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# ELEVEN YEAR EVALUATION OF AMERICAN (GENEVA®) AND POLISH ROOTSTOCKS WITH 'GOLDEN DELICIOUS REINDERS' APPLE IN POLAND

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A B S T R A C T

A field study of dwarf apple rootstock performance using 'Golden Delicious Reinders' as scion cultivar was conducted during the year 2001-2011. The study included 6 rootstocks from Cornell Geneva rootstock breeding program (G.11, G.16, G.41, G.202, CG.3007 and CG.4013) 4 rootstocks from the Polish rootstock breeding program (P 14, P 16, P 59 and P 60) and 3 Malling rootstocks as control (M.9 T337, M.9 Pajam 2 and M.26). During the eleven years of growth (2001-2011), there was no tree loss due to root system or cultivar damage caused by frost or diseases including fire blight (*Ervinia amylovora* Burr. Winsl.) infestation on the rootstock. Trees growing on P 59 and P 16 had the weakest growth while the strongest growing trees were on P 14, M.26, P 60, G.202 and CG.4013. The size of the trees on M.9 Pajam 2, G.16, G.41, CG3007 and CG.4013 were similar to that of the trees growing on the standard rootstock M.9 T337, while the trees on P 59, P 16 and G.11 were significantly smaller from standard trees on M.9 T337. After eleven years of the growth, the cumulative yield varied from 56.7 kg (on P 59) to 237.8 kg (on CG.4013). High yields were also obtained from vigorously growing trees on: G.202, P 14, G.41 and M.26. The cumulative yield expressed as yield per $cm^2$ of trunk cross-sectional area was highest for trees on G.11, P 16, M.9 Pajam 2 and G.41 and lowest for vigorously growing trees on P 60, P 14 and M.26. In 2009, a year of good cropping, the mean mass of fruits varied from 140 g on G.16 to 213 g on P 60. The fruit size from trees on P 14, M.26 and P 16 was statistically similar to fruits from trees on M.9 T337. The results of the eleven-year study lead to the conclusion that the rootstocks G.11 and G.41, which are highly resistant to fire blight, can be recommended for growing 'Golden Delicious Reinders' apple in the Polish climate, similarly to trees on M.9 T337, P 16 and M.9 Pajam 2. For orchards located on light soils the following rootstocks are also promising: G.202, CG.3007, CG.4013 and P 14 and P 60 rootstocks of polish selection.

**Kay words**: apple tree, rootstock, growth, yielding,, quality of apples

## INTRODUCTION

Notable warming of the climate in Poland in recent years has led to planting more trees of apple cultivars which were less winter hardy in our climate as: 'Jonagold', 'Szampion', 'Golden Delicious' and 'Gala' with their mutants. The cultivar Golden Delicious especially his mutant 'Golden Delicious Reinders' which is free from russeting is one of the more promising cultivar, whose production in commercial orchards is increasing each year (Kruczyńska, 2008). The possibility of growing 'Golden Delicious Reinders' in the Polish climate was studied by Sosna (2004), Jadczuk et al. (2007), Bielicki and Czynczyk (2005), Czynczyk and Bielicki (2006) and Czynczyk et al. (2010). In Polish climatic condition, a lot attention has to be paid to obtain fruits of good size over 7.5 cm, most accepted by Polish consumers. In our experiment Czynczyk and Bielicki (2006), 'Golden Delicious Reinders' come in to biennial bearing quite early. It is known from the foreign literature (Musacchi et al., 2007; Crassweller et al., 2001; Bonany et al., 2002), that all growers of 'Golden Delicious Reinders', in order to obtain good size and regularly yielding trees, have to thin fruitlets very heavily using bioregulators, which is often corrected by hand. To obtain good results, a lot attention has to be paid to pruning and thinning of fruitlets. This is very important in Polish climate condition, where vegetation period is shorter than in southern European countries. Additionally included in this experiment the Geneva® or "G" series of rootstocks from Cornell University (New York, USA) has been shown to have a high level of resistance to fire blight. Previous results from this study for period (2001-2007) was published by Czynczyk et al. (2010). The aim of this experiment was to determine in the long period of eleven years the adaptability and pomological performance of the fire blight resistant Geneva® rootstocks, with the Polish series rootstocks and the common Malling rootstocks M.9 and M.26, for growing 'Golden Delicious Reinders' trees on a podsolic soil in the climate of Poland. So many rootstocks for 'Golden Delicious Reinders' not tested yet in our climatic conditions.

## MATERIAL AND METHODS

The field experiment was established in the late spring of 2001 (June 10) at the Pomological Orchard of the Institute of Pomology and Floriculture in Skierniewice, Poland. One year old feathered maiden trees of 'Golden Delicious Reinders' grafted on 6 clones of the Geneva® rootstock series (G.11, G.16, G.41, G.202, CG.3007 and CG.4013), 4 rootstock clones from the Polish rootstocks series (P 14, P 16, P 59 and P 60) and 3 Malling rootstock clones as controls (M.9 T337, M.9 Pajam 2 and M.26) were used (Tab. 1). A great advantage of the Geneva® series of rootstocks is their high resistance to fire blight (*Ervinia amylovora*), (Cummins and Aldwickle,

1983; Norelli et al., 2003; Robinson et al., 2003; Baritt et al., 2004). The control function was fulfilled by trees on M.9 T337, M.26, and M.9 Pajam 2 commonly used in apple tree production in Poland, Holland, England and France. All of the tested rootstocks were described by Baritt et al. (2004), Czynczyk and Jakubowski (2004), Johnson et al. (2001), Robinson and Hoying (2002) and Robinson et al. (2003). The trees of the Geneva® rootstocks and those on M.9 T337, M.9 Pajam 2 and P 16 were produced by Johan Nicolai nursery in Sint-Truiden, Belgium. The trees on P 14, P 59, P 60 and M.26 were produced in a Polish nursery at the Centre for Elite Nursery Stock in Prusy, near Skierniewice, Poland. The experiment was set up on a podsolic soil, pH 5.5 overlaying light clay on a site where various species of fruit trees had been grown for over 70 years. One year before planting, a green manure crop of mustard was grown. The soil was not fumigated before planting. The experimental design was a randomized complete block design, with the blocks based on the initial trunk circumference, with tenth replicates and a single tree per plot. All the trees were planted at the same distance of 3.75 m x 1.50 m. They soil cultivation, fertilization, orchard protection and weed control procedures were applied according to the recommendations for commercial orchards in Poland. The grass in the alley-ways was moved 3-4 times a year. All the trees were drip irrigated. The herbicide strips under the trees were 160 cm wide. Each year the fruitlets were hand-thinned, leaving one fruit per cluster and a spacing of 18 cm between fruits. Annually tree trunk circumference was measured at 30 cm above ground level and converted to trunk cross-section area (TCA). The height and spread of tree canopies were measured in late autumn (October) before pruning from the lowest branches, to the top of tree. The spread of the tree was measured along the row and perpendicular to the row. Number of suckers and area of burr-knots were counted after 11 years in (November). Fruit yields was recorded each year. Mean fruit size and mass of all picked apples was recorded for the three years (2008-2010) by using on electronic machine manufactured by Greefa (4190CA Geldermalsen, Holland). All fruits from each rootstock (which were larger than 70 mm) were randomly collected after grading and were analysed for pink colour (% of pink blush area). The results concerning tree size, fruit yield, mean fruit mass were subjected to an analysis of variance (R.A. Fisher Statistica ver. 7.1 Stats) with the differences between means evaluated by Duncan's t-test at $p \leq 0.05$.

## RESULTS AND DISCUSSION

**Tree growth**. During the eleven years period of tree growth there was no tree loss due to the root system or to the cultivar caused by frost or diseases, neither were any trees lost to infection by fire blight (*Ervinia amylovora*). All the trees of 'Golden Delicious Reinders' survived very

well, the very severe winter of 2005/2006, when the temperature drooped to –31.6 °C (Tab. 1). Before the winter the trees of 'Golden Delicious Reinders' had been very well, naturally hardened for such low temperatures. After eleven years of growth 'Golden Delicious Reinders' apple trees growing on P 59, P 16 and G.11 shoved the weakest growth and were significantly smaller than standard trees grafted on M.9 T337. The size of the trees grown on the rootstocks selected at Cornell Geneva Station G.16, G.41, CG.3007 and CG.4013 were very similar to that of the trees grown on M.9 T337. The trees grown on: G.202 were significantly larger than the tress grafted on M.9 T337 and M.9 Pajam 2, and were similar to the standard trees on M.26. The trees on P 60 were similar to that on M.26. The largest trees were obtained on P 14 and there were significantly larger from all the tress on tested rootstocks (Tab. 1). The trees on P 14 usually in fully yielding period grown weaker. Small yield obtained from trees on P 14 after heavy thinning, promote the strong growth of these trees. More vigorous rootstocks than M.9 are usually recommended in Poland for orchards planted on light soils (Czynczyk and Jakubowski, 2004; Czynczyk and Bielicki, 2006; Czynczyk et al., 2010).

Table 1. Survival, tree size, number of root suckers and burr knots of 'Golden Delicious Reinders' apple trees grown on Geneva® and Polish rootstocks throughout eleven growing seasons (2001-2011)

| Rootstock | Tree survival rate [%] | Trunk cross-sectional area 2011 [cm$^2$][1] | Tree height 2011 [m] | Tree width 2011 [m] | Cum. no root suckers 2001-2011 | Mean area of burr knots 2011 [cm$^2$] |
|---|---|---|---|---|---|---|
| P 59 | 100 | 11.2 a* | 1.48 a | 1.06 a | 0.0 a | 9.8 b |
| P 16 | 100 | 22.6 b | 2.28 bcd | 1.64 b | 0.0 a | 0.0 a |
| G.11 | 100 | 29.6 bc | 2.34 bcd | 1.69 bcd | 0.0 a | 0.0 a |
| M.9 Pajam 2 | 100 | 31.6 cd | 2.26 bc | 1.76 b-e | 0.3 a | 0.0 a |
| G.16 | 100 | 33.6 cd | 2.19 b | 1.66 bc | 0.0 a | 4.2 ab |
| G.41 | 100 | 38.1 cde | 2.43 cde | 1.84 def | 0.0 a | 0.0 a |
| M.9 T337 | 100 | 39.5 def | 2.43 cde | 1.87 ef | 0.0 a | 0.0 a |
| CG.3007 | 100 | 42.8 efg | 2.40 cde | 1.82 c-f | 0.0 a | 0.0 a |
| CG.4013 | 100 | 47.5 fg | 2.56 e | 1.89 ef | 0.0 a | 1.5 a |
| G.202 | 100 | 50.1 gh | 2.55 e | 1.85 def | 0.0 a | 0.0 a |
| P 60 | 100 | 56.5 h | 2.57 e | 1.88 ef | 0.0 a | 0.6 a |
| M.26 | 100 | 58.4 h | 2.47 de | 1.96 f | 0.0 a | 2.0 a |
| P 14 | 100 | 68.0 i | 2.60 e | 1.98 f | 1.7 b | 7.6 ab |

[1]Rootstocks ranked by trunk cross-sectional area

*Means within a column followed by the same letter are not significantly different (Duncan's multiple range test $p \leq 0.05$)

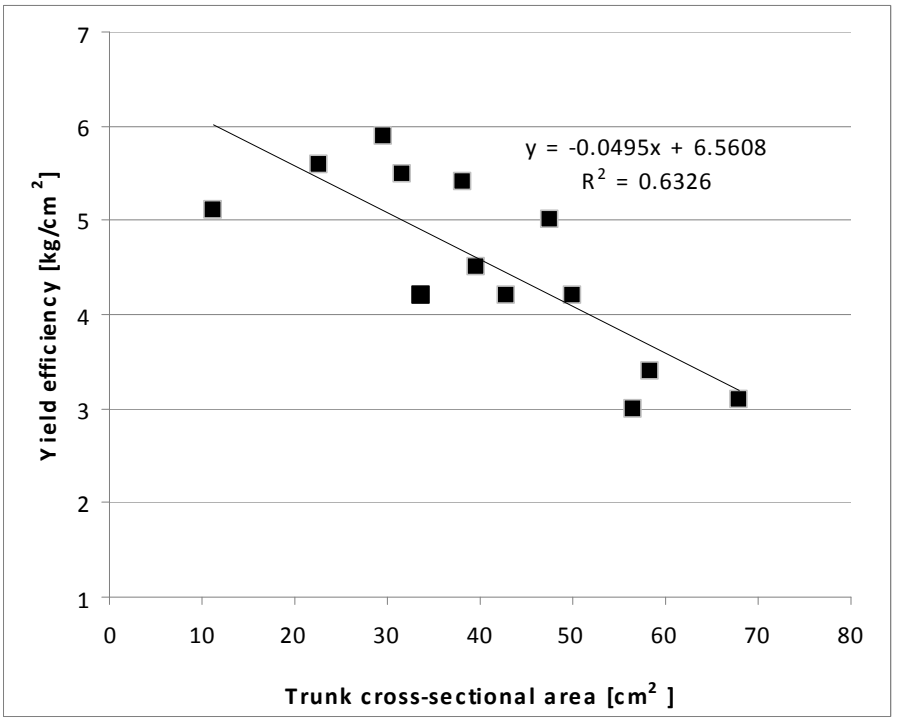


**Figure 1**. Relationship between 11-year cumulative yield efficiency and trunk cross-section area of13 rootstocks after 11 years in Poland

The size of tree canopy (tree height and tree width) was well correlated with the trunk cross-sectional area (Fig. 1). Trees on G.11 tender to be taller than expected from their TCA, while the trees on G.16 and M.26 tender to be shorter than expected from their TCA. The width was more correlated to TCA. Only tress on G.16 tended to be narrower than expected from their TCA. The results, obtained from this trial, suggest that trees on CG.4013, G.202, P 60, M.26 and P 14 can be recommended for orchards planted on light soils in Poland.

**Roots suckers and burr knots**. During the period of eleventh years of tree growth we had observed very limited number of root suckers. Only trees on P 14 and M.9 Pajam 2 produced very small number of root suckers. The production of root suckers is known to be influenced by the rootstock and compatibility with grafted scion (Marini et al., 2006; Musacchi et al., 2007; Wertheim 1998). Applied herbicides to control weeds efficiency reduced growing up root suckers. The largest mean size of burr knots was found on the rootstocks shanks of P 59, P 14, G.16 and M.26. The burr knots noticed

earlier on rootstock shanks on trees of M.9 T337, P 60, M.9 Pajam 2 and M.26 were callused.

**Yielding**. The trees of 'Golden Delicious Reinders' started bearing fruits on all the rootstocks in the second year after planting. The effect of the rootstock on the cumulative yield in the first six years of cropping (2002-2007) varied significantly among the rootstocks (Tab. 2). The trees on P 59 and G.16 had the lowest yields over the first six cropping years. The trees on M.9 T337 were intermediate in early yield. Trees on most of the Geneva® rootstocks yielded similarly to the trees on M.9 T337. Trees on CG.4013, G.41, P 14 and G.202 were in the group with the highest yield (Czynczyk et al., 2010). In the last four years of the experiment (2008-2011) the highest yield was obtained from trees on CG.4013, G.202, P 14, M.26 and G.41, while the lowest yield was from trees on P 59 and P 16. The yields from all the remaining trees grafted on the Geneva® rootstocks: G.11, G.41, CG.3007 and Polish rootstocks P14 and P60 and standard rootstock M.26 were similar to the yields obtained from standard trees on M.9 T337 (Tab. 2). The cumulative yield for the eleventh year period after planting was highest from trees on CG.4013, followed by G.202, P 14, G.41 and M.26 (Tab. 2). The lowest yield was obtained from trees on P59 and P16. The cumulative yields from the trees grown on the remaining Geneva® rootstocks G.11 and G.16 and Polish rootstock P60 and M.9 Pajam 2 were lower in comparison with the yield obtained from the trees on M.9 T337 (Tab. 2). In general the cumulative yields from our trial would have been higher if we have not thinned aggressively to achieve large-sized fruits (> 7.5 in diameter and heaving mass (over 192 g). In most years fruitlets were thinned to a distance of about 18cm between fruits. Thus the cumulative yields obtained in Poland from the standard dwarfing rootstocks M.9 T337 and M.9 Pajam 2 were lower than the cumulative yields obtained after seven years old trees in Italy or in Spain (Bonany et al. 2002, Musacchi et al. 2007). By our opinion this tendency will be also kept in older age of trees. Nevertheless the yield data from this study show the high yielding potential of 'Golden Delicious Reinders' trees in Poland and are comparable with the data obtained by previous studies in Poland (Bielicki and Czynczyk, 2005; Buczek and Szczygieł, 2004; Jadczuk et al., 2007; Sosna, 2004).

**Yield efficiency**. The trees on G.11 and P 16 had the highest cumulative yield efficiency, followed by M.9 Pajam 2, G.41, CG.4013, P 59, M.9 T337 and some, and the lowest yield efficiency was with trees on P 60 and P 14 (Tab. 2). Yield efficiency index was negatively correlated with TCA, $R^2 = 0.6326$ (Fig. 1). It indicate when TCA will increasing on $1cm^2$, the yield will be decreased average about 0.05 kg. Trees on G.11, G.41 and CG.4013 had higher than expected yield efficiencies from their TCA, while trees on P 59, G.16 and P 60 had lower yield efficiencies than expected from their TCA.

Table 2. Cumulative yield, cumulative yield efficiency (CYE) and quality of fruit of 'Golden Delicious Reinders' apple trees grown on Geneva® and Polish rootstocks

| Rootstock | Cumulative yield [kg/tree] | | | CYE [kg/cm$^2$ TCA] 2011[1] | Fruit mass [g] | | | Fruits ≥ 7 cm diameter [%] | | | Percentage of fruits with pink blush > 50% in 2008-2010 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2002-2007 | 2008-2011 | 2002-2011 | | 2008 | 2009 | 2010 | 2008 | 2009 | 2010 | |
| G.11 | 69.9 bcd | 104.6 de | 174.5 e | 5.9 h | 201 cde | 159 a | 123 c | 56.1 cd | 52.4 abc | 15.0 b | 5.4 ab |
| P 16 | 62.1 bc | 65.0 b | 127.1 b | 5.6 g | 202 cde | 212 b | 126 cd | 57.7 cde | 90.1 de | 22.3 bcd | 3.9 a |
| M.9 Pajam 2 | 76.4 cde | 96.5 cd | 172.9 d | 5.5 fg | 207 de | 164 a | 124 c | 64.9 def | 60.7 bc | 15.0 b | 2.9 a |
| G.41 | 90.1 ef | 115.4 de | 205.5 h | 5.4 f | 216 ef | 159 a | 130 cd | 75.6 ef | 57.6 abc | 28.1 cd | 4.8 ab |
| P 59 | 31.9 a | 24.8 a | 56.7 a | 5.1 e | 145 a | 143 a | 92 a | 11.1 a | 43.9 ab | 1.5 a | 17.2 c |
| CG.4013 | 92.7 f | 145.1 f | 237.8 j | 5.0 e | 185 bc | 158 a | 138 d | 41.7 bc | 56.7 abc | 31.4 d | 7.3 ab |
| M.9 T337 | 71.4 bcd | 106.9 de | 178.3 f | 4.5 d | 229 f | 212 b | 128 cd | 79.7 f | 95.2 e | 23.7 bcd | 5.5 ab |
| CG.3007 | 68.9 bcd | 110.6 de | 179.5 f | 4.2 c | 190 bcd | 148 a | 119 bc | 45.3 bc | 50.6 abc | 30.4 d | 2.2 a |
| G.202 | 79.7 def | 128.6 ef | 208.3 i | 4.2 c | 220 ef | 171 a | 125 c | 68.5 def | 70.7 cd | 18.2 bc | 5.6 ab |
| G.16 | 59.6 b | 80.6 bc | 140.2 c | 4.2 c | 177 b | 140 a | 109 b | 29.3 b | 35.7 a | 4.2 a | 10.4 b |
| M.26 | 78.8 def | 119.5 de | 198.3 g | 3.4 b | 209 de | 207 b | 127 cd | 65.1 def | 89.8 de | 20.3 bcd | 5.5 ab |
| P 14 | 88.2 ef | 120.7 de | 208.9 i | 3.1 a | 219 ef | 207 b | 127 cd | 75.8 ef | 88.8 de | 23.6 bcd | 3.3 a |
| P 60 | 72.1 bcd | 99.8 cd | 171.9 d | 3.0 a | 221 ef | 213 b | 124 c | 75.9 ef | 90.8 de | 20.0 bcd | 6.8 ab |

[1]Rootstocks ranked by cumulative yield efficiency
*Explanation, see Table 1

**Fruit quality**. The effected of the rootstocks on fruit mass in the three years (2008-2010) was modest and varied from year to year. In 2008 the highest mass had fruits from trees on standard rootstock M.9 T337 followed by G.202, P 60, G.41 and P 14, while only fruit mass from the trees on P 59 was significantly smaller, from fruits on all remainder rootstocks. In 2009 the highest mass of fruit had fruits from trees on P 60 followed by M.9 T337, P 16, P 14 and M.26. The significantly smaller mass of fruits from trees on M.9 T337 had fruits from the trees on all reminded rootstocks. In 2010 the highest mass had fruits from trees on CG.4013, G.41, M.9 T337, M.26, P 14 and P 16. The mass of fruit from trees on P 59 was significantly smaller from fruits grown on all remainder rootstocks. The mass of fruits obtained in the years (2008-2010) was in line with weight of fruits presented by Jadczuk et al. (2007), Buczek and Szczygieł (2004) and Sosna (2004). In the case of fruits larger than 7.0 cm diameter obtained tendency were similar to the results presented with the fruit mass. The highest percentage of large fruits was obtained in the three years (2008-2010) from trees on standard rootstock M.9 T337. High percentage of large fruits over 7.0 cm diameter was obtained also from trees on P 14, P 60, M.26, P 16, and G.41. In the case of pink blush area all tested rootstocks had small effect on mean percentage area of pink blush. The trees grafted on most dwarfing rootstocks P 59 and G.16 had highest percentage area of pink blush on fruits. Mean area of pink blush on fruits from remainder rootstocks were very similar. The fruits not covered by leaves, had usually larger area of pink blush.

## CONCLUSIONS

1. After eleven years the trees of 'Golden Delicious Reinders' on P 59, P 16 and G.11 were the smallest and significantly smaller in comparison with trees on standard rootstock M.9 T337. The size of trees on M.9 Pajam 2, G.16, G.41, CG.3007 and CG.4013 were similar in size to those on the standard dwarfing rootstock M.9 T337. The strongest growing trees were on P 14, followed by M.26, P 60 and G.202. The size of trees on CG.3007, CG.4013, G.202 and P 60 were intermediate between those on M.9 T337 and M.26.
2. The highest cumulative yield for eleven years was from the trees on CG.4013, followed by those on G.202, P 14, G41 and M.26. The yield from the trees on CG.3007, G11, M.9 Pajam 2 and P 60 were similar to the yield obtained on standard rootstock M.9 T337.The highest yield efficiency index was found for the trees on G.11, followed by those on P 16 and M.9 Pajam 2, while the trees on P 60 and P 14 had the lowest yield efficiencies.
3. The Geneva® series rootstocks and Polish rootstocks with different growth vigour included in this trial had little effect on mass of fruits,

which varied from year to year. The smallest fruits tended to be produced by the trees on P 59. In 2009, a heavy cropping year, the largest fruits were from the trees on M.9 T337, P 16, P 60, P 14 and M.26. In countries with short growing seasons like Poland where is very difficult to obtain high quality fruits of 'Golden Delicious Reinders' (over 146 g or diameter over 7.0 cm) that are acceptable by most Polish consumers, have to be obligatory properly thinned. All tested rootstocks had small and similar effect on percentage of fruits with pink blush $\geq$ 50%. During three years (2008-2010) only most dwarf rootstock P 59 and G.16 induced higher area of pink blush.

4. The results of the eleventh-year study lead to the conclusion that the rootstocks: G.11 and G.41 are highly suitable in the Polish climate for 'Golden Delicious Reinders' apple trees, as are trees grown on M.9 T337, P 16 and M.9 Pajam 2. For orchards located on light soils, the more vigorous rootstocks: CG.4013, G.202, M.26, P 14 and P 60 are also promising.

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# JEDENASTOLETNIE WYNIKI OCENIAJĄCE PRZYDATNOŚĆ PODKŁADEK SELEKCJI AMERYKAŃSKIEJ (GENEVA®) I POLSKIEJ DLA ODMIANY GOLDEN DELICIOUS REINDERS

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S T R E S Z C Z E N I E

W latach 2001-2011 badano przydatność podkładek selekcji amerykańskiej (Geneva®) i polskiej odmiany Golden Delicious Reinders. Badano 6 podkładek ze stacji doświadczalnej Cornell Geneva (USA): G.11, G.16, G.41, G.202, CG.3007, CG.4013, 4 podkładki hodowli polskiej: P 14, P 16, P 59 i P 60 oraz podkładki kontrolne z serii Malling: M.9 T337, M.9 Pajam 2 i M.26. W ciągu 11 lat wzrostu nie stwierdzono obumierania drzew z powodu uszkodzenia ich przez mróz lub choroby, włącznie z zarazą ogniową (*Erwinia amylovora* Burr. Winsl.). Najsłabiej rosły drzewa na P 59 i P 16, a najsilniej na P 14, M.26, P 60, G.202 i CG.4013. Wielkość drzew na M.9 Pajam 2, G.16, G.41, CG.3007 i CG.4013 była zbliżona do drzew na standardowej podkładce M.9 T337, a drzewa na P 59, P 16 i G.11 były nawet istotnie mniejsze od drzew na M.9 T337. Po 11 latach wzrostu sumaryczne plony wynosiły od 56.7 kg (na P 59) do 237.8 kg (na CG.4013). Wysokie plony otrzymano również z drzew silnie rosnących na G.202, P 14, G.41 i M.26. Najwyższe sumaryczne plony przypadające na 1 $cm^2$ powierzchni poprzecznego przekroju pnia (PPPP) otrzymano z drzew na G.11, P 16, M.9 Pajam 2 i G.41, a najniższe z silnie rosnących na P 60, P 14 i M.26. W roku 2009, kiedy owocowanie było dobre, średnia masa owoców wynosiła od 140 g na G.16 do 213 g na P 60. Wielkość owoców z drzew na P 14, M.26 i P 16 była zbliżona do wielkości zebranych na M. 9 T337. Jedenastoletnie wyniki pozwalają stwierdzić wysoką przydatność podkładek G.11 i G.41 odpornych na zarazę ogniową dla odmiany Golden Delicious Reinders w Polsce, podobną jak na M.9 T337, P16 i M.9 Pajam 2. Dla sadów zakładanych na lżejszych glebach obiecujące są również podkładki G.202, CG.3007, CG.4013, a także podkładki polskie P 14 i P 60.

**Słowa kluczowe**: jabłoń, podkładka, wzrost, plonowanie, jakość owoców