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# GROWING OF APPLE GENOTYPES WITH GENETIC RESISTANCE TO DISEASES - AN EFFICIENT METHOD TO MITIGATE PESTICIDE POLLUTION IN THE VOINEȘTI APPLE GROWING AREA

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***Abstract***

*The aim of this study is to provide information on genetically diseases-resistant varieties of apple inbred at Voinești station and their behaviour under reduced number of phytosanitary treatments. The evolution of two harmful pathogens attack (apple scab and powdery mildew) on two common varieties, nine Romanian varieties and three foreign varieties was monitored in untreated control samples, samples treated following specific scheme and samples with no specific fungicides. The degree of attack and the effectiveness of the treatments were calculated. Assessments have shown that the classic varieties Ionathan and Golden Delicious had a high sensitivity to diseases in the climatic conditions of 2020. Romanian apple varieties proved total resistance to scab (100%) and very low susceptibility to powdery mildew (0.26-4.54%) so that a limited number of fungicidal treatments are needed. Their yields were at high level of quality and quantity, ranging from 24 to 36.7 tons/ha. The result of the growing of genetically diseases-resistant varieties is that pollution is mitigated and increased fruit production is achieved.*

***Key words****: apple diseases, effectiveness, resistance, treatments, yield.*

## INTRODUCTION

Fruit growing, considering the diversity of species cultivated almost all over the world, is an important branch of agriculture by reason of its occupied area, ecological plasticity, and the nutritional importance of fruits. At the same time, it ensures the development of related economic fields (production of pesticides and fertilizers, manufacture of agricultural machinery and tools, employment and maintenance in rural areas, fruit trade, etc.). Practiced at high technological parameters, it can provide significant income to farmers. The apple (*Malus domestica* Borkh) is one of the oldest fruit species and ancient Roman and Greek historians have offered extensive descriptions (Jaloba et al., 2019). Apples have an energy value that sometimes reaches and exceeds 85 calories per 100 g (Chira & Pasca, 2004), and their content in aromatic and nutritious compounds gives them both nutritional and therapeutic value. Its high ecological plasticity, adaptability to different climatic conditions make it possible to grow apples from the plains to the mountain areas on any continent, except the Arctic. Due to this fact and the role played in human nutrition, the apple provides, along with bananas and citrus fruits, 2/3 of world fruit production (Popescu et al., 1982). The apple is very well adapted to the temperate climate whose extremes endures much better than other fruit tree species (Hoza, 2000). Soil and climatic conditions in Romania are very favourable for obtaining high quality apple productions as apple ranks second after plum, both in terms of production and area (Ghena & Braniste, 2003). A significant number of pathogens may cause large qualitative and quantitative losses in apple orchards and warehouses (Cociu et al., 1999). In the Voinești area, the most harmful are scab (*Venturia inaequalis*) and powdery mildew (*Podosphaera leucotricha*), which makes it mandatory to apply phytosanitary treatments. The reason is the long-lasting monoculture and the climatic conditions specific to the area, too, which makes it possible the existence of a significant amount of inoculum in the area (Jaloba et al., 2019). The cost of the treatments is very high and represents approximately 50% of the maintenance costs and their non-application can lead to the loss of the yield both quantitatively and qualitatively (Chira & Pasca, 2004). On the other hand, the damages generated by the attack of pathogens and pests represent over 50% of the harvest, sometimes when no treatments are applied, the production being completely compromised (Ghena & Braniste, 2003). At the same time, chemical treatments are absolutely necessary (Baicu & Sesan, 1996), especially for sensitive varieties and in wetlands. For example, in the UK, current control of scab and mildew of apple requires the routine application of fungicides at 7-14-day intervals to achieve the blemish-free fruit required by the market. Such practices are generally effective, but with increased public concern about pesticides and rising costs to the grower, they are now less acceptable (Berrie & Xu, 2003).

The **scab** caused by the pathogen *V. inaequalis* is found in all areas where there are apple orchards (personally I saw apple attacked by scab in the extreme southeast of the country, too, in Lipnita village, CT county). Scab is important in areas of rain-fed agriculture throughout the world and must be controlled to produce marketable fruit on susceptible varieties (Aylor, 1998). The pathogen infects all the green organs of the tree, leaves, shoots, fruits. On both sides of the leaf surface appear small, gray spots with radial development (Gheorghies & Geaman, 2003). The attack causes exfoliation of shoots and branches and changes in tissues, which at strong infections, endanger the life of the tree itself (Dulugeac, 2011). The attacked fruits have gray-olive spots on which the tissue turns brown and cracks (Tomsa & Tomsa, 2003). Economic losses can be compounded by secondary rotting pathogens that enter these wounds and further destroy the apples (Aylor, 1998). The commercial aspect is damaged, the fruits become unfit for sale. The disease is favored by high atmospheric humidity, heavy rains, steam-saturated atmosphere and a temperature of 18°C, at which ascospores produce infections in 9-18 days, after an incubation period of 8 days. The primary infection is favored by high humidity that persists for 30 hours at 6°C (12 hours at 11°C or 9 hours at 25°C) (Gheorghies & Geaman, 2003). Secondary infections occur if plant parts are moistened for 4 to 18 hours at temperatures between 15 and 25°C (optimally at 19-20°C) (Baicu & Sesan, 1996).

*V. inaequalis* overwinters predominantly as pseudothecia (sexual fruiting bodies) that develop in apple leaf litter following a phase of saprobic growth after leaf abscission. Some overwintering may also occur as conidial pustules on shoots and bud scales without the involvement of the teleomorph (Becker et al., 1992; Holb et al., 2006; Holb, 2006). Infection is initiated in spring and early summer by ascospores (sexual spores) that are released by rainfall from pseudothecia. This release is timed to coincide with host budburst and leaf unfurling (Szkolnik, 1969; Brook, 1976; MacHardy & Gadoury, 1986.). Infection risk is greatest early in the growing season when leaves and fruit are young and at their most susceptible (Bowen et al., 2011).

**Powdery mildew** is also a disease found in all fruit growing areas and can cause significant damage to susceptible varieties (Ionathan, James Grives, Ionared). Its importance results from the fact that it can start very early, from the bud burst and can manifest throughout the growing season (Gheorghies & Geaman 2003; Dulugeac, 2011). The attack can be manifested on leaves, shoots, flowers and less often on fruits. The young leaves are most susceptible to attack.When young leaves are infected, they tend to increase in length but not in width, to be stunted, and to become folded longitudinally (Anderson, 1956). Infected leaves initially show white lesions on the adaxial surface and chlorotic patches on the abaxial surface. Infected leaves tend to crinkle and curl, turn brown and drop prematurely (Turechek et al., 2005). Severely infected terminals have shortened internodes, and are covered with a silver-gray mycelium. The grayish white fungal growth turns brown, any many dark brown fruiting bodies appear (Hickey & Yoder, 1990; Gheorghies & Geaman, 2003). The attack on young fruits, caused by secondary infection, can lead to their drying and falling, but they often result in the appearance of a brown network of suberified tissue, very obvious after the fruit has developed (Gheorghies & Geaman, 2003). Infected plants are characterized by reduced photosynthesis and transpiration, resulting in suboptimal carbohydrate assimilation and reduced growth (Ellis et al., 1981). In nureseries, the fungus can spread to all developing leaves and cause severe stunting of vegetative terminal shoot (Hickey & Yoder, 1990). Mycelium overwintering in dormant buds normally initiates primary infection on young leaves, which produce inoculum in the form of conidia for the secondary cycles (Urbanietz & Duneman, 2005). The fungus typically overwinters in vegetative buds. In the early spring, the fungus resumes growth, and spores from infected shoots can initiate secondary infections (Turechek et al., 2005). Secondary infections may occur on newly forming flower buds, which will remain dormant until the following spring. Since these buds will be diseased when they open, severe infection can eliminate the crop the following season (Marine et al., 2010). The fungus survives the winter in buds, making it difficult to control during the early spring development of apple trees. First sprays against powdery mildew can only be effective after bud burst when budscales open and overwintered mildew mycelia become available for fungicides (Holb, 2014). Perennating in buds, it makes it difficult to control and, although it can cause fruit russet, it primarily causes losses due to its chronic effect on tree vigor and yield (Biggs et al., 2009).

## MATERIALS AND METHODS

The aim of this paper was to monitor the behaviour towards the main diseases of some apple varieties created at the Research and Development Station for Fruit Growing Voineşti in comparison with two well-known classic varieties, as well as their yield.

The research was carried out between March and October 2020. The climatic conditions of the area are favorable for apple growing, with an average annual temperature of 8.8°C and an average annual rainfall exceeding 750 mm. The soil is brown-eumezobasic, weakly pseudogleized, loamy texture, weakly acidic pH (5.6-6). The humus content is medium at the surface: 2.15-3.25. Two classic varieties were tested (Ionathan and Golden Delicious, 17-year-old orchards), apple varieties with genetic resistance to diseases created at S.C.D.P. Voineşti, between 2004 - 2009 (Real, Revidar, Remar, Voinicel, Cezar, Iris, Inedit, Valery, Redix) and 3 varieties from abroad (Rubinola, Goldrush, Topaz). The trial was conducted using the randomized complete block method in four repetitions. Each plot had 5 trees. For the classic varieties (Ionathan and Golden Delicious) taken as a control, four untreated plots were included, and for the rest of the orchard a scheme of 14 treatments with fungicides, insecticides and foliar fertilizers was applied, as shown in table 1. Varieties with genetic resistance have not been treated with fungicides for scab and powdery mildew. Assessments made 10 to 12 days after each treatment focused on the evolution of the pathogens *V. inaequalis* (scab) and *P. leucotricha* (powdery mildew).

Thus, a comparative study was made between the apple varieties with genetic resistance to diseases created at SCDP Voinești and the apple varieties from abroad, tested in the orchard, in conditions of reduced number of treatments, cultivated in high density plantations, regarding the reaction to the attack of the two pathogens, in order to identify the optimal assortment for this region in the conditions of a technology as clean as possible.

50 leaves per tree and 30 fruits per three trees in the middle of each plot were assessed. Assessments were made on the frequency (F %) and the intensity (I %) of pathogen attack and the degree of attack (DA %) and efficacy (E %) were calculated. The degree of attack was calculated using the formula: F % x I %/100. The efficacy of fungicide was calculated according to Abbott`s formula: (degree of attack in untreated control - degree of attack in treated plot)/ degree of attack in untreated control x 100. All data were subjected to statistical analysis provided by ARM-9 software. At harvest time, the yield/tree was also recorded by weighing all the fruits per tree. The application equipment was a mist blower Solo 423 atomizer. The planting distance for Ionathan and Golden Delicious

varieties is 4 meters between rows and 3 meters between trees within a row. (833 trees/ha) The shape of the crown is palmette with oblique arms. For the varieties with genetic resistance to diseases, the trees were planted at a distance of 3.5 x 1 m (2,857 trees/ha), being grafted on M9 rootstock, with the shape of a spindle crown. In 2020, the trees have reached the age of 11 years.

Table 1. Schedule of phytosanitary treatments performed on apples to prevent and control diseases and pests (Mix tank 1500 l/ha)

| No. crt. | Stage (Season) | Disease or/and pest | Recommended commercial products and rates | | | |
|---|---|---|---|---|---|---|
| | | | Sensitive varieties | | Resistant varieties | |
| | | | Products | Conc. % | Products | Conc. % |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | Bud swelling | San José scale, moths eggs, aphids, mites, etc. | Chemol 90 EL | 1.5 | Chemol 90 EL | 1.5 |
| 2 | Bud break | Apple blossom weevil<br>Powdery mildew | Novadim Progress<br>Kumulus DF (Polisulf tip MIF) | 0.1<br>0.1<br>(0.2) | | |
| 3 | Leaves unfolded | Fireblight<br>Scab, powdery mildew<br>Mites | Bouillie Bordelaise WDG<br>(Topsin 70 WDG + Merpan 80)<br>Novadim progres | 0.5<br>(0.07, 0.15)<br>0.1 | | |
| 4 | Beginning of flowering: about 10% of flowers open | Scab, powdery mildew<br>Fireblight<br>Leafminers, defoliators, aphids | Chorus 50 + (Score 250 EC)<br>Merpan 80 WDG<br>Aliette 80 WG<br>Insegar 25 WG<br>Foliar fertilizer | 0.05<br>(0.02)<br>0.15<br>0.3<br>0.03<br>0.2 | Aliette 80 WG<br>Insegar 25 WG<br>Foliar | 0.3<br>0.03<br>0.2 |
| 5 | Flowers fading: majority of petals fallen | Scab, powdery mildew<br>Leafminers, defoliators | Score 250 EC +<br>Dithane M 45<br>Mavrik 2 F<br>Foliar NPK | 0.02<br>0.2<br>0.05<br>0.5 | Mavrik 2 F<br>Foliar NPK | 0.05<br>0.5 |
| 6 | Fruit size up to 10 mm | Scab, powdery mildew<br>Leafminers, defoliators, aphids | Sercadis<br>(Embrelia)<br>Merpan 80 WDG<br>Actara 25 WG | 0.015<br>(0.1)<br>0.15<br>0.01 | Actara 25 WG | 0.01 |
| 7 | Fruit diameter up to 40 mm | Identical to treatment 6 + Codling moth | Luna Experience 400 SC+<br>Dithane M 45<br>Novadim Progress<br>Foliar - Calcibor | 0.05<br>0.2<br>0.1<br>0.2 | Novadim Progress<br>Foliar - Calcibor | 0.1<br>0.2 |
| 8 | Fruit about half final size | Identical to treatment 6 + Codling moth | Sercadis<br>Delan Pro<br>Actara 25 WG | 0.015<br>0.16<br>0.01 | | |
| 9-10 | Fruit about 70% final size | San José scale<br>Scab, powdery mildew<br>Apple woolly aphid | Luna Experience 400 SC +<br>Dithane M 45<br>Mospilan 20 SG | 0.05<br>0.2<br>0.025 | Mospilan 20 SG | 0.025 |
| 11 | Fruit about 90% final size | Scab, powdery mildew<br>San José scale<br>Mites | Topsin 70 WDG<br>Dithane M 45<br>Proteus OD 110 | 0.1<br>0.2<br>0.05 | | |
| 12-13 | Beginning of ripening | Scab, powdery mildew<br>Codling moth ($G_2$) | Topsin 70 WDG<br>Merpan 80 WDG<br>Nurelle D 500 EC | 0.1<br>0.15<br>0.1 | Nurelle D 500 EC | 0.1 |
| 14 | Advanced ripening | Scab, powdery mildew<br>Storage diseases<br>Codling moth, mites<br>Reticulated tortrix | Bellis<br>Mospilan 20 SG<br>Foliar Calcitek | 0.05<br>0.025<br>0.2 | Mospilan 20 SG<br>Foliar Calcitek | 0.025<br>0.2 |
| | TOTAL TREATMENTS | | 14 | | 8 | |

- Sensitive varieties: Amount of pesticides = 101.6 kg (l)
- Resistant varieties: Amount of pesticides = 49.4 kg (l) Represents 48.6%

The soil maintenance system includes strips between trees within a row clean of weeds alternating with temporarily grassed strips (1 - 3 years) between rows of trees that have been maintained by 3 passes with the lawn mower during the growing season. During the vegetative rest, the autumn plowing was carried out at a depth of 20 cm. The pruning was carried out in early spring, before the beginning of the vegetation.

## RESULTS AND DISCUSSIONS

### Weather conditions

In the Voinești area, the average annual (normal) temperature is 8.8°C, specific to the hill areas, but optimal for trees growing, especially for apple. The amount of average multiannual precipitation is 782 mm, but in recent decades there has been a rainfall deficit in August-September, when the requirements for fruit growing are increasing, requiring irrigation of trees. The vegetation period covers about 180 days, from April 1-10 to October 1-10.

In the research year 2020, the weather conditions were quite atypical compared to the average of the region. The weather data are summarized in Table 3. It is noted that in May, June and July were recorded the largest amounts of precipitation (61.3 mm, 119.6 mm and 77.2 mm) and that April was very dry (11.2 mm).

### Behaviour of apple varieties against the attack of scab andpowdery mildew

The reaction of apple varieties in the agro-climatic conditions of 2020 was different, especially in terms of the attack of powdery mildew.

The values of temperature and humidity facilitated the spread of the two diseases and the fact that only 8 treaments were applied to the control sample, mainly with insecticides, determined the massive existence of the infection.

Thus, on the leaves, the Ionathan variety registered a degree of attack of 50.85% for scab (which makes it medium resistant to weakly resistant) and 64% for powdery mildew (sensitive). The Golden Delicious variety proved to be very sensitive to rape (degree of attack 63.25%) and quite sensitive to powdery mildew (degree of attack 25.38%).

The scab attack (Figure 1) occured from spring to autumn through isolated or confluent spots on both sides of the leaves, having a gray color and indefinite edges. In their center could be seen a central point, darker coloured, developed subcutically. After a while, the spots became olive-green or brown, due to the appearance of the fruiting bodies of the fungus (Severin et al., 2001). The symptoms on the fruit were in the form of spots similar to those on the leaves, circular, brownish-black, with a diameter of 5-10 mm. Young, intensely attacked fruits were also noted, which remained underdeveloped and cracked near the spots.

Figure 1. Scab on Ionathan leaves (original)

Table 2. Behaviour of apple varieties studied against the attack of scab and powdery mildew on leaves

| No. crt | Variety | Degree of atack (%) | |
|---|---|---|---|
| | | Scab | P. mildew |
| **I. Control varieties** | | | |
| 1. | Ionathan | 50.85b | 64a |
| 2. | Golden Delicious | 63.25a | 25.38b |
| **II. Varieties inbred at SCDP Voinești** | | | |
| 1 | Real | 0.0c | 4.54c |
| 2 | Revidar | 0.0c | 0.0e |
| 3 | Remar | 0.0c | 2.16cde |
| 4 | Voinicel | 0.0c | 0.6de |
| 5 | Cezar | 0.0c | 0.0e |
| 6 | Iris | 0.0c | 4.2c |
| 7 | Inedit | 0.0c | 0.72de |
| 8 | Valery | 0.0c | 2.36cde |
| 9 | Redix | 0.0c | 0.36de |
| **III. Varieties from abroad** | | | |
| 1 | Rubinola | 0.0c | 2.8cde |
| 2 | Goldrush | 0.0c | 0.6de |
| 3 | Topaz | 0.0c | 3.6cd |
| LSD P = .05 | | 3.592 | 2.053 |
| Standard Deviation | | 2.511 | 1.436 |

The attack of powdery mildew produced the first symptoms on the young leaves, which in the strongly attacked varieties were covered by white powder, then yellowish, formed by the mycelium and conidiophores with conidias of the pathogen. Over time, the leaves remained small, narrow, thickened and twisted towards the upper face, taking on the appearance of a little boat (Figure 2).

Figure 2. Powdery mildew on Ionathan leaves (original)

Many of them became breakable and fell early. On the fruit, the attack generated the appearance of a brown network of suberified tissue, very visible when harvesting the fruit. The results are shown in Tables 2 and 4.

Assessing the behaviour of genetically resistant varieties to diseases against powdery mildew, it was found the manifestation of a slight sensitivity differentiated from variety to variety. The values of the degree of attack are insignificant compared to the attack recorded on the variety Ionathan (64%), known as standard of sensitivity to powdery mildew.

Table 3. Precipitation and temperature during 2020 growing vegetation season

| | Month | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Apr | May | June | July | Aug. | Sept | Oct | |
| Periods | The growing season 2020: Precipitation (mm) for 10-day periods | | | | | | | Sum |
| 1-10 | 0 | 29.7 | 21.1 | 22.5 | 0 | 49.5 | 43.8 | 166.6 |
| 11-20 | 11.4 | 0.6 | 91.4 | 54.7 | 14.1 | 0 | 9.1 | 181.3 |
| 21-30 | 1 | 31 | 7.1 | 0 | 0.2 | 2.7 | 5 | 47 |
| Sum | 12.4 | 61.3 | 119.6 | 77.2 | 14.3 | 52.2 | 57.9 | 394.9 |
| | The growing season 2020: Mean min. air (°C) for 10-day periods | | | | | | | Mean |
| 1-10 | -0.2 | 7.2 | 10.7 | 16.5 | 17.4 | 13.9 | 12.4 | 11.12 |
| 11-20 | 2.6 | 11.4 | 15.6 | 13.3 | 15.3 | 12.3 | 6.6 | 11.01 |
| 21-30 | 3.3 | 7.8 | 14.9 | 16.7 | 15.6 | 10.2 | 6.3 | 10.68 |
| Mean | 1.9 | 8.8 | 13.73 | 15.5 | 16.1 | 12.3 | 8.43 | 10.93 |
| | The growing season 2020: Mean max. air (°C) for 10-day periods | | | | | | | Mean |
| 1-10 | 17.7 | 22.4 | 25.9 | 31 | 32.5 | 30.1 | 24.1 | 26.24 |
| 11-20 | 21.2 | 25.6 | 27.5 | 29.47 | 30.8 | 28.3 | 20.2 | 26.14 |
| 21-30 | 22.1 | 20.8 | 29.8 | 32.6 | 33.5 | 26 | 17.5 | 26.04 |
| Mean | 20.33 | 22.93 | 27.73 | 31.00 | 32.27 | 28.13 | 20.60 | 26.14 |

On fruits, the DA% values in scab were between 12.3% in Ionathan and 15.49% in Golden Delicious. In powdery mildew, DA% in the control varieties had values of 20.6% in Ionathan and 7.14% in Golden Delicious. These values made the fruit look damaged, crusty and rough, with no commercial value. They are also susceptible to be attacked by other pathogens such as moniliosis (Chitulescu & Cristea, 2017a; 2017b; Cristea et al., 2017) and do not resist during storage.

Under these conditions, in all studied varieties, the scab infection was non-existent, they showed maximum resistance on both leaves and fruits (Figure 3).

In contrast, in the case of *P. leucotricha* infection, some varieties showed some sensitivity to leaf attack (Real 4.54%, Remar 2.16%, Iris 4.2%, Valery 2.36%, Rubinola 2.8%, Topaz 3.6%). This requires the need for treatments against this disease at critical stages.

Regarding the treated sample in which the treatment scheme was applied in 14 phenophases (Table 1) to the two varieties, Ionathan and Golden Delicious, a good efficacy was found in controlling the 2 pathogens. The negative consequence was the increase of production cost due to major inputs and the intensification of pesticide pollution. The results are summarized in Tables 5 and 6.

**The influence of genotype and treatments on production.** The production potential of the apple varieties studied is expressed by the production achieved per unit area, recorded in 2020 (Table 7). The yield of the studied varieties had good and very good values, the production obtained per hectare being different, clearly superior in quantity and quality to that of the classic varieties without antifungal treatments.

Tabel 4. Behaviour of apple varieties studied against the attack of scab and powdery mildew on fruits

| No. crt | Variety | Degree of atack (%) | |
|---|---|---|---|
| | | Scab | P. mildew |
| **I. Control varieties** | | | |
| 1. | Ionathan | 12.3b | 20.6a |
| 2. | Golden Delicious | 15.49a | 7.14b |
| **II. Varieties inbred at SCDP Voineşti** | | | |
| 1 | Real | 0c | 1.56c |
| 2 | Revidar | 0c | 0c |
| 3 | Remar | 0c | 0.76c |
| 4 | Voinicel | 0c | 0c |
| 5 | Cezar | 0c | 0c |
| 6 | Iris | 0c | 1.38c |
| 7 | Inedit | 0c | 0.26c |
| 8 | Valery | 0c | 0.81c |
| 9 | Redix | 0c | 0c |
| **III. Varieties from abroad** | | | |
| 1 | Rubinola | 0c | 0.92c |
| 2 | Goldrush | 0c | 0c |
| 3 | Topaz | 0c | 1.18c |
| Standard Deviation | | 1.235 | 1.413 |
| LSD P = .05 | | 0.864 | 0.988 |

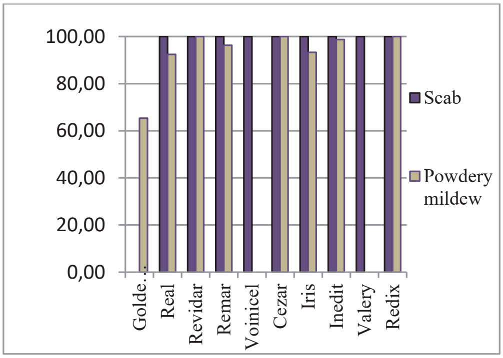


Figure 3. Effectiveness% of growing varieties with genetic resistance to scab and powdery mildew on leaves

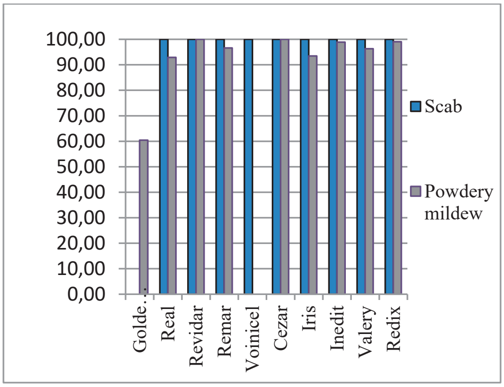


Figure 4. Effectiveness% of growing varieties with genetic resistance to scab and powdery mildew on fruits

Table 5. Behaviour of treated control apple varieties to the attack of scab and powdery mildew on leaves

| No. crt | Variety | Degree of attack (%) Leaves | |
|---|---|---|---|
| | | Scab | P. mildew |
| **Untreated** | | | |
| 1. | Ionathan | 50.85 | 64 |
| 2. | Golden Delicious | 63.25 | 25.3 |
| **Treated** | | | |
| 1 | Ionathan | 5.59 | 15.51 |
| 2 | Golden Delicious | 16.99 | 2.14 |

Table 6. Behaviour of treated control apple varieties to the attack of scab and powdery mildew on fruits

| No. crt | Variety | Degree of attack (%) Fruits | |
|---|---|---|---|
| | | Scab | Scab |
| **Untreated** | | | |
| 1. | Ionathan | 12.3 | 20.6 |
| 2. | Golden Delicious | 15.49 | 7.14 |
| **Treated** | | | |
| 1 | Ionathan | 2.18 | 3.24 |
| 2 | Golden Delicious | 3.69 | 0 |

In the 2020 study year, the production of the varieties created at SCDP Voinești was between 24 t/ha for the Redix variety and 36.7 t/ha for the Valery variety. Productions of over 30 t/ha were also made by Real (31.5 t/ha), Remar (34.7 t/ha), Cezar (35.6 t/ha) and Iris (36.5 t/ha) varieties. For varieties of foreign origin, productions were made for all varieties over 30 t/ha, culminating in 39.7 t/ha (Goldrush).

The classic varieties where no fungicides were applied to control rape and powdery mildew used as a control had low and poor quality yields (14.3 and 12.4 t/ha), which differed significantly from the others (Table 7).

Even if there is research on the application of non-chemicals in controlling plant pathogens (Cristea et al., 2017; Ichim et al., 2017) the application of fungicides is the main interven-tion in stopping the attack of dangerous pathogens on plants.

In the Voinești orchards, in the years with excessive rains in May and June, the non-application of one or two treatments against scab to sensitive varieties compromises the harvest in proportion of 50-70%, especially in terms of fruit quality (Petre et al., 2006).

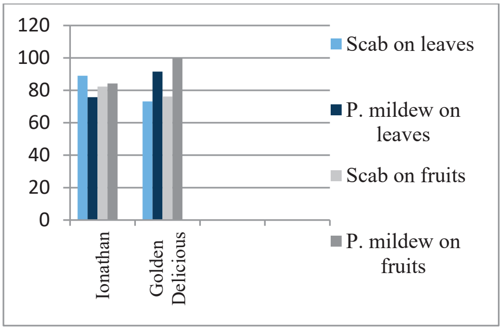


Figure 5. Effectiveness% of treatments applied to control varieties in 2020

Figure 6. Experimental orchard in Voinești

Tabel 7. Production of varieties with genetic resistance to diseases compared to untreated controls

| No. crt. | Variety/ rootstock | Yield potential (t/ha) | Diference (%) |
|---|---|---|---|
| **I. Control varieties - Untreated** | | | |
| 1 | Ionathan | 14.3 | 15.3 |
| 2 | Golden Delicious | 12.4 | 0 |
| **II. Varieties created at SCDP Voineşti** | | | |
| 1 | Redix / M.9 | 24.0 | 93.5 |
| 2 | Iris / M.9 | 36.5 | 194.3 |
| 3 | Real / M.9 | 31.5 | 154 |
| 4 | Remar / M.9 | 34.7 | 179.8 |
| 5 | Inedit / M.9 | 29.9 | 141.1 |
| 6 | Voinicel / M.9 | 25.4 | 104.8 |
| 7 | Valery / M.9 | 36.7 | 195.9 |
| 8 | Cezar / M.9 | 35.6 | 187 |
| 9 | Revidar / M.9 | 26 | 109.6 |
| **III. Varieties from abroad** | | | |
| 1 | Rubinola / M.9 | 31.7 | 155.6 |
| 2 | Goldrush / M.9 | 39.7 | 220.2 |
| 3 | Topaz / M.9 | 33.6 | 170.9 |

Regarding the grouping of fruits in quality classes for each apple variety studied, for fruits Extra + I$^{st}$ category, the best performing varieties were the varieties Real (94%), Cezar (93%), Remar (92%), Valery (91%) and Redix (90%). Furthermore, a number of 5 varieties, respectively: Redix, Real, Remar, Valery and Cezar, created at SCDP Voineşti, offered fruits in the extra category, with a percentage of over 70%.

The apple varieties from abroad, Rubinola and Topaz, also registered excellent results, having over 70% fruits in the extra category and 86%, respectively 85% cumulated in the extra + I$^{st}$ categories (table 8). The lowest percentage of fruits in the extra category was registered by the varieties Iris (62%), Revidar (63%), Inedit (65%) and Goldrush (60%), which indicates that these varieties may have a more suitable destination, much for industrialization.

Table 8. Grouping of fruits in quality classes for the apple varieties studied

| Nr. crt | Variety | Quality classes (%) | | | |
|---|---|---|---|---|---|
| | | Extra | I$^{st}$ | II$^{nd}$ | Extra + I$^{st}$ |
| **I. Varieties created at SCDP Voineşti** | | | | | |
| 1 | Redix | 72 | 18 | 10 | 90 |
| 2 | Iris | 62 | 13 | 25 | 75 |
| 3 | Real | 75 | 19 | 6 | 94 |
| 4 | Remar | 74 | 18 | 8 | 92 |
| 5 | Inedit | 65 | 13 | 22 | 78 |
| 6 | Voinicel | 68 | 13 | 19 | 81 |
| 7 | Valery | 74 | 17 | 9 | 91 |
| 8 | Cezar | 76 | 17 | 7 | 93 |
| 9 | Revidar | 63 | 17 | 20 | 80 |
| **II. Varieties from abroad** | | | | | |
| 1 | Rubinola | 71 | 15 | 14 | 86 |
| 2 | Goldrush | 60 | 15 | 25 | 75 |
| 3 | Topaz | 70 | 15 | 15 | 85 |

Varieties Iris (25%), Inedit (22%) and Goldrush (25%) had the highest percentage of low quality fruits, but their productions were satisfactory.

## CONCLUSIONS

In 2020, all apple varieties known to have genetic resistance to diseases, grown in a high density system, showed a very good resistance to scab (*V. inaequalis*) and a high degree of resistance to powdery mildew (*P. leucotricha*) with insignificant degree of attack values, between 0.26 and 4.54%.

On the other hand, the classic varieties Ionathan and Golden Delicious, in the untreated samples, proved high susceptibility to diseases. At scab, on the leaf, the degree of attack% was 50.85 and 63.25%, respectively, and at powdery mildew 64, respectively 25.3%.

It is therefore necessary to apply a large number of phytosanitary treatments to reduce the negative effects on the production and integrity of orchard trees, applied to the warning at the optimal stages and with appropriate pesticides.

Depending on the treatments applied to the sensitive apple varieties, in number of 14, there was a consumption of pesticides of 101.6 kg per hectare, compared to 8 for the varieties with disease resistance in which the amount of pesticides was only 49.4 kg, representing 48.6%.

The treatment scheme applied to sensitive varieties failed, under the climatic conditions of 2020, to control the two pathogens completely, resulting in an efficiency on leaves of 89% (scab) and 75.77% (powdery mildew) for the variety Ionathan, respectively of 73.14% (scab) and 91.55% (powdery mildew), for the Golden Delicious variety.

In terms of fruit production, varieties with genetic resistance to diseases to which no treatment for scab and powdery mildew were applied had a high productive yield, clearly superior in quantity and quality to that offered by the untreated classic varieties.

Apple varieties with genetic resistance to diseases, grown in a high density system, offer beneficial economic results for producers, environmental protection and commercial products with low pesticide residues, fit for human consumption, marketable and increasingly demanded in the distribution network.

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