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COMPARISON OF 18 ROOTSTOCKS FOR APPLE TREE CV. 'ELISE' IN V PLANTING SYSTEM

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The experiment was set up on a fertile alluvial soil, at the Warsaw-Wilanów Experimental Station, Central Poland, in spring of 2000. Apple trees of cv. 'Elise' were planted on 18 rootstocks of different origin and grew in V planting system. Different rootstocks were classified into three groups, depending on expected tree vigour: semi-dwarfing (P 14, P 60, B.396 and M.26), dwarfing (B.9, B.146, P 2, P 59 and seven subclones of M.9 – EMLA, Burgmer 984 & 751, T339, Pajam 1, Pajam 2, RN29) and superdwarfing (M.27, P 16, PB-4). Trees on rootstocks assumed as semi-dwarfing were spaced at a distance of 3.8 × 1.0 m, on dwarfing – at a distance of 3.5 × 0.7 m and on superdwarfing – at a distance of 3.2 × 0.5 m. The trunk cross-sectional area (TCSA) after 6 years on semi-dwarfing rootstocks was the greatest on P 14; vigour of trees on other rootstocks was similar. The cumulative yield per tree (2001–2005) was the lowest on M.26. Fruit size did not depend on the rootstock. The cropping efficiency coefficient (CEC) was the highest of trees on B.396 and the lowest – on P 14. On rootstocks considered as dwarfing, TCSA after six years was the smallest on P 59 and the largest on M.9 EMLA; vigour of trees on other subclones of M.9 was smaller and similar. The lowest cumulative yield per tree was obtained on P 59 and the highest – on M.9 751, M.9 984 and M.9 EMLA. Fruit size was similar and did not depend on rootstock. The CEC was the highest on P 59. On superdwarfing rootstock trees on PB 4 were the smallest. The highest cumulative yield per tree gave the trees on P 16, while on PB 4 – the lowest one. Fruit size did not depend on the type of superdwarfing rootstock. In this group, CEC was the highest for trees on P 16.

Key words: apple, tree vigour, planting density, productivity, cumulative yield, cropping efficiency, fruit size.

Introduction. For intensive planting system of apple fruit orchard, the ideal tree is one that does not grow too vigorously, is early and regular bearing, and produce high quality fruits (Wertheim, 1989; Vebster, 1992; Vercammen, 2004). M.9 EMLA is considered as standard and the most commonly used dwarfing rootstock for high-density apple orchards. Its popularity is due to its moderate vigour, high precocity of bearing, productivity of trees grown on it and good fruit size. Many experiments with apple rootstocks have been carried out in different countries searching

for rootstocks best adapted to local climatic and soil conditions (Ferree et al., 1995; Riesen and Monney, 1996; Quamme et al., 1999; Czynczyk et al., 2001; Sadowski et al., 2004).

The aim of our experiment was to assess eighteen rootstocks of different origin and vigour for cultivar 'Elise' planted in the "V" system.

Material and methods. The experiment was set up on a fertile salty loam alluvial soil, at the Warsaw-Wilanów Experimental Station, Central Poland, in spring of 2000. Apple trees 'Elise' on 18 rootstocks of different origin and vigour were planted and trained in the V planting system. Different rootstocks were classified into three groups, depending on expected tree vigour: semi-dwarfing (P 14, P 60, B.396 and M.26), dwarfing (B.9, B.146, P 2, P 59 and seven subclones of M.9 – EMLA, Burgmer 984 & 751, T339, Pajam 1, Pajam 2, RN29) and superdwarfing (M.27, P 16, PB-4). Trees on rootstocks assumed as semi-dwarfing were spaced at a distance of 3.8 × 1.0 m (2631 trees/ha), on dwarfing at a distance of 3.5 × 0.7 m (4082 trees/ha) and on superdwarfing at a distance of 3.2 × 0.5 m (6250 trees/ha). Each rootstock was represented by 10 trees per plot, in four replications. Alleyways were under sward and herbicide strips were maintained along tree rows.

After six years, tree growth was estimated by the trunk cross-sectional area (TCSA) derived from diameter measurements at 30 cm above the ground. The yield was harvested every year and in this paper is presented as cumulative yield of five years (2001–2005). Mean fruit mass was also determined. The cropping efficiency coefficient (CEC) was calculated as a cumulative yield to the final TCSA ratio.

The results were elaborated by analysis of variance, separately for each group of rootstocks. For evaluation of significance of differences between treatment means the Newman-Keuls test was used, at α=0.05.

Results. After six years in the orchard (spring of 2006) the TCSA on semi-dwarfing rootstocks was the largest on P 14. The vigour of trees on other rootstocks was similar (Table 1). The cumulative yield per tree (2001–2005) was the lowest on M.26. Fruit size did not depend on the rootstock (Table 2). The cumulative cropping efficiency coefficient (CEC) was the highest for trees on B.396 and the lowest on P 14 (Table 5).

On rootstocks considered as dwarfing, TCSA after six years was the smallest on P 59 and the largest on M.9 EMLA. No significant differences in vigour between the different subclones of M.9 were noted (Table 1). The lowest cumulative yield per tree was obtained on P 59 and the highest on M.9 751, M.9 984 and M.9 EMLA. Fruit size was similar and did not depend on rootstock (Table 3). The CEC was the highest on P 59 (Table 5).

On superdwarfing rootstocks the lowest TCSA had trees on PB 4, significantly higher – on M.27 and the highest on P 16 (Table 1). The highest cumulative yield per tree gave the trees on P 16, while on PB 4 – the lowest. Fruit size did not depend on the type of superdwarfing rootstock (Table 4). In this group, CEC was the highest for trees on P 16 (Table 5).

Table 1. **Size of apple tree cv. 'Elise' six years after planting (spring of 2006)**

1 lentelė. **'Elise' veislės obelų dydis, praėjus šešeriems metams po pasodinimo, 2006 m. pavasaris**

Semidwarfing rootstock Pusiau žemaūgiai poskiepiai	Trunk cross-sectional area (TCSA) Kamieno skerspjūvio plotas (KSP), cm^2	Dwarfing rootstock Žemaūgiai poskiepiai	Trunk cross-sectional area (TCSA) Kamieno skerspjūvio plotas (KSP), cm^2	Superdwarfing rootstock Nykštukiniai poskiepiai	Trunk cross-sectional area (TCSA) Kamieno skerspjūvio plotas (KSP), cm^2
P 14	36.0 b	M.9 EMLA	18.83 d	M.27	7.65 b
P 60	20.16 a	M.9 984	16.93 cd	P 16	8.20 b
B.396	18.60 a	M.9 751	16.68 cd	PB 4	5.69 a
M.26	22.15 a	M.9 T339	14.79 bc		
		M.9 Pajam 1	14.74 bc		
		M.9 Pajam 2	17.74 cd		
		M.9 RN29	14.66 bc		
		B.9	4.40 bc		
		B.146	12.11 b		
		P 2	15.95 cd		
		P 59	7.23 a		

Table 2. **The cumulative yield (2001–2005) and mean fruit mass of apple tree cv. 'Elise' on semi-dwarfing rootstocks**

2 lentelė. **'Elise' veislės obelų su pusiau žemaūgiais poskiepiais suminis derlius (2001–2005 m.) ir vidutinė vaisiaus masė**

Rootstock Poskiepis	Yield (kg $tree^{-1}$) Derlius, kg $medis^{-1}$	Mean fruit mass Vidutinė vaisiaus masė, g
P 14	49.9 b	220 a
P 60	50.3 b	225 a
B.396	56.8 b	233 a
M.26	42.1 a	222 a

Table 3. **The cumulative yield (2001–2005) and mean fruit mass of apple tree cv. 'Elise' on dwarfing rootstocks**

3 lentelė. **'Elise' veislės obelų su žemaūgiais poskiepiais suminis derlius (2001–2005 m.) ir vidutinė vaisiaus masė**

Rootstock Poskiepis	Yield (kg $tree^{-1}$) Derlius, kg $medis^{-1}$	Mean fruit mass Vidutinė vaisiaus masė, g
M.9 EMLA	49.3 b	231 a
M.9 984	48.5 b	230 a
M.9 751	50.1 b	239 a
M.9 T339	43.7 ab	230 a
M.9 Pajam 1	46.9 ab	237 a
M.9 Pajam 2	46.0 ab	240 a
M.9 RN29	39.2 ab	231 a
B.9	43.2 ab	226 a
B.146	38.9 ab	230 a
P 2	37.4 ab	230 a
P 59	31.3 a	217 a

Table 4. **The cumulative yield (2001–2005) and mean fruit mass of apple tree cv. 'Elise' on superdwarfing rootstocks**

4 lentelė. **'Elise' veislės obelų su nykštukiniais poskiepiais suminis derlius (2001–2005 m.) ir vidutinė vaisiaus masė**

Rootstock Poskiepis	Yield (kg tree^{-1}) Derlius, kg medis^{-1}	Mean fruit mass Vidutinė vaisiaus masė, g
M.27	21.9 b	166 a
P 16	29.5 c	176 a
PB 4	16.6 a	162 a

Table 5. **Cropping efficiency coefficient of apple tree cv. 'Elise'**

5 lentelė. **'Elise' veislės obelų produktyvumas**

Semidwarfing rootstock Pusiau žemaūgiai poskiepiai	CEC Produktyvumas, kg cm^{-2}	Dwarfing rootstock Žemaūgiai poskiepiai	CEC Produktyvumas, kg cm^{-2}	Superdwarfing rootstock Nykštukiniai poskiepiai	CEC Produktyvumas, kg cm^{-2}
P 14	1.39 a	M.9 EMLA	2.63 a	M.27	2.88 a
P 60	2.51 b	M.9 984	2.88 a	P 16	3.65 b
B.396	3.12 c	M.9 751	3.00 a	PB 4	2.93 a
M.26	1.90 a	M.9 T339	3.03 a		
		M.9 Pajam 1	3.22 a		
		M.9 Pajam 2	2.64 a		
		M.9 RN29	2.66 a		
		B.9	3.02 a		
		B.146	3.19 a		
		P 2	2.36 a		
		P 59	4.34 b		

Discussion. Kurlus and Ugolik (1996), Sadowski et al. (1997) and Wlosek and Jadczuk (1998) reported that trees on P 14 showed the highest vigour; branches of trees spaced at 1 m in the row overlapped, and this indicated that this rootstock was too vigorous in comparison with other rootstocks classified as semi-dwarfing and dwarfing. Czynczyk et al. (2001) confirmed their opinion that trees on P 14 grew too vigorously in the first years only. Later the growth of trees on P 14 is usually much weaker. Results of above-mentioned authors partly confirmed our experiment. The growth of trees on P 14 was stronger than M.26 and other rootstock, both at the first years after planting and after six years. Fruit bud formation on P 14 was delayed, and CEC was the lowest. Similar results were also obtained by Skrzyński and Poniedziałek (2000) and Słowiński (2004).

In the present study none of the M.9 subclone had any consistent effect on the trunk diameter of trees and yield in the orchard, however trees on M.9 EMLA showed a slightly more vigorous growth and better yielding. Our report corresponded to the results obtained by Loreti et al. (2001) and Webster et al. (2000), who pointed that size of trees on M.9 subclones was similar; albeit some differences in vigour of trees and yielding on some subclones and on M.9 EMLA had been noticed. Czynczyk et al. (2001) pointed that trees on P 59 grew weakly, and yielded not very abundantly,

what is in line with our study. Trees on P 59 were the smallest and gave the low yield.

According to Łukuć (1994), trees on rootstock PB 4 have similar vigour to M.9. Our experiment did not confirm this opinion. Tress on PB 4 were very dwarfing, showing in the orchards weaker vigour than M.27 and P 16. This confirms the observations of Sadowski et al. (2000, 2004), who described its vigour as lower than on M.9 and even on P 22. Dwarfing effect of PB 4 as well P 22 has been successively intensified; the contrast between trees on PB 4 and M.9 increased with the age.

Conclusions. 1. Trees on semi dwarfing rootstock P 14 showed too vigorous growth, delayed fruit bud formation and had the lower cropping efficiency coefficient. On fertile soils in particular this rootstock is not acceptable for high-density plantings.

2. Dwarfing rootstock M.9 EMLA and other subclones of M.9 providing early bearing and high productivity but not significant differences in vigour and yielding between them were noted. This rootstock remains as universal rootstock for intensive orchard.

3. For intensive orchard the most promising alternative rootstock for M.9 is P 16. Trees on this rootstock had a relatively low vigour and high cropping efficiency coefficient.

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References

1. Czynczyk A., Bielecki P., Bartosiewicz B. Testing new dwarfing apple rootstocks from Polish and foreign breeding programmes. Acta Hort. 2001. 557. P. 83-89.

2. Ferree D. C., Hirst P. M., Schmid J. C., Dotson P. E. Performance of three apple cultivars with 22 dwarfing rootstocks during 8 seasons in Ohio. Fruit Var. 1995. J. 49(3). P. 171-178.

3. Kurlus R., Ugolik M. Wzrost i plonowanie drzew jabłoni Szampion, Rogal Gala i Jonagored na podkładkach polskiej hodowli. XXXIV Ogólnopolska Konf. Sad. 1996. P. 271-273.

4. Loreti F., Massai R., FeiC., Cinelli F. Cecconi B. Evaluation of eleven dwarfing apple rootstock: preliminary results. Acta Hort. 2001. 557. P. 155-161.

5. Łukuć T. PB 4 – obiecująca podkładka dla jabłoni. Sad Nowoczesny. 1994. (7). 9 p.

6. Quamme H. A., Hampson C. R., Brownlee R. T. Apple rootstock evaluation for the climate of British Columbia. Proc. Int. Seminar „Apple Rootstocks for Intensive Orchards" (Warsaw-Ursynów, Poland, 18–21.08.1999). 1999. P. 87-88.

7. Riesen W., Monney P. Apfelunterlagen: Zwischenergebnisse deutsch und westschweizerischer Versuche. Obst und Weinbau. 1996. 132(21). P. 548-552.

8. S a d o w s k i A., M a c i e j c z a k G., W r o n a D. Growth and early bearing of ‘Šampion’apple trees depending on rootstock and tree quality. Internat. Conf. „Modern Orchards: Achievements and Tendencies”. Collection of Scientific Articles. 1997. P. 28-34.

9. S a d o w s k i A., G r o c h o w a l s k i W., S ł o w i ń s k i A., Ż ó ł t o w s k i J. Ocena siły wzrostu jabłoni na podkładce PB 4. Zesz. Nauk. Ins. Sad. I Kw. Skierniewice. 2000. 8. P. 71-76.

10. S a d o w s k i A., D z i u b a n R., J a b ł o ń s k i K. Growth and cropping of three apple cultivars on different rootstocks over a 7-year period. Acta Hort. 2004. 658. P. 257-263.

11. S k r z y ń s k i J., P o n i e d z i a ł e k W. Wzrost i plonowanie odmiany ‘Jonagold’ na kilku podk³adkach wegetatywnych. Zesz. Nauk. Inst. Sad. I Kwiat. W Skierniewicach. 2000. T. 8. P. 53-58.

12. S ł o w i ń s k i A. Comparison of 22 rootstock of different vigour and origin used for *Elise* apple trees. Acta Hort. 2004. 658. P. 279-286.

13. W e r t h e i m S. J. Preliminary results of trials with dwarfing apple and pear rootstock. Acta Hort. 1989. 243. P. 59-70.

14. W e b s t e r A. D. New dwarfing rootstocks for apple, pear, plum and sweet cherry – a brief review. Acta Hort. 1992. 349. P. 145-153.

15. W e b s t e r T., T o b u t t K., E v a n s K. Breeding and evaluation of new rootstocks for apple, pear and sweet cherry. Compact Fruit Tree. 2000. 33(4). P. 100-104.

16. W l o s e k S t a n g r e d C. R., J a d c z u k E. Wpływ podkładki na wzrost i plonowanie jab³oni. XXXVII Ogólnopolska Konf. Sad. 1998. P. 526-527.

17. Vercammen J. Search for a more dwarfing rootstock for apple. Acta Hort. 2004. 658. P. 313-318.

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‘ELISE’ OBELŲ VEISLĖS SU 18 POSKIEPIŲ PALYGINIMAS V FORMOS SODINIMO SISTEMOJE

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Santrauka

Bandymas pradėtas derlingoje aliuvinėje dirvoje Varšuvos-Vilanovo eksperimentinėje stotyje, Centrinėje Lenkijoje, 2000 metų pavasarį. ‘Elise’ veislės obelys buvo pasodintos su 18 skirtingos kilmės poskiepių ir augo V formos sodinimo sistemoje. Skirtingi poskiepiai buvo suskirstyti į tris grupes, priklausomai nuo vaismedžio tikėtino augumo: pusiau žemaūgiai (P 14, P 60, B.396 ir M.26), žemaūgiai (B.9, B.146, P 2, P 59 ir septyni M.9 subklonai – EMLA, Burgmer 984 ir 751, T339, Pajam 1, Pajam 2, RN29) ir nykštukiniai (M.27, P 16, PB-4). Vaismedžiai su pusiau žemaūgiams priskirtais poskiepiais buvo pasodinti 3,8 × 1,0 m, su žemaūgiais – 3,5 × 0,7 m ir su nykštukiniais – 3,2 × 0,5 m atstumais. Po 6 metų pusiau žemaūgių poskiepių grupėje didžiausias buvo kamieno skerspjūvio plotas (KSP) vaismedžių su P 14 poskiepiu; vaismedžių augumas su kitais poskiepiais buvo panašus. 2001–2005 m. mažiausias suminis derlius buvo vaismedžio su M.26 poskiepiu. Vaisių dydis nuo poskiepių nepriklausė. Produktyviausi buvo vaismedžiai su B.396, o mažiausiai produktyvūs – su P 14 poskiepiu. Iš žemaūgiams priskirtų poskiepių grupės po šešerių metų mažiausias KSP buvo vaismedžių su P 59, didžiausias – su M.9 EMLA poskiepiu. Vaismedžių augumas su kitais M.9 subklonais buvo mažesnis, bet panašus. Mažiausias suminis derlius buvo vaismedžio su P 59, didžiausias – su M.9 751, M.9 984 ir M.9 EMLA poskiepiais. Vaisių dydis buvo panašus ir nuo poskiepių nepriklausė. Produktyviausi vaismedžiai buvo su P 59 poskiepiu. Iš nykštukinių poskiepių augumą labiausiai sumažino PB-4. Didžiausias suminis derlius buvo vaismedžių su P 16, mažiausias – su PB-4 poskiepiu. Vaisių dydis nuo nykštukinių poskiepių rūšies nepriklausė. Šioje grupėje produktyviausi buvo vaismedžiai su P 16 poskiepiu.

Reikšminiai žodžiai: obelys, vaismedžių augumas, sodinimo tankumas, derlingumas, suminis derlius, produktyvumas, vaisių dydis.