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

PART I: BLOSSOMING OF TREES, YIELD AND FRUIT QUALITY

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A B S T R A C T

Blooming, yield and fruit quality of several apricot cultivars were evaluated 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. In the Wrocław region, yield in apricots was primarily determined by weather conditions. In the first experiment, yields were recorded in only three out of eight years, and in the second experiment, yields were recoded in six out of ten years. The main reason for crop failure was damage to buds, blossoms and fruitlets by winter and spring frosts. In only two years were high yields recorded for most of the cultivars evaluated. Apricot production in Lower Silesia is therefore possible, but risky. On the combined basis of blooming period, harvest time, yield and fruit quality, the cultivars most suitable for commercial production in Lower Silesia are 'Harcot', 'Moorpark', 'Hargrand', 'Bergeron' and 'Karola'. 'Somo' can be recommended only for home gardens because of small fruit size.

Key words: apricot, cultivar, yield, quality, blooming, climate conditions

INTRODUCTION

Research is being conducted all over the world to optimize production of high-quality apricots (Vachůn et al., 1995). In Europe, apricot yields vary from year to year because of frost damage during the blossoming period or because the cultivars planted do not tolerate annual swings in weather conditions (Jakubowski, 1988; Krška, 1993; Szalay et al., 1997; Bassi, 2001). Buds and blossoms are particularly susceptible to frost damage right after post dormancy period (Vachůn, 1995). Many of the best apricot varieties blossom early, and when the buds and blossoms are damaged by spring frosts, the fruit set is reduced (Frecon, 1991).

It is not easy to incorporate traits such as heat and cold requirements, blossoming time, frost hardiness, disease resistance, and high fruit quality into a single breeding program (Bassi, 2001; Benedikova, 2004). Nevertheless, the best and most promising cultivars have been selected for possible commercial production and for further use in breeding programs (Vachůn et al., 1995; Benedikova, 2004). Special efforts have been taken to develop late blooming genotypes (Krška, 1994; Milatović et al., 2000).

Special efforts have also been taken to develop cultivars that can adapt to different and changing environmental conditions. In many countries, apricot production is based on local cultivars, which are well adapted to local conditions prevalent in only one or a few small regions (Bassi, 2001). New cultivars need to be evaluated and selected that can perform well on a commercial scale under local environmental conditions (Bassi, 2001; Tapor 2002). Over the past few years, there has been a growing interest in cultivating some of these newer, better apricot cultivars in Poland. With these improved varieties, the risk associated with adverse weather conditions can be minimized, which will increase interest in apricot production in Poland (Somorowski, 1958; Grzyb et al., 1996).

The aim of this study was to evaluate blossoming time, yield and fruit quality in several new 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'. In the first eight years after planting, yield and fruit quality data were recorded only in 1992, 1993 and 1995 because of weather conditions.

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.

From 1997 to 2005, the following data were recorded for all three groups in the second experiment: yield, fruit quality, beginning of vegetation, blossoming period, and harvest time. Yield was recorded separately for each tree. Fruit weight was recorded as the mean weight of 25 fruits. In 2000 and 2004, marketable yield and unmarketable yield were also recorded. Unmarketable yield included fruits damaged by disease, cracked fruits, and fruits which fell down too early.

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

Beginning of vegetation, blossoming period and harvest time were recorded separately for each tree for all twelve cultivars and all three clones. Blossoming time was estimated based on the visual inspection of the trees on average of five times each spring. Harvest time was recorded every summer. Starting date and duration were recorded for each of the following phenological phases of blossoming:

- White bud phase: bud takes on white or pink colour;
- Full bloom: 50 to 75% of the blossoms are in bloom;
- End of bloom: petals fall and only 5 to 10% of the blossoms are still in bloom.

Data on mean daily air temperature during the blossoming period were recorded at the Agricultural University Meteorological Station in Wrocław-Swojec.

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

The only way to increase apricot production in many countries is to prevent or minimize the risks associated with adverse weather conditions. This was confirmed by the experiments we conducted from 1988

to 2005, when buds, blossoms and fruitlets were frequently injured by winter and spring frosts.

In the first eight years of the experiment, apricot trees yielded only three times (Tab. 2). In 1990, blossoms were damaged by frost at the end of March. In 1991 and 1994 flower buds were frozen in February after a warm January (Tab. 1).

In many countries, including Poland, yield in apricots was primarily determined by weather conditions (Jakubowski, 1978; Krška, 1993; Nitransky, 1993; Szalay and Szabo, 1999; Licznar-Malanczuk and Sosna, 2000). For example, in Hungary, apricot trees bore well in only five years over a ten year period (Porpaczy, 1957).

When grafted on 'Myrobalan' seedling rootstock, apricot trees yielded rather poorly (Tab. 2). The highest total yield was recorded for 'Early Orange', and the lowest for 'Harcot'. 'Myrobalan' seedling rootstock therefore does not seem to be a good rootstock for 'Harcot'. Much lower yields were recorded in similar experiments (Jakubowski, 1988; Grzyb et al. 1996).

Of the cultivars evaluated, 'Harcot' bore the largest fruits (62 g), and 'Morden 604' the smallest (49 g). 'Morden 604' also tended to drop fruits before harvest.

There is a clear correlation between the date on which blossoming begins and the air temperature up to the end of March (Blasse and Hofmann, 1993). Air temperatures have to stay above +4°C for apricot blossoms to open properly. Blasse and Hofmann (1993) also reported that the blossoming period lasted an average of ten days. Here in Wrocław, the blossoming period is about two days shorter (Tab. 3).

Table 1. Mean decade air temperatures during winter and blooming period in 1990-2005

Year	Mean decade air temperature [°C]											
	January			February			March			April		
	I	II	III	I	II	III	I	II	III	I	II	III
1990	-2.3	4.3	5.6	5.7	3.7	7.6	5.7	8.3	9.0	7.0	8.1	9.6
1991	6.0	-1.7	-0.9	-8.8	-3.9	2.3	4.1	8.3	5.5	10.0	7.5	7.6
1992	3.2	1.4	-3.2	2.0	3.2	2.7	5.5	3.5	4.3	6.7	8.2	11.7
1993	-4.7	7.1	1.7	-1.2	0.3	-1.8	-2.7	6.4	3.9	4.6	7.5	17.2
1994	3.6	2.9	3.3	1.8	-5.9	1.0	4.7	5.4	7.0	7.2	7.4	13.2
1995	-3.2	-1.0	3.4	3.4	6.2	4.0	3.9	2.7	3.9	6.8	6.6	12.7
1996	-3.2	-2.1	-8.5	-9.6	-0.2	-2.6	-2.2	-0.7	2.2	4.9	6.0	13.7
1997	-8.5	-3.9	-0.7	1.1	2.3	7.1	5.5	3.8	3.3	5.8	3.6	9.5
1998	5.6	2.9	-2.7	-0.7	7.8	8.3	5.4	1.5	3.8	10.9	7.6	14.3
1999	3.7	1.9	-0.6	0.3	-2.4	2.8	6.2	1.7	8.5	10.8	7.8	11.7
2000	1.1	-0.5	-1.2	6.6	2.1	2.9	5.2	2.9	6.9	6.9	12.3	17.5
2001	2.6	-1.5	1.1	2.2	2.6	-0.9	2.6	5.8	2.1	9.4	4.9	10.0
2002	-3.7	-2.3	7.6	7.5	3.8	3.4	5.3	7.2	4.3	4.7	10.3	11.9
2003	-7.2	0.7	1.7	-3.0	-5.5	-0.5	0.9	4.2	5.8	2.8	8.4	13.7
2004	-5.4	1.8	-5.1	7.3	-0.9	-0.6	-0.4	8.4	5.6	7.7	9.8	11.9
2005	6.0	2.7	-2.1	-2.7	0.2	-2.1	-4.4	3.4	5.8	9.2	11.0	9.1

Table 2. Yield and mean fruit weight in three apricot cultivars evaluated from 1988 to 1995

Cultivar	Yield [kg tree^{-1}]					Mean fruit weight [g]				
	1992	1993	1994	1995	total	1992	1993	1994	1995	mean
Early Orange	8.4	21.1	0.0	25.2	54.7	41	61	-	63	55
Harcot	4.8	14.3	0.0	12.8	31.9	48	67	-	70	62
Morden 604	18.4	24.8	0.0	7.2	50.4	41	50	-	56	49
$LSD_{0.05}$	4.7	6.9	-	9.4	9.9	5	5	-	3	3

Table 3. Starting date and duration of blooming period for several apricot cultivars from 1999 to 2005 and for three apricot clones from 1997 to 2004

Phenological phase	Starting date [day/month/year]		Duration [days]		
	earliest	latest	shortest	longest	mean
Earliest blooming: Early Orange, Morden 604, Veecot					
White bud phase	19.03.02	17.04.03	1	3	
Full bloom	22-23.03.02	20-21.04.03	4	11	7.5
End of blooming	30.03-04.02	25-27.04.03	-	-	-
Intermediate blooming: Harcot, Karola, Moorpark, Velkopavlovicka LE12/2, Velkopavlovicka LE19/2, Hargrand, LS-4, LS-5, LS-7					
White bud phase	20-21.03.02	18-20.04.03	1	4	2.5
Full bloom	23-28.03.02	21-23.04.03	3	13	8.0
End of blooming	1-8.04.02	25-27.04.03	-	-	-
Latest blooming: Somo, Bergeron, Ungarische Beste					
White bud phase	23-24.03.02	19-20.04.03	1	3	2.0
Full bloom	28-30. 03.02	22-23.04.03	4	11	7.5
End of blooming	6-9.04.02	27.04.03	-	-	-

In years with a cold early spring, apricot trees started to bloom late and the blooming period was relatively short. This agrees with an earlier report that the later the blossoming period starts, the shorter it lasts (Szalay and Szabo, 1999). The cultivars which bloomed the earliest were 'Early Orange', 'Morden 604' and 'Veecot', and the cultivars which bloomed the latest were 'Somo', 'Bergeron', and 'Ungarische Beste'.

Over the first eight years of the experiment, blossoming time varied by about one month. However, blossoming occurred most often in the middle of April, at about the same time as in other warmer countries (Szalay and Szabo, 1999; Krejzova, 2000).

In the second experiment, ripening time differed from genotype to genotype and from year to year (Tab. 4). In the coldest years, fruits were ready for harvest about month later than in the warmest years. The cultivars which ripened the earliest were 'Karola', 'Early Orange' and 'Harcot', and the cultivars which

Table 4. Harvest time in several apricot cultivars from 1999 to 2005 and for three apricot clones from 1997 to 2004

Cultivar/clone	Harvest time [day/month]	
	earliest	latest
Early cultivars		
Karola, Early Orange, Harcot	27-29.06	20-27.07
Morden 604, Veecot	5.07	23-24.07
Intermediate cultivars and clones		
Ungarische Beste, Velkopavlovicka LE12/2, Velkopavlovicka LE19/2, LS-5, LS-4	5-9.07	30.07-4.08
Moorpark, LS-7	9-12.07	4.08
Late cultivars		
Somo, Hargrand, Bergeron	12-16.07	8-11.08

Table 5. Yield and mean fruit weight in several apricot cultivars evaluated from 1996 to 2005

Cultivar	Yield [kg tree^{-1}]							
	1999	2000	2001	2002	2003	2004	2005	total/mean
Yield [kg tree^{-1}]								
Early Orange	-	36.7	8.0	14.7	67.2	0.0	10.8	137.3
Harcot	-	48.0	6.8	13.6	73.3	7.3	18.0	167.0
Morden 604	-	38.1	2.4	-	-	-	-	-
Moorpark	-	35.1	7.5	1.3	35.5	59.7	2.0	141.1
Somo	0.7	51.8	13.0	9.9	65.6	1.0	72.4	214.3
$LSD_{0.05}$	-	8.4	4.0	3.7	12.1	5.4	16.4	27.8
Mean fruit weight [g]								
Early Orange	-	40	70	55	25	-	57	49
Harcot	-	44	77	66	37	73	72	61
Morden 604	-	42	62	-	-	-	-	-
Moorpark	-	50	66	63	45	60	65	58
Somo	41	24	32	38	14	32	25	29
$LSD_{0.05}$	-	3	4	5	6	5	6	2

ripened the latest were 'Somo', 'Hargrand' and 'Bergeron'. These results agree with other studies (Frecon, 1991).

Over the ten year study period, yields were recorded in six years, but high yields were recorded only in 2000 and 2003 (Tab. 5, 6 and 7). Alternate bearing was observed, especially in 'Early Orange', 'Somo' and 'Veecot'. In another study on cultivation of some varieties without fruitlet thinning, yields tended to be very high in some years and very low the following year (Vachůn, 2001).

From 1997 to 2005, yield varied widely from genotype to genotype.

Table 6. Yield and mean fruit weight in several apricot cultivars in the cultivar collection evaluated in 1996-2005

Cultivar	Year						
	2000	2001	2002	2003	2004	2005	total/mean
	Yield [kg tree^{-1}]						
Bergeron	13.6	25.0	8.8	43.3	13.1	21.0	124.8
Hargrand	32.4	17.6	7.2	45.2	13.1	0.0	115.5
Karola	24.7	4.5	0.4	54.3	30.2	0.9	115.0
Ungarische Beste	11.4	8.4	0.3	17.3	23.9	0.5	61.8
Veecot	40.9	0.0	31.8	63.6	0.0	4.9	141.2
Velkopavlovicka LE12/2	19.5	1.5	0.3	47.5	34.3	1.8	104.9
Velkopavlovicka LE19/2	11.4	1.6	0.4	9.9	14.2	0.6	38.1
	Mean fruit weight [g]						
Bergeron	43	48	44	23	66	63	48
Hargrand	55	82	92	51	94	-	75
Karola	37	58	52	37	46	54	47
Ungarische Beste	45	62	64	48	63	64	58
Veecot	42	-	45	33	-	51	43
Velkopavlovicka LE12/2	64	72	69	50	64	69	65
Velkopavlovicka LE19/2	46	66	58	41	65	63	57

Table 7. Yield and mean fruit weight in three apricot clones evaluated from 1995 to 2004

Clone	Year								
	1997	1998	1999	2000	2001	2002	2003	2004	total/ mean
	Yield [kg tree^{-1}]								
LS 4	1.5	0.5	0.3	59.4	0.8	19.5	120.6	5.8	208.4
LS 5	2.7	0.2	0.5	66.4	1.6	65.4	71.9	20.1	228.8
LS 7	2.0	0.7	0.2	100.0	8.5	1.2	83.3	26.4	222.3
	Mean fruit weight [g]								
LS 4	53	63	58	41	57	48	21	42	48
LS 5	46	55	60	38	52	38	30	49	46
LS 7	43	35	35	25	49	46	26	47	38

The cultivar with by far the highest yield was ‘Somo’ (214 kg). High yields were also recorded for ‘Harcot’, ‘Moorpark’, ‘Veecot’, ‘Bergeron’ ‘Hargrand’ and ‘Karola’. All of the clones from Albigowa bore over 200 kg/tree. With ‘Morden 604’, data were recorded for only six years because so many trees had died off. ‘Somo’ and ‘Bergeron’ have been reported to be

high yielding cultivars in other studies as well (Grzyb et al., 1996; Milatović et al., 2000; Vachůn, 2001). In other studies, 'Harcot' was reported to bear very low crops (Grzyb et al., 1996; Jakubowski, 1988).

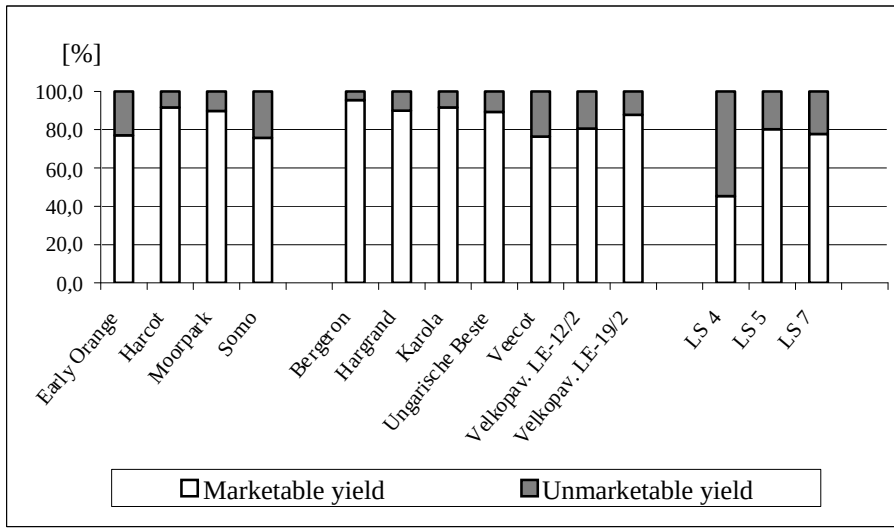

Figure 1. The structure of apricot yield (mean for 2000 and 2004)

Fruit weight depended on the cultivar and on crop load (Tab. 5, 6 and 7). Fruits were smaller in years when productivity was high. In the second experiment, the cultivars with the largest fruits were 'Harcot' (61 g) and 'Moorpark' (58 g). The cultivar with by far the lowest fruit weight was 'Somo' (29 g). In the collection, the cultivar with the largest fruit was 'Hargrand', which was also reported to bear large fruit in another study (Lopez and Brunton, 2000). In this experiment, mean fruit weight in 'Bergeron' was 48 g, which agrees well with an earlier report that mean weight in 'Bergeron' was 45 g (Milatović et al., 2000).

The varieties with the highest marketable yields were 'Bergeron', 'Harcot', 'Karola' and 'Hargrand' (Fig. 1). The variety with the lowest marketable yield was the clone LS-4, which was prone to extensive pre-harvest fruit dropping.

CONCLUSIONS

In the Wrocław region, yield in apricots was primarily determined by weather conditions. In the first experiment, yields were recorded in only three out of eight years, and in the second experiment, yields were recoded in six out of ten years. The main reason for crop failure was damage to buds, blossoms and fruitlets by winter and spring frosts. In only two years were high yields recorded for most of the evaluated cultivars. Apricot production in Lower Silesia is therefore possible, but risky.

On the combined basis of blooming period, harvest time, yield and fruit quality, the cultivars most suitable for commercial production in Lower Silesia are 'Harcot', 'Moorpark', 'Hargrand', 'Bergeron' and 'Karola'. 'Somo' can be recommended only for home gardens because of small fruit size.

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OCENA KILKUNASTU ODMIAN I KLONÓW MORELI W WARUNKACH KLIMATYCZNYCH DOLNEGO ŚLĄSKA

CZĘŚĆ I: KWITNIENIE DRZEW, PLONOWANIE ORAZ JAKOŚĆ OWOCÓW

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

W latach 1988-2005 w Stacji Badawczo-Dydaktycznej Samotwór w okolicach Wrocławia prowadzono badania nad kwitnieniem, plonowaniem oraz jakością owoców 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 1996 roku (odmiany) również metodą losowanych bloków. Jednoroczne okulanty 12 odmian i 3 klonów na siewkach moreli 'Somo' posadzono w rozstawie 5 x 4 m. W okolicach Wrocławia plonowanie moreli jest uzależnione od warunków pogodowych. W doświadczeniu 1. w okresie 8 lat po posadzeniu morele plonowały tylko 3 razy, a w drugim okresie w pierwszych 10 lat po posadzeniu 6 razy, ale tylko dwa zanotowane plony były dla wszystkich odmian wysokie. Na podstawie 8-10-letnich wyników badań można stwierdzić, że uprawa moreli w warunkach klimatycznych Dolnego Śląska jest możliwa, ale ryzykowna. Biorąc pod uwagę wysokość i jakość zebranego plonu oraz termin kwitnienia i dojrzewania owoców, za najcenniejsze odmiany do produkcji towarowej można uznać morele 'Harcot', 'Moorpark', 'Hargrand', 'Bergeron' i 'Karola'. Ze względu na zbyt drobne owoce, odmianę 'Somo' można polecać tylko do uprawy amatorskiej.

Słowa kluczowe: morela, odmiana, plon, jakość, kwitnienie, warunki klimatyczne