costs.
Thus, in the orchard with sensitive varieties in the years 2014 - 2016 it was performed 14 sprays; while in the orchard with resistant varieties only 7. The savings made in the orchard with resistant varieties, by the elimination of fungicides in the proportion of 90% and 81% reduction in insecticides and acaricides, represents 66% of susceptible varieties, which means that in orchards with resistant varieties apply 50% fewer sprays and their value is 2 times lower than orchards with a classically sensitive range. Diesel fuel consumption is reduced by 53%.

Table 5. Economic efficiency of some scab resistant apples varieties vs susceptible varieties (2014 - 2016)

| Item | Susceptible varieties | Scab resistant varieties | Economic effect (%) |
|---|---|---|---|
| No of sprays | 14 | 7 | 50 |
| Insect-fungicide consumption (kg,l): | 122 | 54 | 56 |
| - fungicide (kg,l) | 63 | 6 | 90 |
| - insecticide – acaricide (kg,l) | 59 | 48 | 81 |
| Costs (ron): | 11808 | 4464 | 62 |
| - phytosanitary products | 8400 | 2856 | 66 |
| - labour | 1200 | 600 | 50 |
| - mechanic works | 2208 | 1008 | 54 |
| Diesel consumption (l) | 90 | 42 | 53 |
| - value (lei) | 540 | 252 | 53 |

In addition to the beneficial economic effects, we must add pollution reduction, faster recovery of predators and natural parasites, and maintaining the quality standard of fruit.

## CONCLUSIONS

Depending on the diameter of the trunk of the trees, the scab resistant varieties were grouped as follows:

- vigorous varieties: 'Luca', 'Golden Lasa', 'Enterprise', 'Rebra', 'Redix', 'Remar';
- medium-vigorous varieties: 'Iris', 'Inedit', 'Voinicel', 'Real', 'Ariwa';
- small vigorous: 'Saturn', 'Goldrush'.

The volume of the tree crown recorded in the 10$^{th}$ year since planting indicate 'Iris', 'Goldrush' and 'Inedit' as less vigorous varieties than 'Enterprise' variety.
The volume of crown calculated per unit area oscillated between 5,100 cubic meters/ha for 'Goldrush' and 'Inedit' varieties, up to 8,250 mc/ha in the 'Enterprise' variety.

Varieties with small vegetative growth are suitable for expansion in high-density orchards at distances of 4 x 1 m at a density of 2,500 trees / ha.

The highest yield was achieved by 'Real' 'Saturn', 'Enterprise', 'Remar' and 'Iris'

The size of the fruit was influenced by the size of the crop load with fairly large amplitude, from 148 g ('Goldrush') to 175 g ('Real' variety).

'Goldrush', 'Ariwa', 'Golden Lasa', 'Enterprise', 'Luca', 'Real', 'Rebra', 'Saturn', 'Redix' and 'Remar' varieties produce firm fruits with average penetration resistance between 8.60 and 10.8 kgf/cm$^2$.

The lowest content in dry substance was recorded in the 'Real' variety.

The high-density apple system with genetically resistant varieties is recommended for fruit-growing areas in our country due to the high economic efficiency and continuously need for better cultivars.

The elimination of fungicidal products and use of highly selective insecticides, correlated with the quality and productivity of new resistant varieties, support the environmental effects.

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