

Influence of selected Polish and American rootstocks on the growth and yield of ‘Golden Delicious Reinders’ apple trees

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Abstract

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This study was conducted in the period 2010–2015 to assess the influence of rootstocks on the growth and fruiting of apple trees of the ‘Golden Delicious Reinders’ cultivar. The experiment was conducted in an experimental orchard in Dąbrowice, Poland. The experimental material consisted of the Polish rootstocks P 66, P 67, P 68 and P 16, and the following American rootstocks of the Cornell Geneva series resistant to fire blight: CG.11, CG.41, CG.013 and CG.202. The rootstocks M.9T337, M.26, P 14 and P 60 were used as the control combination. The best-yielding trees were those from the CG.11 rootstock, while those from P 14 and P 67 were the lowest-yielding. Trees from the latter rootstocks grew most vigorously and had the lowest productivity index.

Keywords: apple cultivation; fruiting trees; fruit quality

According to many authors, the rootstock has considerable influence on the growth vigour of a given cultivar, its productivity as well as health status and other vital features (CZYNCZYK et al. 1999; JADCUK-TOBJASZ, ZYGMUNTOWSKA 2009; CZYNCZYK 2010). When cultivating apple trees the possible occurrence of diseases that can hinder or even prevent the production of fruit must be taken into account. One such disease for apple trees is fire blight caused by the bacterium *Erwinia amylovora* (Burr.) Winsl. (SOBICZEWSKI et al. 2002; CZYNCZYK 2006). Its development is promoted by high temperature and high air humidity (KIELAK, SOBICZEWSKI 2002). The disease can cause great losses both in the nursery and the orchard. Bearing this in mind, cultivars and rootstocks that are resistant or less susceptible to this disease should be selected when establishing an orchard. In Poland, dwarfing and semi-dwarfing Polish and American rootstocks resistant to fire blight are recommended for the production of apple trees. Preliminary stud-

ies have shown that such rootstocks are suitable for ‘Golden Delicious Reinders’ apples, a cultivar less susceptible to this disease, commonly grown worldwide in commercial orchards (KRUCZYŃSKA 2002, 2008; JADCUK-TOBJASZ, ZYGMUNTOWSKA 2009; CZYNCZYK, BIELICKI 2012).

The aim of this study was to assess the influence of selected Polish rootstocks and rootstocks of the American Cornell Geneva series, the latter being considered resistant to fire blight, on the growth and fruiting of apple trees of the ‘Golden Delicious Reinders’ cultivar.

MATERIAL AND METHODS

Apple trees from various rootstocks were planted in the spring of 2009 in the Experimental Orchard of the Research Institute of Horticulture in Dąbrowice near Skierniewice (Central Poland) in a sandy-loam podzolic soil and loamy subsoil. The experimental

material consisted of one-year-old apple trees of the cultivar ‘Golden Delicious Reinders’ grafted onto 11 different clone rootstocks. They were divided into three groups. The first group included the Polish rootstocks P 66, P 67, P 68 and P 16; the second group was comprised of American rootstocks selected at Cornell University’s New York State Agricultural Experimental Station in Geneva: CG.11, CG.41, CG.013 and CG.202; the third group included the rootstocks M.9T337, M.26, P 14 and P 60. The rootstocks in the last group constituted the control combination for the first two groups. The experiment was set up in a randomised block design with four replications of three trees per plot, planted at a spacing of 4.5×1.75 m. The tree crowns were trained in the form of a slender spindle. Soil cultivation, fertilisation, and the protection of trees against pests and diseases were in line with measures commonly employed in commercial apple orchards. The experiment assessed tree growth vigour as measured by the cross-sectional area of the tree trunk (TCSA in cm^2), and also fruit yield (kg per tree), the weight of 100 fruit (kg), fruit diameter (over 7 cm), extent of the blush (%) and the productivity index (kg/cm^2).

The results were analysed statistically using one-way analysis of variance. Comparisons of the mean values for the combinations were performed with Duncan’s test at $p < 0.05$. Fruit size and blush area percentages were transformed with the Bliss for-

mula. Tabulated values that do not differ significantly from one another are denoted with the same letters. Statistica version 10 PL 2012 (StatSoft, Poland) was used for statistical calculations.

RESULTS

The most vigorously growing trees were those on the P 14 and M.26 rootstocks, and the least vigorous were those on P 16 and P 68. The highest yields in the first five years of fruiting were collected from the trees grafted onto P 14 (51.87 kg), CG.11 (46.23 kg) and M.26 (42.17 kg), and the lowest – from those on the rootstocks of Polish selection: P 16 (19.59 kg) and P 68 (21.31 kg) (Table 1). The productivity index was highest for trees growing on CG.11. For the remaining trees, this index was markedly lower, but the values for the different rootstocks did not differ significantly from one another. Least productive were the trees growing on P 14 and P 67. The type of rootstock had no significant effect on the mean fruit weight. The highest percentages of apples with diameters of greater than 7 cm were found for the CG.11 and P 14 rootstocks, 91.48% and 90.63%, respectively, and the lowest – for the P 68 rootstock (72.38%). The most extensively coloured apples were from the trees growing on the CG.202 rootstock, and the least – from the trees on P 14 (Table 2).

Table 1. Growth vigour and fruit yield of apple trees cv. ‘Golden Delicious Reinders’ grafted onto various rootstocks

No.	Rootstock	TCSA (cm^2)	Fruit yield (kg/tree)		Productivity index (kg/cm^2)
			2015	2010–2015	
1	M.9T337	12.2 ^{abc}	13.9 ^{ab}	25.7 ^{ab}	2.1 ^{ab}
2	M.26	20.5 ^c	20.3 ^{abcd}	42.2 ^{cd}	2.1 ^{ab}
3	P 14	30.3 ^d	26.9 ^d	51.9 ^d	1.7 ^a
4	P 60	16.9 ^{abc}	20.0 ^{abcd}	39.7 ^{bcd}	2.3 ^{ab}
5	P 66	10.8 ^{ab}	13.8 ^{ab}	28.5 ^{abc}	2.7 ^{ab}
6	P 67	17.8 ^{bc}	17.0 ^{abc}	32.6 ^{abcd}	1.8 ^a
7	P 68	9.5 ^{ab}	11.7 ^a	21.3 ^a	2.2 ^{ab}
8	P 16	8.2 ^a	9.7 ^a	19.6 ^a	2.4 ^{ab}
9	CG.11	16.4 ^{abc}	21.8 ^{bcd}	46.2 ^d	2.8 ^b
10	CG.41	16.0 ^{abc}	18.9 ^{abcd}	33.1 ^{abc}	2.1 ^{ab}
11	CG.013	14.9 ^{abc}	19.8 ^{abcd}	39.0 ^{bcd}	2.6 ^{ab}
12	CG.202	16.6 ^{abc}	24.5 ^{cd}	34.4 ^d	2.1 ^{ab}

TCSA – trunk cross-sectional area

Table 2. Fruit quality parameters of 'Golden Delicious Reinders' cv. apple trees grafted onto various rootstocks

No.	Rootstock	Weight of 100 fruit (kg)	Fruit with diameter > 7 cm (%)	Fruit with blush > 50% (%)
1	M.9T337	18.8 ^a	76.7 ^{ab}	24.1 ^{ab}
2	M.26	20.2 ^a	84.2 ^{ab}	31.9 ^{abc}
3	P 14	20.5 ^a	90.6 ^b	19.8 ^a
4	P 60	17.9 ^a	74.9 ^{ab}	49.3 ^{abc}
5	P 66	19.0 ^a	81.0 ^{ab}	52.9 ^{abc}
6	P 67	19.7 ^a	78.9 ^{ab}	69.8 ^{bc}
7	P 68	18.8 ^a	72.4 ^a	56.7 ^{abc}
8	P 16	18.6 ^a	77.8 ^{ab}	67.2 ^{abc}
9	CG.11	20.7 ^a	91.5 ^b	27.8 ^{abc}
10	CG.41	20.2 ^a	84.8 ^{ab}	50.3 ^{abc}
11	CG.013	19.4 ^a	86.0 ^{ab}	48.7 ^{abc}
12	CG.202	19.3 ^a	80.8 ^{ab}	75.7 ^c

DISCUSSION

The rootstock, as reported by many authors, is an important factor in the yield of fruit trees (JADCZUK 2000; BUCZEK, SZCZYGIEL 2004; JADCZUK et al. 2004; BIELICKI, CZYNCZYK 2005; CZYNCZYK et al. 2010; CZYNCZYK, BIELICKI 2012), and it determines the size and quality of the fruit crop they produce. Our results show that the 'Golden Delicious Reinders' cultivar grows most vigorously on the rootstocks M.26 and P 14, and least vigorously on the dwarfing rootstock P 16. These observations are consistent with the results obtained by CZYNCZYK and BIELICKI (2012). They are also consistent with the results reported by LEWANDOWSKI and ŻURAWICZ (2007), which showed that apple trees of some scab-resistant cultivars grew more strongly on the rootstocks P 14 and M.26 than on M.9 and P 60. 'Golden Delicious Reinders' cv. apple trees on the American rootstocks and those grafted onto the other rootstocks were characterised by similar growth vigour. The yield performance of this cultivar, as shown previously by CZYNCZYK and BIELICKI (2012), varies depending on the type of rootstock. In their experiment, the highest yield, calculated per TCSA, was produced by the trees grafted onto the CG.11 rootstock. By comparison, our research indicates that the highest-yielding cv. 'Golden Delicious Reinders' trees were those on P 14, CG.11 and M.26, and the lowest fruit yields were produced on the rootstocks P 16 and P 68. However, the value of the productivity index

showed that the most productive trees were those growing on the CG.11 rootstock, which is in agreement with the results of the above-cited authors. A moderately high productivity index was also shown by the trees growing on the rootstocks P 66 and CG.013, and a low index was exhibited those growing on P 14 and P 67. A study by JADCZUK-TOBJASZ and ZYGMUNTOWSKA (2009) demonstrated that in the first years of fruiting the rootstock has no significant impact on the quality of the fruit, their firmness or the content of soluble solids. Our results also suggest that the influence of the rootstock on the quality of 'Golden Delicious Reinders' apples in the first five years of the experiment was of little significance. However, they do indicate that the choice of rootstock significantly affected the number of fruit with diameters of greater than 7 cm, which can be seen in the increase in such fruit in the case of rootstocks P 14 and CG.11. Rootstock CG.202, meanwhile, clearly increases the extent of colour development on the fruit.

CONCLUSION

The following conclusions can be drawn from our research results:

- 'Golden Delicious Reinders' apple trees grow vigorously on the P 14 and M.26 rootstocks and can be planted in light soils.
- The dwarfing rootstocks P 16 and P 68 markedly reduce the growth vigour of apple trees cv.

‘Golden Delicious Reinders’ and are suitable for planting in fertile soils.

- The CG.11 American rootstock has many positive traits, e.g., resistance to fire blight. Trees of ‘Golden Delicious Reinders’ on this rootstock grow moderately vigorously and are productive.
- The P 66 and CG.013 rootstocks exert a positive influence on the fruiting of ‘Golden Delicious Reinders’ apple trees.

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