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EFFECT OF THE METHOD OF PLANTING AND ROOTSTOCK ON GROWTH AND YIELDING OF SELECTED APPLE CULTIVARS

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Abstract. Dense trees planting is one of the ways to obtain high yielding from area unit soon after establishing an orchard. Diminished space occupied by trees in dense planting systems also brings about their weaker vegetative growth. Another factor influencing growth and yielding is planting trees in ridges. Investigation was conducted in the orchard belonging to Research – Development Station in Samotwór, owned by Department of Horticulture at Wroclaw University of Environmental and Life Sciences. It aimed at the assessment of growth and yielding of four apple cultivars: 'Piros', 'Sunrise', 'Pinova' and 'Ligol', growing on two dwarf rootstocks M.9 and P 22. The trees were planted in ridges in high density. Two – year – old trees were planted in the spring 2004. Research covered the years 2004–2008 and was carried out as two – factorial experiment. The first factor involved particular way of planting trees – traditional or in ridges. The type of rootstock used constituted the second examined factor. The trees on M.9 rootstock were planted in 3.5 m × 0.5 m spacing (5714 trees·ha^{-1}), while apple trees on P 22 rootstock followed the spacing of 3.5 × 0.3 m (9523 trees·ha^{-1}). In the case of young trees growing densely, the effect of planting in ridges on growth and yielding was strictly related to apple cultivar and rootstock. Among the trees on M.9 rootstock, the highest yield was collected from cultivar 'Ligol'. The trees of 'Piros' cv., planted in ridges provided the lowest yield on both used rootstocks. The negative effect of ridges on total yield for 'Ligol' and 'Sunrise' cvs. on M9 was noted. No differences were observed in the total yield from trees of 'Pinova', 'Ligol' i 'Sunrise'cvs. on rootstock P 22. Method of planting had no effect on the yield of each cultivar on this rootstock. Cultivar 'Ligol' on M.9 rootstock, characterized the strongest growth. Among the trees on rootstock P 22, cultivar 'Sunrise' grew the weakest. Planting in ridges, reduced the growth of 'Ligol' on M.9 and 'Piros' cvs. on P 22 rootstock. Dense planting of trees in ridges did not affect yield and vigour of four cultivars of apple trees on two dwarfing rootstocks. In the conditions of high density trees response to planting in ridges was diverse and depended on a cultivar, the kind of a rootstock and the age of trees. Dense planting of trees in ridges did not provide favorable conditions for growth and fruiting of the examined apple trees cultivars in the first five years after planting.

Key words: apple tree, rootstock, sparing, planting in ridges, growth, fruiting

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INTRODUCTION

Analysis of apple fruit development within the period of the last 50 years have proved significant technological-scientific advancement in the field of orchard management. The latter phenomenon has been reflected in measurements and alterations in natural technological parameters, such as orchards area, number of trees, as well as yield size [Brzozowski 2009]. According to the mentioned analysis, the changes leading to higher yielding of apple trees resulted mainly from intensity of apples production in Poland, which, in turn, depended on the increase in the number of trees per area unit. Dense trees planting is one of the ways to obtain high yielding from area unit soon after establishing an orchard [Mika and Krzewińska1999]. According to Mika and Krzewińska [1999], in the conditions of considerable trees density on one hectare, the decrease in unitary yield and deterioration of its quality is caused by trees mutual competence for light and mineral components. In trees planted densely the tendency to biennial fruiting is observed, as well [Licznar-Małańczuk 2001b]. Diminished space occupied by trees in dense planting systems also brings about their weaker vegetative growth [Licznar-Małańczuk, 2004]. In Szewczuk and Gudarowska opinion [2004b], the way of pruning trees affects regularity of fruiting, as well as the size and quality of yield obtained from densely planted trees. Treder and Czynczyk [1997] recorded advantageous effect of irrigation on yield size and quality in density apple trees orchard.

One of the factors influencing growth and yielding is planting trees in ridges [Szewczuk and 2004]. This method is a modification of traditional system of planting consisting in placing trees directly on the surface of soil and then covering root system with soil coming from the space between rows. In this way there are formed elevated ridges in which trees grow during the whole cultivation period. This way of planting is recommended when orchards are established on stands featuring high level of ground water [Perry 1996], and even to improve trees replantating [Bootsma 1995]. In the conditions of trees replanting there was initially obtained more intensive growth regarding trees planted in ridges, yet in the following years it was slightly reduced as compared to trees growth when traditional planting was applied [Bootsma 1995]. So far, the results of the influence of the planting methods on growth and fruiting of the trees have not been univocal. Sako and Laurinen [1986] proved that trees cultivated in that way characterized more intensive growth than control trees planted in a traditional way. However, Treder and Mika [2001] observed weaker trees growth only since the third year after planting. Ridges suppress the development of root system in its upper part [Szewczuk et al. 2009]. The mentioned phenomenon can have disadvantageous impact on nutrients intake, especially in the case of young trees.

In examination by Szewczuk and Gudarowska [2004a] apple trees of ‘Jonagored’ cv. on M.9 rootstock, planted in 3,5 × 0,5 m sparing, featured stronger growth and higher yielding in comparison to traditionally planted trees. Different results were obtained by Sosna [2004] who reported that ‘Golden Delicious’ cv. on M.9 rootstock, densely planted in ridges, characterized weaker vegetative growth in relation to apple trees planted in a traditional way and with moderate density.

Nowadays, due to dwarfing rootstocks, there has been introduced gradually smaller spacing between trees. Dense planting prevents obtaining high yields from area unit in

the first years after planting trees. Along with increasing density, occur problems involving fruit quality, alternate fruiting and yield size, for the trees grow in the condition of strong competition as far as light, water and nutrient components are concerned.

Growth and yielding of densely planted trees are modified by plant variety, age and cultivation conditions. The aim of our research was to determine if combination of high density of trees on area unit with placing trees in elevated ridges can result in positive effect for more intensive vegetative growth, which could translate into higher yielding of apple trees in their first years after planting.

MATERIAL AND METHODS

Investigation was conducted in the orchard owned by Research – Development Station in Samotwór, which belongs to Department of Horticulture at Wroclaw University of Environmental and Life Sciences, in the years 2004–2008.

Two year old trees of 'Piros', 'Sunrise', 'Pinova' and 'Ligol' cv. were planted in the spring 2004. The first examined factor involved determined way of planting trees – traditional and in ridges. The second factor was the type of rootstock. Trees on M.9 rootstock were planted in 3.5 m × 0.5 m spacing (5714 trees·ha^{-1}), and those on P 22 rootstock were planted in 3.5 × 0.3 m spacing (9523 trees·ha^{-1}).

Experiment was established according to split – plot method, in four replications, with three trees on each plot. In the first year after planting there was performer a forming pruning, as well as all the flowers were removed. Trees were trained in the form of a vertical axis crown. The size and quality of yield were subjected to the assessment. The parameter describing vegetative growth was increment in cross – section area of a tree trunk. To determine relation between trees growth and their yielding there was calculated productivity index. The results were analyzed statistically, according to the method of analysis of variance and estimation of significance of differences was done with the use of t-Student test at significance level $\alpha = 0.05$.

Weather conditions during the experiment. To describe weather conditions in the years 2005–2008 there was followed a graphic method worked out by Walter and Lieth [1967]. It consists in juxtaposing mean monthly temperatures with summary monthly precipitation applying the ratio 1°C: 3 mm of a rainfall. In the years 2005–2008 there occurred longer dry periods which could have influenced on both vegetative growth and yielding (fig. 1). In May and July 2005 there took place intensive rainfalls, while the second half of summer and autumn characterized significantly low level of rainfalls which resulted in the fact that the period between August and November could be considered as an unfavourable for the growth of apple trees. In 2006, dry periods occurred several times. Definite precipitation shortage was recorded in May and July which, in August, was followed by record precipitation ranging 230 mm. Then another dry period took place in September. The year 2007 proved to be relatively wet and warm in comparison to the remaining years of the experiment. In summer months there occurred a sufficient amount of rainfall to provide protection from draught and to ensure favourable conditions for apple trees cultivation. The only exception was the beginning of plant growing period, especially April, which featured a slight precipitation

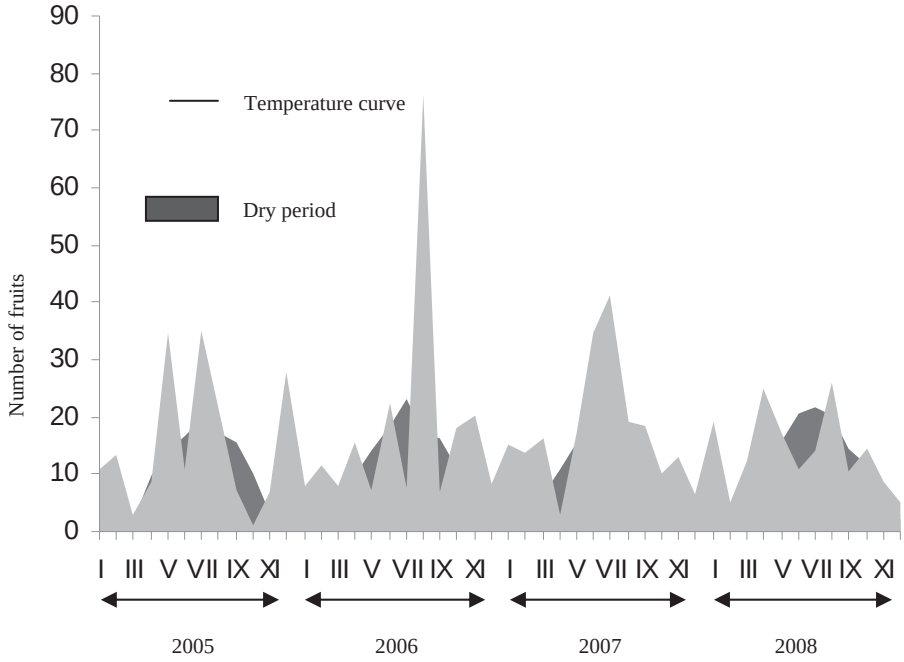

Fig. 1. Climograph for the years 2005–2008
Rys. 1. Klimatogram dla lat 2005–2008

(8.2 mm).Taking into account the temperatures of plant growing period, 2008 can be viewed as a rather warm year. High temperatures, combined with low precipitation level in the summer (especially in July and August) brought about a long – lasting dry period., from May to the half of July and also in September. In one year (2007) the quantity of precipitation can be considered as a satisfactory one, while in the years in 2005–2006 and 2008 precipitation level could reduce trees growth and development.

RESULTS AND DISCUSSION

The influence of estimated method of planting on growth and yielding of apple trees depended on the rootstock and has been modified by the cultivar (tab. 1–7). Among the trees on M.9 rootstock, the highest yield was collected from cultivar 'Ligol'. The trees of 'Piros' cv., planted in ridges provided the lowest yield on both used rootstocks (tab. 1–2). The method of planting did not affect the yield of trees of 'Piros' i 'Pinova' cvs. on M.9 rootstock. However, there was observed negative effect of planting trees in ridges on summary yield in the case of 'Ligol' and 'Sunrise' cvs. on this rootstock (tab. 1). No significant differences were noted in the total yield from the second to the fifth year after planting, from trees of 'Pinova', 'Ligol' i 'Sunrise'cvs. on rootstock P 22. Also, method of planting had no effect on the yield of examined cultivars on this rootstock (tab. 2).

Table 1. The influence of planting method and cultivar on rootstock M9 on yielding in years 2005–2008

Tabela 1. Wpływ sposobu sadzenia i odmiany na podkładce M9 na plonowanie w latach 2005–2008

Treatment Kombinacja		Yield, kg·tree^{-1} Plon, kg·drzewo^{-1}				Total yield Suma plonu 2005–2008
Cultivar Odmiana	method of planting sposób sadzenia	2005	2006	2007	2008	
Piros	standard planting	0.35 a*	1.04 abc	1.70 a	1.74 c	4.83 ab
	sadz. tradycyjne					
	ridges – redliny	0.25 a	0.75 ab	1.33 a	1.41 bc	3.75 a
Pinova	standard planting	0.91 ab	2.35 abc	2.43 a	1.24 abc	6.93 abc
	sadz. tradycyjne					
	ridges – redliny	0.68 a	1.48 bc	1.93 a	1.91 c	5.99 abc
Ligol	standard planting	3.08 e	1.36 bc	8.91 c	0.55 ab	13.93 d
	sadz. tradycyjne					
	ridges – redliny	2.01 cd	0.00 a	5.89 b	1.69 c	9.59 c
Sunrise	standard planting	1.5 b	2.0 bc	4.2 ab	1.4 bc	9.2 c
	sadz. tradycyjne					
	ridges – redliny	2.2 d	1.7 bc	4.2 ab	0.5 a	8.5 ab

* Means marked by the same letter are not significantly different
*Średnie oznaczone tą samą literą nie różnią się istotnie

Table 2. The influence of planting method and cultivar on rootstock P22 on yielding in years 2005–2008

Tabela 2. Wpływ sposobu sadzenia i odmiany na podkładce P22 na plonowanie w latach 2005–2008

Treatment Kombinacja		Yield, kg·tree^{-1} Plon, kg·drzewo^{-1}				Total yield Suma plonu 2005–2008
Cultivar Odmiana	method of planting sposób sadzenia	2005	2006	2007	2008	
Piros	standard planting	0.35 a	1.21 de	1.70 a	1.39 c	4.65 ab
	sadz. tradycyjne					
	ridges – redliny	0.50 a	0.75 bc	1.37 a	1.32 c	3.94 a
Pinova	standard planting	1.64 bc	2.05 f	2.64 ab	1.48 a	7.82 c
	sadz. tradycyjne					
	ridges – redliny	1.30 b	1.48 e	1.46 a	1.67 d	5.91 abc
Ligol	standard planting	1.71bc	0.37 ab	4.09 c	0.13 a	6.30 bc
	sadz. tradycyjne					
	ridges – redliny	1.40 b	0.10 a	4.56 c	0.16 a	6.22 bc
Sunrise	standard planting	1.9 c	1.1 cde	3.9 bc	0.6 b	7.4 c
	sadz. tradycyjne					
	ridges – redliny	1.4 b	0.9 cd	3.6 bc	0.7 b	6.5 bc

* Means marked by the same letter are not significantly different
*Średnie oznaczone tą samą literą nie różnią się istotnie

A significant effect of a cultivar on trees planted in ridges in high density, was proved by other research conducted in the conditions of Lower Silesia. In investigation by Szewczuk and Gudarowska [2004a], Jonagored cv. on M.9 rootstock, planted in ridges, produced higher yield than trees traditionally planted. Increase in spacing up to 1 m between trees of Ligol cv. on M 26 rootstock did not affect differences in yielding of trees planted in a traditional way and those planted in ridges. Cultivated in the same conditions trees of Pinowa cv., planted traditionally, provided significantly higher yield size [Dereń et al. 2010]. Examination results dealing with trees yielding and analysis of the course of weather can confirm Perry's opinion [1996] and that shared by Treder and Mika [1996] about more intensive drying of soil and increased exposition of trees to drought in the conditions of cultivation in ridges. As supporting evidence can serve the fact that in examination by Szewczuk and Gudarowska [2004a] and by Dereń et al. [2010], irrigation or introduction of agrogel strengthened favorable effect of planting in ridges on apple trees yielding.

Table 3. The influence of planting method and cultivar on rootstock M9 and rootstock on mean weight of fruit in years 2005–2008

Tabela 3. Wpływ sposobu sadzenia i odmiany na podkładce M9 na średnia masę owocu w latach 2005–2008

Treatment Kombinacja		Mean weight of fruit Średnia masa jednego owocu g				Mean for years Średnia z lat 2005–2008
Cultivar Odmiana	method of planting sposób sadzenia	2005	2006	2007	2008	
Piros	standard planting sadz. tradycyjne	101 a*	94 ab	114 a	106 ab	104 ab
	ridges – redliny	93 a	82 a	107 a	116 b	99 a
Pinova	standard planting sadz. tradycyjne	142 d	110 b	101 a	106 ab	115 bc
	ridges – redliny	114 b	97 b	112 a	80 a	101 a
Ligol	standard planting sadz. tradycyjne	182 e	230	176 a	235 d	206 d
	ridges – redliny	115 bc	-	211 b	241 d	189 d
Sunrise	standard planting sadz. tradycyjne	148 d	93 ab	115 a	131 bc	122 c
	ridges – redliny	123 c	112 c	98 a	148 c	120 c

* Means marked by the same letter are not significantly different
*Średnie oznaczone tą samą literą nie różnią się istotnie

For trees on M.9 rootstock, the lowest mean weight of fruit noted for 'Piros' and 'Pinova' cvs, and the highest for 'Ligol' cv. (tab. 3). Traditional method of planting had positive influence on the weight of 'Pinova' fruit. Planted in this way trees of cultivars: 'Pinova', Ligol' and 'Sunrise' had fruit of greater weight in the first year of yielding. Cultivar and method of planting affected the weight of fruit collected from trees on P 22 rootstock. Trees of 'Piros' and 'Ligol' planted on this rootstock, in traditional way, provided fruit with higher weight, in comparison with trees planted in ridges. Favorable

effect of traditional method of planting on fruit quality for 'Sunrise' cv, was noted only in the first, two year of yielding (tab. 4). The quality of fruit obtained in the experiment conducted and expressed as mean weight of one fruit was, in spite of low yielding, poor and it confirmed the opinion about problems with the quality of fruits harvested from densely planted trees [Mika and Chlebowska 1997].

Table 4. The influence of planting method and cultivar on rootstock P22 and rootstock on mean weight of fruit n years 2005–2008

Tabela 4. Wpływ sposobu sadzenia i odmiany na podkładce P22 na średnia masę owocu w latach 2005–2008

Treatment Kombinacja		Mean weight of fruit Średnia masa jednego owocu g				Mean for years Średnia z lat 2005–2008
Cultivar Odmiana	method of planting sposób sadzenia	2005	2006	2007	2008	
Piros	standard planting	106 bc	88 b	109 a	95 a	100 b
	sadz. tradycyjne					
	ridges – redliny	83 a	73 a	93 a	79 a	82 a
Pinova	standard planting	120 d	95 b	97 a	91 a	101 b
	sadz. tradycyjne					
	ridges – redliny	114 cd	83 ab	106 a	89 a	98 ab
Ligol	standard planting	96 b	162 d	113 a	219 c	147 d
	sadz. tradycyjne					
	ridges – redliny	84 a	189 e	155 b	235 c	166 e
Sunrise	standard planting	113 cd	112 c	99 a	177 b	125 c
	sadz. tradycyjne					
	ridges – redliny	101 b	91 b	99 a	151 b	110 bc

*Means marked by the same letter are not significantly different
*Średnie oznaczone tą samą literą nie różnią się istotnie

Among the trees on M.9 rootstock, cultivar 'Ligol' characterized the stronger growth expressed by the increment of cross-sectional area. Trees of this cultivar, planted in ridges grew weaker, in comparison with trees planted traditionally. The method of planting did not influence on the growth of other cultivar on M.9 rootstock. For trees on P 22, the lowest increment of cross-sectional area was noted for 'Sunrise' cv., planted in ridges. The other cultivar grew more intensively. Planting in ridges, reduced the growth of 'Piros' cv. on P 22 rootstock.

According to Sosna and Szewczuk [1998], planting trees in ridges can be the way of reducing trees growth, which is recommended for dense orchard cultivation. Yet in the opinion by Szewczuk [2004], more favorable yielding of Jonagored cv., planted in the sparing 0.5 m and in ridges, resulted from better conditions provided by ridges regarding the growth of trees in the first years after planting.

Productivity index, calculated for the purpose of this research, was the effect of low yielding and weak growth of the trees assessed and it confirmed the lack of influence of planting trees in ridges on the relation between growth and fruiting of apple trees cultivated at a small spacing. Productivity index for the trees on the used rootstock depended on the cultivar (tab. 7–8). Among the trees on M9 rootstock the lowest productivity

Table 5. The influence of planting method and cultivar on rootstock M9 on increment of trunk cross- sectional area [TCSA] in years 2005–2008

Tabela 5. Wpływ sposobu sadzenia i odmiany na podkładce M9 na przyrost pola przekroju poprzecznego pnia [PPPP] w latach 2005–2008

Treatment Kombinacja		Increment of trunk cross-sectional area Przyrost pola przekroju poprzecznego pnia cm^2					Increment Przyrost 2004–2008
Cultivar Odmiana	method of planting sposób sadzenia	2004	2005	2006	2007	2008	
Piros	standard planting	0.22 b	0.28 ab	1.12 ab	0.40 a	0.39 a	2.41 a
	sadz. tradycyjne						
	ridges – redliny	0.22 b	0.24 a	1.06 a	0.46 a	0.56 ab	2.54 ab
Pinova	standard planting	0.26 b	0.49 bc	1.14 ab	0.47 a	0.51 ab	2.87 ab
	sadz. tradycyjne						
	ridges – redliny	0.21 b	0.24 a	0.98 a	0.42 a	0.49 ab	2.34 a
Ligol	standard planting	0.22 b	0.62 c	2.30 c	0.93 b	1.83 c	5.90 c
	sadz. tradycyjne						
	ridges – redliny	0.09 a	0.63 cd	1.69 b	0.62 a	1.15 b	4.18 b
Sunrise	standard planting	0.30 b	0.84 d	0.77 a	0.64 ab	0.68 ab	3.23 ab
	sadz. tradycyjne						
	ridges – redliny	0.26 b	0.74 d	0.75 a	0.59 a	0.57 ab	2.92 ab

* Means marked by the same letter are not significantly
*Średnie oznaczone tą samą literą nie różnią się istotnie

Table 6. The influence of planting method and cultivar on rootstock P 22 on increment of trunk cross-sectional area [TCSA] in years 2005–2008

Tabela 6. Wpływ sposobu sadzenia i odmiany na podkładce P 22 na przyrost pola przekroju poprzecznego pnia [PPPP] w latach 2005–2008

Treatment Kombinacja		Increment of trunk cross-sectional area Przyrost pola przekroju poprzecznego pni cm^2					Increment Przyrost 2004–2008
Cultivar Odmiana	method of planting sposób sadzenia	2004	2005	2006	2007	2008	
Piros	standard planting	0.20 ab	0.36 bc	1.24 d	0.52 c	0.69 bc	3.01 d
	sadz. tradycyjne						
	ridges – redliny	0.16 ab	0.38 bc	0.95 cd	0.32 abc	0.40 ab	2.21 bc
Pinova	standard planting	0.24 bc	0.45 c	1.05 cd	0.33 abc	0.43 ab	2.50 cd
	sadz. tradycyjne						
	ridges – redliny	0.31 c	0.33 abc	0.85 bc	0.33 abc	0.45 ab	2.27 bc
Ligol	standard planting	0.15 a	0.26 ab	0.94 cd	0.34 abc	0.63 bc	2.32 bc
	sadz. tradycyjne						
	ridges – redliny	0.15 a	0.22 a	1.22 d	0.35 bc	0.85 c	2.79 cd
Sunrise	standard planting	0.23 abc	0.42 c	0.55 ab	0.26 ab	0.21 a	1.68 ab
	sadz. tradycyjne						
	ridges – redliny	0.17 ab	0.29 ab	0.29 a	0.13 a	0.18 a	1.06 a

* Means marked by the same letter are not significantly
*Średnie oznaczone tą samą literą nie różnią się istotnie

Table 7. The influence of planting method and cultivar on rootstock M 9 on productivity index in years 2005–2008

Tabela 7. Wpływ sposobu sadzenia i odmiany na podkładce M 9 na wartość współczynnika plenności w latach 2005–2008

Treatment Kombinacja		Productivity index, kg·cm^{-2} Współczynnik plenności, kg·cm^{-2}				Mean for years Średnia z lat 2005–2008
Cultivar Odmiana	method of planting sposób sadzenia	2005	2006	2007	2008	
Piros	standard planting sadz. tradycyjne	0.22 ab	0.36 bc	0.46 a	0.37 cd	0.35 a
	ridges – redliny	0.17 a	0.29 b	0.45 a	0.40 cd	0.33 a
Pinova	standard planting sadz. tradycyjne	0.51 cd	0.81 d	0.74 b	0.26 abc	0.58 b
	ridges – redliny	0.45 bc	0.59 cd	0.68 b	0.51 d	0.56 b
Ligol	standard planting sadz. tradycyjne	1.30 g	0.30 b	1.58 d	0.07 a	0.81 c
	ridges – redliny	1.06 fg	0.00 a	1.60 d	0.31 bc	0.74 bc
Sunrise	standard planting sadz. tradycyjne	0.72 de	0.71 d	1.19 c	0.32 cd	0.73 bc
	ridges – redliny	0.98 ef	0.55 bcd	1.16 c	0.12 ab	0.70 bc

* Means marked by the same letter are not significantly different within the rootstock
*Średnie oznaczone tą samą literą nie różnią się istotnie w obrębie danej podkładki

Table 8. The influence of planting method and cultivar on rootstock P 22 on productivity index in years 2005–2008

Tabela 8. Wpływ sposobu sadzenia i odmiany na podkładce P 22 na wartość współczynnika plenności w latach 2005–2008

Treatment Kombinacja		Productivity index, kg·cm^{-2} Współczynnik plenności, kg·cm^{-2}				Mean for years Średnia z lat 2005–2008
Odmiana Cultivar	sposób sadzenia method of planting	2005	2006	2007	2008	
Piros	standard planting sadz. tradycyjne	0.21 a	0.43 cd	0.55 a	0.40 bc	0.40 a
	ridges – redliny	0.36 b	0.33 bc	0.49 a	0.45 bc	0.41 a
Pinova	standard planting sadz. tradycyjne	1.01 d	0.76 e	0.85 a	0.39 bc	0.56 a
	ridges – redliny	0.90 d	0.63 de	0.52 a	0.53 c	0.64 a
Ligol	standard planting sadz. tradycyjne	0.90 d	0.13 ab	1.30 b	0.04 a	0.59 a
	ridges – redliny	0.70 c	0.04 a	1.36 b	0.04 a	0.53 a
Sunrise	standard planting sadz. tradycyjne	1.24 e	0.54 d	1.67 bc	0.23 ab	0.92 b
	ridges – redliny	0.96 d	0.50 cd	1.96 c	0.36 bc	0.95 b

* Means marked by the same letter are not significantly different within the rootstock
*Średnie oznaczone tą samą literą nie różnią się istotnie w obrębie danej podkładki

index was noted for 'Piros' cv. significant differences between other cutivars occurred between 'Ligol' planted in ridges and 'Piros' and 'Pinova', regardless of method of planting. In case of trees on P 22, cultivar 'Sunrise' characterized significantly higher productivity index in comparison with other cultivars. The method on planting did have influence on the productivity index for trees on P 22 rootstock

The poor level of yielding, low quality of fruit, the weak growth of the estimated trees could be caused high density of planting. This opinion confirms Licznar-Małańczuk's experiment [2001a]. According this author, at several times diminished sparing between trees, yield size from one ha reached twice or three times higher values, yet they did not rise proportionally along with the increase in trees density. In conditions of high number of the trees per area unit, there are not enough number of new shoots each year and optimum light conditions, the required to form flower buds [Taylor and Lenz 1991]. Therefore, according to Mika and Chlebowska [1997], exceeding the number of 2000–3000 trees on one ha requires introduction of additional treatments aimed at the improvement in insolation of densely planted tree crowns. However in this experiment the most important factor of better for growing and yielding of apple trees planted in high density was cultivar. For some of estimated cultivar better condition for trees provided traditional method of planting.

CONCLUSIONS

1. Simultaneous application of dense planting and planting trees in ridges did not significantly affect yield size and quality, as well as vigour of four cultivars of apple trees on two dwarfing rootstocks.

2. In the conditions of high density trees response to planting in ridges was diverse and depended on a cultivar, the kind of a rootstock and the age of trees.

3. Dense planting of trees in ridges did not provide favorable conditions for growth and fruiting of the examined apple trees cultivars in the first five years after planting.

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WPŁYW SPOSOBU SADZENIA I PODKŁADKI NA WZROST I OWOCOWANIE KILKU ODMIAN JABŁONI

Streszczenie. Gęste sadzenie drzew jest jedna z metod uzyskania wysokich plonów z jednostki powierzchni zaraz po założeniu sadu. Zmniejszenie powierzchni zajmowanej przez drzewa gęsto sadzone powoduje ich słabszy wzrost wegetatywny. Innym czynnikiem wpływającym na wzrost i plonowanie jest sadzenie drzew redliny. Badania prowadzono

w latach 2004–2008 w sadzie stacji Badawczo-Dydaktycznej w Samotworze, należącej do Katedry Ogrodnictwa Uniwersytetu Przyrodniczego we Wrocławiu. Przedmiotem badań była ocena wzrostu i plonowania czterech odmian jabłoni: Piros, Sunrise, Pinova i Ligol rosnących w dużym zagęszczeniu na dwóch podkładkach słabo rosnących M.9 i P22, sadzonych w redliny. Dwuletnie drzewka posadzono wiosną 2004 r. Czynnikiem pierwszym doświadczenia był określony sposób sadzenia – tradycyjny lub w redliny. Czynnikiem drugim był rodzaj użytej podkładki. Drzewa na podkładce M.9 posadzono w rozstawie 3,5 m × 0,5 m (5714 drz.·ha^{-1}), natomiast drzewa na podkładce P22 w rozstawie 3,5 × 0,3 m (9523 drz.·ha^{-1}). W przypadku młodych drzew rosnących w gęstej rozstawie, wpływ sadzenia w redliny oraz na wzrost i plonowanie drzew zależał od odmiany i podkładki. Wśród drzew na podkładce M.9 najwyższe plony zebrano z drzew odmiany 'Ligol', sadzonych tradycyjną metodą. Drzewa odmiany 'Piros' posadzone w redliny wydały najniższe plony na obu zastosowanych podkładkach. Sadzenie w redliny wpłynęło na słabsze plonowanie drzew odmiany 'Ligol' i 'Sunrise' na M.9. Nie zanotowano istotnych różnic w sumarycznym plonie z drzew odmian 'Pinova', 'Ligol' i 'Sunrise' na podkładce P 22. Sposób sadzenia nie miał wpływu na plonowanie badanych odmian na tej podkładce. Na podkładce M 9, największą siłą wzrostu charakteryzowała się odmiana 'Ligol'. Na podkładce P 22, najsłabiej rosły drzewa odmiany 'Sunrise'. Drzewa odmiany 'Ligol' na M.9 i 'Piros' na P 22, sadzone w redliny rosły słabiej. Gęste sadzenie drzew w redlinach nie wpłynęło na plonowanie i wzrost czterech odmian jabłoni na dwóch podkładkach słabo rosnących. W warunkach wysokiej gęstości sadzenia, reakcja na uprawę w redlinach była zróżnicowana i zależała od odmiany, rodzaju podkładki i wieku drzew. Gęste sadzenie drzew w redliny nie stworzyło sprzyjających warunków dla wzrostu i owocowania badanych odmian jabłoni w pierwszych pięciu latach po posadzeniu.

Słowa kluczowe: jabłoń, podkładka, rozstawa, sadzenie w redliny, wzrost, plon

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