

## THE EFFECT OF ROOTSTOCK AND AGE TREES ON THE GROWTH AND CROPPING OF SZAMPION CULTIVAR APPLE TREES

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**Abstract.** In 2001–2003 on Sandomierska Upland researches were done in order to estimate the influence of the rootstock and the age on the growth and yielding of the ‘Szampion’ trees. This cultivar was grafted on P60 and M.26 rootstock. It was stated that the ‘Szampion’ had given abundant crops (73–113 t/ha on average) due to magnificent conditions of Sandomierska Upland. The height of the yield depended in a significant way on the rootstock (six-year-old trees on P60 yielded considerably better than on M.26) and the age of trees – the trees on M.26 younger by 2 years provided a significantly better yield. The growth and quality of fruits of the ‘Szampion’ depended on the age of scrutinized trees. The proportion of fruit with the diameter of more than 7.0 cm in all the studied combinations exceeded 80% and it was the highest in the trees on P60.

**Key words:** apple, rootstock, yield, growth, fruit quality

### INTRODUCTION

The future of the profitable production of apples is to a large extent dependent on the proper choice of cultivar and rootstock, which affect the growth, size of trees, earliness of fruiting, the quality of fruit and the yield [Autio et al. 1991, Czynczyk and Omiecińska 1992, Skrzyński and Poniedziałek 2000]. The choice of rootstocks as well as cultivars intended for the establishment of modern orchards should be adjusted to the soil-climatic conditions [Czynczyk 1998].

Analyzing the present situation in Polish fruit growing we find out that cultivar Szampion enjoys considerable interest both among the producers and consumers. Without any doubt it occupies the second place, after Jonagold cv., as the basic cultivar cultivated in our orchards. The properties that are decisive of the popularity of this cultivar include the quality and taste of the fruit and reliability in the production [Kuczyńska 2002].

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The purpose of the experiment was to estimate the effect of rootstock and the age of trees on the growth and yielding of Szampion cv. apple trees.

## MATERIAL AND METHODS

The studies were conducted in the years 2001–2003 on the Sandomierska Upland. The experimental material consisted of Szampion cv. trees grafted on rootstocks M.26 at the age of 6 and 8, and P60 at the age of 6 at the moment of setting the experiment. The trees were planted in the spring of 1994 and 1996 at the spacing of  $3.0 \times 1.0$  m on loess soil as one-year-old grafts. The tree crowns were led in the axis form and metal poles with wires and wooden stakes were used as supports.

The experiment was established in the scheme of random blocks and it included 3 combinations in 5 repetitions. The combinations were Szampion cv. trees on rootstocks P60 and M.26 at different ages, while the repetitions were the plots, where 5 plants grew on each.

The measurements and observations carried out in the years 2001–2003 concerned the growth, yielding and quality of fruit. The growth of the trees was evaluated yearly in autumn after the vegetation period was over, making the measurement of the diameter at the height of 30 cm above the place of grafting. The fruit were picked in the last 10 days of September, separately for each tree within each class. The production index was estimated converting the yield per  $\text{cm}^2$  of the trunk cross-sectional area. The fruit were divided in regards of the size of a randomly selected group of 100 apples from each repetition. The fruit firmness was established by means of a firmness measurer one day after the picking on the basis of 10 apples from each repetition.

The results achieved in the experiment were statistically analyzed by means of variance analysis. t-Tukey test was used to evaluate the significance of differences, at the significance of 5%.

## RESULTS AND DISCUSSION

The mean yield in the period of three years ranged from 22.0 to  $34.3 \text{ kg}\cdot\text{tree}^{-1}$ , whereas in conversion to an area unit it was from 73.1 to  $113.4 \text{ t}\cdot\text{ha}^{-1}$ . On average, a significantly higher yield was obtained from older trees as compared to younger ones on M.26. The yield was proportional to the size of the trees (tab. 1 and 2). This is in agreement with earlier studies of other authors [Stangret and Jadczyk 1998, Rejman et al. 2002].

Analyzing the differences in the size of the yield in particular years it was observed that in the first and last years the yield in all the examined trees differed from each other in a significant way. Significantly the best yield was given by older trees, while the worst by younger ones on M.26. In 2002 the statistical analysis did not show any significant differences in the yielding of older trees and those that were grafted on P60.

It was shown that in the group of younger trees the rootstock had a significant influence on the yielding. In the successive three years of studies a significantly higher yield

was obtained from the trees on P60 as compared to M.26. Similar results were achieved by Kurlus and Ugolik [1996] and Skrzyński and Poniedziałek [1998, 2000] as well as Ostrowska and Mazurczak [2001], when studying Jonagold cv.

Table 1. Effect of rootstock and age of trees on cropping of 'Szampion' apple trees  
Tabela 1. Wpływ podkładki i wieku drzew na plonowanie jabłoni odmiany Szampion

Yield Plon	Combination Kombinacja	2001	2002	2003	$\bar{x}$	Differences between years Różnica między latami			LSD <sub>0.05</sub> NIR <sub>0.05</sub>
kg tree <sup>-1</sup> kg z drzewa	'Szampion' P60 trees age – 6 years wiek drzew – 6 lat	26.4 b	33.5 a	27.5 b	29.1 ab	B	A	B	2.8
	'Szampion' M.26 trees age – 6 years wiek drzew – 6 lat	19.6 c	24.8 b	21.6 c	22.0 b	B	A	B	3.0
	'Szampion' M.26 trees age – 8 years wiek drzew – 8 lat	35.4 a	35.1 a	32.5 a	34.3 a	-	-	-	ns ni
	LSD <sub>0.05</sub> NIR <sub>0.05</sub>	4.1	3.5	2.8	7.1				
t ha <sup>-1</sup>	'Szampion' P60 trees age – 6 years wiek drzew – 6 lat	87.3 b	110.6 a	91.0 b	96.3 ab	B	A	B	9.4
	'Szampion' M.26 trees age – 6 years wiek drzew – 6 lat	64.6 c	82.0 b	72.7 c	73.1 b	B	A	B	9.0
	'Szampion' M.26 trees age – 8 years wiek drzew – 8 lat	117.0 a	116.0 a	107.3 a	113.4 a	-	-	-	ns ni
	LSD <sub>0.05</sub> NIR <sub>0.05</sub>	13.6	11.7	10.5	23.4				

Explanation: Means followed by the same letter are not significantly different at  $\alpha = 0.05$

Objaśnienie: Średnie oznaczone tą samą literą nie różnią się istotnie przy  $\alpha = 0,05$

Table 2. Growth and productivity index of Szampion apple trees  
Tabela 2. Wzrost i produktywność drzew odmiany Szampion

Combination Kombinacja	Trunk cross-sectional area, cm <sup>2</sup> Pole powierzchni przekroju poprzącznego pnia, cm <sup>2</sup>				Productivity index, kg cm <sup>-2</sup> Współczynnik plenności, kg cm <sup>-2</sup>			
	2001	2002	2003	$\bar{x}$	2001	2002	2003	$\bar{x}$
'Szampion' P60 trees age – 6 years wiek drzew – 6 lat	20.3 b	23.4 b	25.7 b	23.1 b	1.3 a	1.4 a	1.1 a	1.3 a
'Szampion' M.26 trees age – 6 years wiek drzew – 6 lat	18.2 b	20.6 b	24.7 b	21.2 b	1.1 ab	1.2 a	0.9 b	1.1 ab
'Szampion' M.26 trees age – 8 years wiek drzew – 8 lat	46.8 a	52.8 a	60.0 a	53.2 a	0.8 b	0.7 b	0.5 c	0.7 b
LSD <sub>0.05</sub> NIR <sub>0.05</sub>	9.2	7.6	9.8	11.3	0.3	0.4	0.1	0.4

For explanations: see table 1 – Objąśnienie: patrz tabela 1

Table 3. Effect of rootstock and age of trees on quality of fruits of 'Szampion' apple trees  
Tabela 3. Wpływ podkładki i wieku drzew na jakość owoców odmiany Szampion

	Combination Kombinacja	2001	2002	2003	$\bar{x}$	Differences between years Różnica między latami			LSD <sub>0.05</sub> NIR <sub>0.05</sub>
Number of fruit per tree Liczba owoców z drzewa w szt.	'Szampion' P60 trees age – 6 years wiek drzew – 6 lat	163.3 b	178.4 a	175.4 a	172.4	-	-	-	ns ni
	'Szampion' M.26 trees age – 6 years wiek drzew – 6 lat	114.5 c	141.3 b	154.1 b	136.6	B	A	A	24.2
	'Szampion' M.26 trees age – 8 years wiek drzew – 8 lat	219.0 a	151.8 b	194.1 a	188.3	A	B	A	31.2
	LSD <sub>0.05</sub> NIR <sub>0.05</sub>	34.2	20.8	19.0	ni ns				
Fruit weight, g Masa owocu, g	'Szampion' P60 trees age – 6 years wiek drzew – 6 lat	162.0	188.0 b	157.0 ab	169.0	B	A	B	10.0
	'Szampion' M.26 trees age – 6 years wiek drzew – 6 lat	172.0	176.0 b	143.0 b	164.0	A	A	B	21.0
	'Szampion' M.26 trees age – 8 years wiek drzew – 8 lat	163.0	231.0 a	167.0 a	187.0	B	A	B	17.0
	LSD <sub>0.05</sub> NIR <sub>0.05</sub>	ns ni	12.4	17.8	ns ni				
Fruits with diameter >7,0 cm, % Owoce o średnicy >7,0 cm, %	'Szampion' P60 trees age – 6 years wiek drzew – 6 lat	84.4 a	93.5 a	85.0 a	87.6	B	A	B	3.9
	'Szampion' M.26 trees age – 6 years wiek drzew – 6 lat	87.4 a	77.2 b	81.0ab	81.9	A	C	B	3.4
	'Szampion' M.26 trees age – 8 years wiek drzew – 8 lat	74.3 b	94.3 a	79.0 b	82.5	C	A	B	3.5
	LSD <sub>0.05</sub> NIR <sub>0.05</sub>	3.8	3.2	4.0	ns ni				
Fruit firmness, kg·cm <sup>2</sup> Jędrność owoców, kg·cm <sup>2</sup>	'Szampion' P60 trees age – 6 years wiek drzew – 6 lat	5.0 c	6.5 a	5.3 b	5.6	B	A	B	0.5
	'Szampion' M.26 trees age – 6 years wiek drzew – 6 lat	5.2 b	5.8 b	5.3 b	5.4	B	A	B	0.3
	'Szampion' M.26 trees age – 8 years wiek drzew – 8 lat	5.9 a	6.0 b	5.9 a	5.9	-	-	-	ns ni
	LSD <sub>0.05</sub> NIR <sub>0.05</sub>	0.4	0.3	0.4	ns ni				

For explanations: see table 1 – Objaśnienie: patrz tabela 1

The estimation of the yielding of trees between the years showed that the oldest trees yielded on a similar level in successive years, while younger ones had a considerably higher yield in 2002 as compared to the other years.

The strength of growth defined as the trunk cross-sectional area was differentiated and it depended on the age of the examined trees (tab. 2). Throughout the three years of studies older trees of Szampion cv. were characterized by a significantly larger trunk area than the younger ones. It was observed in the group of younger trees that those on P60 had a slightly larger area than the trees on M.26, the differences being insignificant. The results do not confirm the observations made by Ostrowska and Mazurczak [1999] and Stangret and Jadczyk [1998].

On average, in the years 2001–2003 older trees were distinguished by a significantly lower value of the productivity index as compared to the trees grafted on rootstock P60. A similar regularity was observed in the first year of studies. In the successive years older trees were significantly less productive than the younger ones. The apple-trees grafted on P60 were characterized by greater productivity than the trees of the same age on M.26. Those differences were significant in the last year. Similar results were achieved by Ostrowska et al. [2002] and Skrzyński and Poniedziałek [2000] in earlier studies.

The number of fruit on a tree ranged from 136.6 to 188.3 (tab. 3). The greatest number of fruit in 2001 and 2003 was obtained from older trees, while in the second year of the research – from the trees grafted on P60. In the group of younger trees the number of fruit depended significantly on the type of rootstock. In particular years much fewer apples were obtained from the trees on M.26 than on P60.

The fruit quality was estimated for example on the basis of the fruit weight, which ranged from 164.0 to 187.0 g. In the first year of the research and for the mean value of three years the studies showed no significant effect of the rootstock or the age of the trees on the mean fruit weight. In the second and third years of studies older trees formed the fruit with a greater weight than younger trees on M.26. The mean fruit weight from the trees of the same age was fairly equal and it did not differ in a significant way. Similar results were achieved by Ostrowska et al. [2002] and Skrzyński and Poniedziałek [2000]. In 2002 the fruit from the trees on P60 and the older ones were characterized by a significantly higher weight than in the remaining years. The fruit from the younger trees of Szampion cv. in the last year had a significantly smaller weight than in the years 2001 and 2002.

A yield of good quality was obtained from the trees on the studied types of rootstock in all the years of the research. The percentage proportion of apples with the diameter of more than 7.0 cm on all rootstocks exceeded 80%. The highest percentage of fruit with the diameter of more than 7.0 cm was gathered from the trees on rootstock P60 (87.6%). Similar results were also obtained by Ostrowska et al. [2002].

The studies did not show any distinct influence of the rootstock or the age of trees on the fruit firmness. The best mean firmness in the period of collective ripeness was characteristic of the apples from older trees. Łysiak [1999] estimated the fruit firmness of Szampion cv. fruit during the harvest and he stated that the fruit from the trees growing on rootstock P60 were characterized by significantly better firmness than the fruit from the trees on M.26. This observation was confirmed in the present study only in the

year 2002. In the first and last years significantly better firmness was characteristic of the fruit from older trees as compared to the younger ones. Evaluating the differences between the years, it was observed that the fruit firmness on older trees in the successive years remained on the same level, while in the other combinations in 2002 the fruit had between firmness than in the other years.

## CONCLUSIONS

1. A very good yielding of Szampion cv. was obtained in the conditions characterizing the Sandomierska Upland ( $73\text{--}113\text{ t}\cdot\text{ha}^{-1}$ , on average).

2. The height of the yield depended in a significant way on the rootstock (six-year-old trees on P60 yielded considerably better than on M.26) and the age of trees – the trees on M.26 younger by 2 years provided a significantly better yield.

3. The productivity of the studied trees was related to their age. Older trees were less productive than the younger ones, while in the second and third years those differences were significant.

4. The examined rootstocks did not significantly differentiate the strength of growth and the weight of fruit of Szampion cv, those properties considerably depending on the age of the trees.

5. The proportion of fruit with the diameter of more than 7.0 cm in all the studied combinations exceeded 80% and it was the highest in the trees on P60.

6. The fruit firmness of Szampion cv. was related to the age of the studied trees. On average, the fruit from older trees were characterized by better firmness than the apples from younger trees.

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## **WPŁYW PODKŁADKI I WIEKU DRZEW NA WZROST I PLONOWANIE JABŁONI ODMIANY SZAMPION**

**Streszczenie.** W latach 2001–2003 na Wyżynie Sandomierskiej przeprowadzono badania mające na celu ocenę wpływu podkładki i wieku drzew na wzrost i plonowanie jabłoni odmiany Szampion okulizowanej na podkładce P60 i M.26. Stwierdzono, że w warunkach Wyżyny Sandomierskiej drzewa odmiany Szampion plonowały bardzo obficie (średnio 73–113 t/ha). Wysokość plonu zależała istotnie od podkładki (drzewa „sześćioletnie” na P60 plonowały istotnie lepiej niż na M.26) oraz od wieku drzew – drzewa na M.26 o 2 lata młodsze dawały istotnie niższy plon. Siła wzrostu, produktywność i masa owoców odmiany Szampion zależały od wieku badanych drzew. Udział owoców o średnicy powyżej 7.0 cm we wszystkich badanych kombinacjach przekraczał 80% i był największy u drzew na P60.

**Słowa kluczowe:** jabłoń, podkładka, odmiana, plon, wzrost, jakość owoców

Accepted for print – Zaakceptowano do druku: 12.03.2005