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EVALUATION OF SEVERAL APRICOT CULTIVARS AND CLONES IN THE LOWER SILESIA CLIMATIC CONDITIONS

PART II: VIGOR, HEALTH AND MORTALITY

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A B S T R A C T

Vigour, health and mortality were assessed in several apricot cultivars in two experiments conducted from 1988 to 2005 at the Fruit Experimental Station near Wrocław in south-western Poland. In the first experiment, the cultivars studied were 'Harcot', 'Morden 604' and 'Early Orange'. All were grafted on 'Myrobalan' seedling rootstock. In the second experiment, the cultivars evaluated were 'Early Orange', 'Harcot', 'Morden 604', 'Moorpark', 'Somo', 'Bergeron', 'Hargrand', 'Karola', 'Ungarische beste', 'Veecot', 'Velkopavlovicka LE 12/2', 'Velkopavlovicka LE 19/2' and three clones which had been bred at the Fruit Experimental Station in Albigowa: LS-4, LS-5 and LS-7. All were grafted on 'Somo' seedling rootstock. Vigour depended on both the cultivar and the rootstock. The most vigorous genotypes were 'Morden 604', 'Moorpark', 'Velkopavlovicka LE 12/2, 'Veecot' and LS-4. The least vigorous cultivars were 'Early Orange', 'Bergeron' and 'Karola'. Cultivars grew more vigorously when grafted on 'Myrobalan' seedling rootstock than on 'Somo' seedling rootstock. Mortality was especially high in 'Morden 604'; probably because of incompatibility with the 'Somo' seedling rootstock. Susceptibility to cankers was lowest in 'Karola', 'Somo', 'LS-4' and 'Early Orange'. Susceptibility to *Monilia laxa* Sacc. was lowest in 'Hargrand', 'Bergeron' and 'Somo'.

Key words: apricot, cultivar, rootstock, growth, healthiness, longevity

INTRODUCTION

Vigour in apricot trees varies widely from cultivar to cultivar. As part of a long-term breeding programme, new genotypes have been developed which not only crop better, but also grow with 15 to 30% less vigour (Vachůn et al., 1995; Vachůn, 2001). In most of currently available cultivars, vigour can be reduced only by using the right rootstock (Grzyb et al., 1996). Rootstock affects not only vigour, but the lifespan of the trees as well (Dimitrova, 2001)

Health in apricots can be reduced by disease, poor adaptation to the growing environment, and grafting incompatibility. Diseases not only damage the health of the tree, but also limit yields. The most serious disease of apricots in Europe is probably the plum pox virus (Bassi, 2001). Fungal and bacterial diseases depend on weather conditions. Brown rot can affect either blossoms or ripening fruit and is caused by fungi of the genus *Monilinia* sp. Bacterial cankers are caused by *Pseudomonas* sp. (Frecon, 1991; Bassi, 2001). In Poland, one of the most important diseases in apricots is cytospora canker, caused mainly by *Cytospora cinta* Sacc. Infectious diseases can be reduced by implementing a proper protection program in the orchard (Bielenin et al., 1986).

Cultivars which are poorly adapted to the growing environment are often damaged by winter frosts. The damaged trees are then more susceptible to diseases and often die early (Bielenin et al., 1986; Kruczyńska et al., 1988).

Mortality also depends on the rootstock used (Grzyb et al., 1996; Dimitrova, 2001). During thirty years of research in Bulgaria, Dimitrova and Marinov (2002) never detected any sign of graft incompatibility in apricots grafted on 'Myrobalan' seedling rootstock. In a seven-year trial of apricot rootstocks in Poland, mortality was highest with 'Wangenheim Prune' rootstock. 'Somo 86' seedling rootstock was found to be a good rootstock for all of the cultivars investigated except 'Harcot' (Grzyb et al., 1996). Graft incompatibility has also been observed with 'Morden 604' grafted on 'Somo' seedling rootstock (Licznar-Małańczuk and Sosna, 2000).

The aim of the present study was to estimate vigour, health and longevity in several apricot cultivars and clones in terms of their suitability for cultivation in Lower Silesia.

MATERIAL AND METHODS

Two experiments on apricot varieties were conducted at the Fruit Experimental Station of the Agricultural University of Wrocław in south-western Poland.

The first experiment was started in the spring of 1988. One year old trees of three apricot cultivars grafted on 'Myrobalan' seedling rootstock were planted 4 x 4 m apart (625 trees/ha) in a randomized block design with four replications of four trees per plot. The cultivars evaluated were 'Early Orange', 'Harcot' and 'Morden 604'. The second experiment was started in April 1996. One year old trees of five apricot cultivars grafted on 'Somo' seedling rootstock were planted 5 x 4 m

apart (500 trees/ha) in a randomized block design with five replications of four trees per plot. The cultivars evaluated were 'Early Orange', 'Harcot', 'Morden 604', 'Moorpark' and 'Somo'.

From 1996 to 2005, a collection of seven apricot cultivars grafted on 'Somo' seedling rootstock was also evaluated as part of the second experiment. The cultivars evaluated included: 'Bergeron', 'Hargrand', 'Karola', 'Ungarische beste', 'Veecot', 'Velkopavlovicka LE 12/2' and 'Velkopavlovicka LE 19/2'.

From 1995 to 2004, a collection of three Polish apricot clones grafted on 'Somo' seedling rootstock was also evaluated as part of the second experiment. The clones had been bred at the Fruit Experimental Station in Albigowa and were designated LS-4, LS-5 and LS-7.

There were three to thirteen trees of each variety in these two collections.

The following data were recorded for all cultivars and clones in both the first and second experiments: vegetative growth, health and mortality.

Each year, trunk cross-section area (TCSA) was calculated for each tree based on diameter or circumference measured 30 cm above the soil level. At the ends of the observation periods, mean annual increase in TCSA and crop efficiency coefficient (CEC) were calculated for each cultivar and clone.

In the first experiment, annual shoot count and total length of annual shoots were recorded for selected branches in 1990. In the second experiment, annual shoot count and total length of annual shoots were recorded for all cultivars in 1996.

In the second experiment, tree height and crown width were recorded for all cultivars and clones in 2000 and 2004. Tree width was measured with a pole in two directions: north to south and east to west. Crown volume was calculated using a formula for perpendicular volume.

Data from both experiments were statistically elaborated by analysis of variance, followed by means separation with Student's t-test at $\alpha = 0.05$.

The percentage of dead trees was calculated every year and at the end of each experiment.

In the second experiment, trees were visually examined every year. The percentages of healthy, damaged, diseased and dead trees of all cultivars and clones were recorded and the data were compiled at the end of the experiment. Cankers caused by *Pseudomonas* sp. and *Cytospora* sp. damage to wood and bark was noted in 2000 and 2002. On the basis of these observations and on the percentage of dead trees at the end of the trial, the cultivars and clones were categorized as slightly, moderately or highly susceptible to cankers. On the basis of blossom and shoot damage caused by *Monilia laxa* Sacc. in 2001, the cultivars and clones were categorized as slightly, moderately or highly susceptible to brown rot.

All of the trees in both experiments were trained with an open, natural canopy. Minimal pruning was carried out immediately after harvest. Herbicide strips were maintained in the tree rows and grassy strips between the rows. In both experiments, all agrotechnical works were carried out in accordance with standard commercial orchard procedures. Plant

protection was carried out in accordance with the current recommendations of the Orchard Protection Program.

RESULTS AND DISCUSSION

In the first experiment, vegetative growth varied widely from cultivar to cultivar (Tab. 1). The most vigorous cultivar was 'Morden 604', and the least vigorous was 'Early Orange'. Grzyb et al. (1996) reported that trunk cross-sectional area of 'Morden 604' and 'Harcot' grafted on 'Myrobalan' seedling rootstock were the same.

'Early Orange' had tall, narrow crowns with a small number of annual shoots. 'Morden 604' had wide crowns with numerous lateral shoots.

Cultivars grew more vigorously when grafted on 'Myrobalan' seedling rootstock than on 'Somo' seedling rootstock (Tab. 2 and 3). As a result, crop efficiency coefficient was lower in trees grafted on 'Myrobalan' seedling rootstock than in trees grafted on 'Somo' seedling rootstock.

Table 1. Vegetative growth and crop efficiency coefficient (CEC) in three apricot cultivars grafted on 'Myrobalan' seedling rootstock from 1988 to 1995

Cultivar	Trunk cross-sectional area [cm^2]			Annual shoots per selected branch autumn 1990		CEC 1988-95 [kg cm^{-2}]
	autumn		mean annual increase 1994-95	number	total length [cm]	
	1989	1995				
Early Orange	10.7	170.9	34.8	30.5	1579	0.32
Harcot	13.5	201.3	39.5	79.0	3380	0.16
Morden 604	14.6	218.1	44.2	114.0	3772	0.23
$LSD_{0.05}$	1.2	9.0	2.9	40.6	1052	0.05

Table 2. Vegetative growth and crop efficiency coefficient (CEC) in five apricot cultivars grafted on 'Somo' seedling rootstock from 1996 to 2005

Cultivar	Trunk cross-sectional area [cm^2]			Annual shoots per tree Autumn 1996*		Crown volume [m^3]		CEC 1996-2005 [kg cm^{-2}]
	autumn		mean annual increase 2004-05	number	total length [cm]	autumn		
	1996	2005				2000	2004	
Early Orange	5.1	199.3	27.5	19.1	768	35.3	69.9	0.69
Harcot	5.1	236.2	26.3	35.4	1193	42.1	66.9	0.71
Morden 604	5.6	-	-	39.3	1245	49.4	-	-
Moorpark	5.3	242.9	30.7	26.1	948	33.3	104.0	0.58
Somo	6.0	220.2	16.5	37.3	1407	40.6	83.6	0.97
$LSD_{0.05}$	NS	30.4	9.3	10.0	371	7.3	14.0	0.12

* in the first growing season

Table 3. Vegetative growth and crop efficiency coefficient (CEC) in seven apricot cultivars grafted on 'Somo' seedling rootstock from the cultivar collection from 1996 to 2005

Cultivar	Trunk cross-sectional area [cm^2]			Annual shoots per tree autumn 1996*		Crown volume [m^3]		CEC 1996-2005 [kg cm^{-2}]
	autumn		mean annual increase 2004-05	number	total length [cm]	autumn		
	1996	2005				2000	2004	
Bergeron	4.7	183.2	28.9	28.3	990	29.5	65.3	0.68
Hargrand	6.3	211.2	31.5	32.0	1055	28.8	52.7	0.55
Karola	4.4	190.4	28.2	26.3	840	32.1	67.3	0.60
Ungarische Beste	3.8	204.2	32.2	30.8	893	29.6	80.6	0.30
Veecot	5.2	229.7	30.9	55.3	1483	60.1	97.0	0.61
Velkopavlovicka LE12/2	4.5	232.6	33.3	23.5	812	40.2	106.9	0.45
Velkopavlovicka LE19/2	4.3	199.0	30.6	21.5	518	25.5	57.0	0.19

* in the first growing season

In the second experiment, the most vigorous cultivars were 'Moorpark', 'Velkopavlovicka LE 12/2 and 'Veecot', and the least vigorous were 'Early Orange', 'Bergeron' and 'Karola'. This agrees well with earlier reports (Grzyb et al., 1996; Licznar-Małańczuk and Sosna, 2000; Lopez and Brunton, 2000). In an earlier study, 'Veecot' grew with below average vigour when grafted on *Prunus armeniaca* seedling rootstock (Vachůn, 2001).

The cultivar with the highest crop efficiency coefficient was 'Somo' (0.97 kg cm^{-2}), which generally grew rather weakly. 'Moorpark' had a low crop efficiency coefficient (0.58 kg cm^{-2}). In the cultivar collection, the cultivars with the highest crop efficiency coefficients were 'Ungarische Beste' (0.30 kg cm^{-2} and 'Velkopavlovicka LE 19/2' (0.19 kg cm^{-2}). Of the clones evaluate, LS-4 had the highest vigour and the lowest crop efficiency coefficient, and LS-5 had the lowest vigour and the highest crop efficiency coefficient (Tab. 4).

Mortality was lower in trees grafted on 'Myrobalan' seedling rootstock than in trees grafted on 'Somo' seedling rootstock (Fig. 1 and 2). At the end of the first experiment, the mortality rate was 25% in 'Early Orange', 10% in 'Harcot', and 29% in 'Morden 604' grafted on 'Myrobalan' seedling rootstock. At the end of the second experiment, the mortality rate was 40% in 'Early Orange', and 45% in 'Harcot' grafted on 'Somo' seedling rootstock. Mortality was especially high in 'Morden 604'; already by the end of the third year of the experiment, over half the trees had died, probably because of incompatibility with the 'Somo' seedling rootstock.

Table 4. Vegetative growth and crop efficiency coefficient (CEC) in three apricot clones grafted on 'Somo' seedling rootstock from the clone collection

Clone	Trunk cross-sectional area [cm^2]			Crown volume [m^3]		CEC 1995-2004 [kg cm^{-2}]
	autumn		mean annual increase 2003-04	autumn		
	1995	2004		2000	2004	
LS-4	9.5	290.1	27.3	101.4	144.4	0.72
LS-5	10.1	218.3	28.1	74.1	95.5	1.05
LS-7	7.1	289.9	37.4	65.9	102.2	0.77

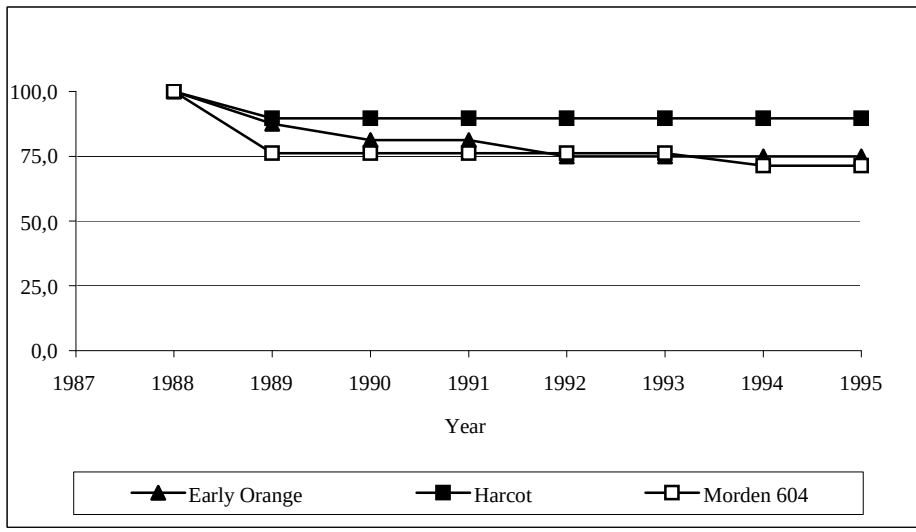

Figure 1. Percentage of survived apricot trees on the 'Myrobalan' seedlings during the first 8 years after planting

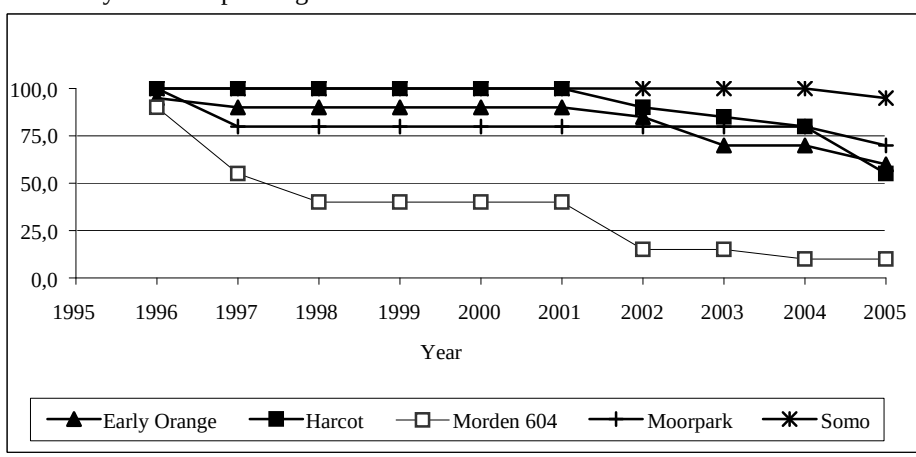

Figure 2. Percentage of survived apricot trees on the 'Somo' seedlings during the first 10 years after planting

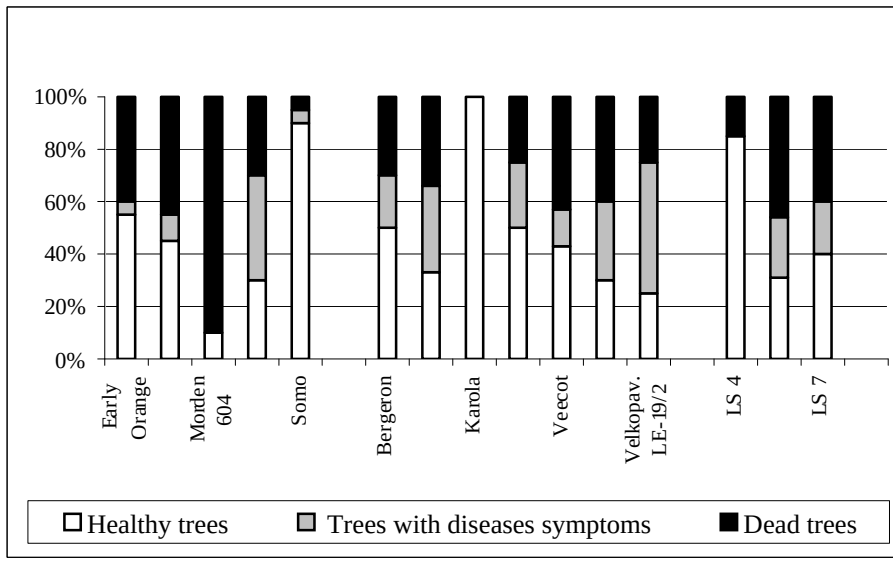

Figure 3. Share of healthy, injured and dead apricot trees on the 'Somo' seedlings 10 years after planting [%]

Table 5. Susceptibility to diseases in apricot cultivars and clones grafted on 'Somo' seedling rootstock

Susceptibility to cankers caused by *Pseudomonas* sp. and *Cytospora* sp.		
low	medium	high
Karola, LS-4, Early Orange, Somo, Bergeron	LS-5, LS-7, Veecot, Ungarische Beste, Morden 604, Harcot	Moorpark, Hargrand, Velkopavlovicka LE12/2, Velkopavlovicka LE19/2
Susceptibility to *Monilia laxa* Sacc.		
low	medium	high
Hargrand, Bergeron, Somo	LS-7, Ungarische Beste, Early Orange, Harcot, Moorpark, Karola	Veecot, LS-5, LS-4, Velkopavlovicka LE12/2, Velkopavlovicka LE19/2, Morden 604

In an earlier study, which included 'Myrobalan' seedling rootstock, mortality was high in 'Harcot' and 'Somo', but low enough in 'Early Orange' to make 'Myrobalan' seedling rootstock a potentially useful rootstock for growing 'Early Orange' (Grzyb et al., 1996). In another study, mortality was highest in 'Harcot', moderate in 'Early Orange' and 'Hargrand' and lowest in 'Veecot' Frecon (1991).

Health status varied widely from cultivar to cultivar (Tab. 5, Fig. 3). Susceptibility to cankers was lowest in 'Karola', 'Somo', 'LS 4' and 'Early Orange', and highest in 'Moorpark', 'Hargrand' and 'Velkopavlovicka LE 19/2'. *Cytospora* sp., *Pseudomonas* sp. and *Chondrostereum purpureum* killed individual branches and even whole trees. Other researchers have also reported that 'Early Orange' is highly

resistant to bark and wood diseases (Bielenin et al., 1986; Grzyb et al., 1996).

Susceptibility to *Monilia laxa* Sacc. was lowest in 'Hargrand', 'Bergeron' and 'Somo', which agrees well with previous reports (Lopez and Brunton, 2000; Topor, 2002).

CONCLUSIONS

The most vigorous genotypes were 'Morden 604', 'Moorpark', 'Velko-pavlovicka LE 12/2, 'Veecot' and LS-4. The least vigorous cultivars were 'Early Orange', 'Bergeron' and 'Karola'. Cultivars grew more vigorously when grafted on 'Myrobalan' seedling rootstock than on 'Somo' seedling rootstock. Mortality was especially high in 'Morden 604'; already by the end of the third year of the experiment, over half the trees had died, probably because of incompatibility with the 'Somo' seedling rootstock. Susceptibility to cankers was lowest in 'Karola', 'Somo', 'LS 4' and 'Early Orange'. Susceptibility to *Monilia laxa* Sacc. was lowest in 'Hargrand', 'Bergeron' and 'Somo'.

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OCENA KILKUNASTU ODMIAN I KLONÓW MORELI W WARUNKACH KLIMATYCZNYCH DOLNEGO ŚLĄSKA

CZĘŚĆ II: WZROST, ZDROWOTNOŚĆ I DŁUGOWIECZNOŚĆ DRZEW

Maria Licznar-Małańczuk i Ireneusz Sosna

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

W Stacji Badawczo-Dydaktycznej Samotwór w okolicach Wrocławia oceniano wzrost wegetatywny, zdrowotność oraz długowieczność drzew kilkunastu odmian i klonów moreli. W doświadczeniu 1. wiosną 1988 roku posadzono jednoroczne drzewa odmian 'Harcot', 'Wczesna z Morden' i 'Early Orange' na siewkach ałyczy w rozstawie 4 x 4 m. Doświadczenie 2. założono wiosną 1995 (klony) i w 1996 roku (odmiany). Jednoroczne okulanty 12 odmian i 3 klonów na siewkach moreli 'Somo' posadzono w rozstawie 5 x 4 m. Na podstawie 8-10-letnich wyników badań można stwierdzić, że na wzrost drzew moreli wpływała zarówno podkładka, jak i odmiana. W porównaniu z morelami uszlachetnionymi na siewkach 'Somo' drzewa na ałyczy rosły znacznie silniej. Najsilniejszym wzrostem wegetatywnym charakteryzowały się odmiany 'Wczesna z Morden', 'Moorpark', 'Velkopavlovicka LE 12/2', 'Veecot' oraz klon LS-4. Z powodu niezgodności fizjologicznej z siewką moreli 'Somo', większość drzew odmiany 'Wczesna z Morden' zamarła już do 3 roku po posadzeniu. Najlepszą zdrowotność (choroby kory i drewna) stwierdzono u drzew odmian 'Karola', 'Somo' 'Early Orange' i klonu LS-4. Najmniejszą wrażliwość na moniliozę stwierdzono u moreli 'Hargrand', 'Bergeron' i 'Somo'.

Słowa kluczowe: morela, odmiana, podkładka, wzrost, zdrowotność, długowieczność