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THE EFFECT OF MULCH TYPE AND PRUNING ON GROWTH AND YIELDING OF NECTARINE (*Prunus persica* L.) CV 'FANTASIA'

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Abstract. Investigations were conducted in the years 2006–2008 in Przybroda near Poznań on nectarine cv. 'Fantasia' trees with vase-trained crowns, planted in spring 2004 on peach cv. 'Mandżurska' rootstocks at a 4.0 × 2.5 m spacing (1000 trees ha^{-1}), strongly damaged by frost during the winter of 2005/2006. In the experiment 2 types of mulch were used in tree rows: fibre sheets and mown grass. In spring 2006 tree tops were headed back by 35–40 cm. In autumn 2006 pruned trees were by 0.4 m lower than unpruned trees, but trees mulched with fibre sheets were taller and had bigger crown projection areas than trees mulched with mown grass. In the 2nd year after heading-back the increment of trunk cross-sectional area was bigger in trees in combinations mulched with mown grass in comparison to fibre sheets mulching, as well as unpruned trees in comparison to pruned trees. Pruning of trees resulted also in the fruit-bearing zone in shooting of longer long shoots with a diameter of ≥0.5 cm, but only in the first year after pruning. In the third year after pruning the highest yield was produced by unpruned trees mulched with mown grass, while unpruned trees mulched with fibre sheets gave the poorest yields.

Key words: fibre sheets, mown grass, heading-back, yielding rate

INTRODUCTION

In the opinion of consumers traditional fruit production methods, requiring the application of large amounts of chemicals, are no longer acceptable not only in terms of wholesomeness of products, but also for the sake of protection of the soil medium. In order to reduce the amounts of applied chemicals, among other things different types of mulches are used, which constitute a physical barrier for germinating weeds, reduce evaporation and retain adequate moisture content in the soil [Lakatos and Buban 2000, Mathews et al. 2002]. Organic mulches such as grass, sawdust, etc. [Marsh et al. 1996, Mantinger and Gasser 1997] do not only protect against weeds, but may also be sources

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of additional organic substances in orchards [Neilsen and Hogue 1998], although it is not clear since what year of mulching they become available to trees.

Peach and nectarine growing in Poland is connected with a high natural risk. Severe winters frequently result in tree damage and eliminate any chance of yielding, as it was observed e.g. as a consequence of the harsh winter season of 2005/2006. Due to considerable damage of one-year shoots and their flower buds it was decided to verify how heading-back would affect growth and yielding of trees. Thus in spring 2006 the heading-back procedure was performed. In the opinion of many authors [Dudziński and Hołubowicz 1985, Radajewska 1989, Marini 2002, Radajewska and Szklarz 2008] pruning not only considerably improves regeneration processes of damaged branches and reduces the size of tree crowns, but also reduces their excessive height.

The aim of the study was to assess the effect of 2 types of mulches and pruning of trees on their growth and yielding.

MATERIAL AND METHODS

Investigations were conducted in the years 2006–2008 in the experimental orchard of the Department of Pomology at the Agricultural and Pomicultural Experimental Station in Przybroda near Poznań. Analyses were conducted on trees of nectarine cv. 'Fantasia' with vase-trained crowns, planted in spring 2004 on peach cv. 'Mandżurska' rootstocks at a 4.0 × 2.5 m spacing (1000 trees/ha), strongly damaged by frost during the winter season of 2005/2006 [Radajewska and Szklarz 2006]. Before trees planting soil was prepared properly regarding to recommendations for commercial orchards. The experiment was established in a 2-factorial design, where one factor was the type of mulch, while the other was the manner of tree pruning.

The experiment included 4 combinations:

1. fibre sheets, unpruned trees,
2. fibre sheets, pruned trees,
3. mown grass, unpruned trees,
4. mown grass, pruned trees.

The experiment was established in the randomized block design in 6 replications, with 3 trees per plot. Rows of trees in combinations 1 and 2 were mulched with fibre sheets of 94 g m^{-2}, in a belt of 1.5 m in width. Single weeds growing through the fibre sheets were removed manually, thus it was not necessary to apply herbicides. Rows of trees in combinations 3 and 4 were mulched every year with grass mown in the interrows and outside the mulch layer in tree rows herbicides were used as supplementary treatments. In spring 2006 in combinations 2 and 4 the heading-back procedure was performed, reducing tree height by 35–40 cm.

In the years 2006–2008 in the autumn growth was measured using the following measurements: tree crown height, tree crown projection area (quotient of 2 widths) and increment of trunk cross-sectional area (TCSA). In the years 2006 and 2007 additionally the number and length of one-year long shoots with a diameter of ≥0.5 cm were recorded, taking measurements of long shoots found in the fruit-bearing zone at the mid-

crown height. Moreover, in the last year of the study tree yielding was also measured and yielding rates were calculated.

Results were analyzed statistically using the analysis of variance for multifactorial experiments with the use of the STAT computer software and the significance of differences was assessed using the Duncan test at the significance level of 0.05.

RESULTS AND DISCUSSION

Trees were strongly damaged by frost during winter 2005/2006 and later regenerated damages of branches and young bearing shoots. As reported Marini [2002] winter-injured trees usually survive. Although yield is reduced for at least one season, properly pruned winter-injured trees can be productive for many years.

Table 1. Effect kind of mulch and trees pruning on growth of nectarine 'Fantasia' (2006)
Tabela 1. Wpływ rodzaju ściółki i cięcia drzew na wzrost nektaryny 'Fantasia' (2006)

Rootstock – Podkładka		Method of trees pruning Sposób cięcia drzew		Mean for mulch Średnia dla ściółki
		control – not pruned kontrola – nie cięte	pruned cięte	
Tree crown height, m Wysokość koron drzew, m	fibre sheets – włóknina	2.8 c*	2.5 b	2.7 b
	mown grass – skoszona trawa	2.8 c	2.3 a	2.5 a
	mean for pruning – średnia dla cięcia	2.8 b	2.4 a	
Tree crown projection, m^2 Projekcja koron drzew, m^2	fibre sheets – włóknina	4.5 b	4.9 b	4.7 b
	mown grass – skoszona trawa	4.6 b	3.8 a	4.2 a
	mean for pruning – średnia dla cięcia	4.5 a	4.4 a	
Increase of TCSA, cm^2 Przyrost PPPP, cm^2**	fibre sheets – włóknina	8.6 a	12.9 b	10.7 a
	mown grass – skoszona trawa	10.1 a	9.3 a	9.7 a
	mean for pruning – średnia dla cięcia	9.3 a	11.1 a	
Number of shoots with diameter ≥0.5 cm Liczba długopędów o średnicy ≥0.5 cm	fibre sheets – włóknina	3.5 a	3.5 a	3.5 a
	mown grass – skoszona trawa	3.3 a	3.4 a	3.4 a
	mean for pruning – średnia dla cięcia	3.4 a	3.5 a	
Mean length of shoots with diameter ≥0.5 cm, cm Średnia długość długopędów o średnicy ≥0.5 cm, cm	fibre sheets – włóknina	58.8 a	69.9 a	64.4 a
	mown grass – skoszona trawa	63.7 ab	71.6 c	67.7 a
	mean for pruning – średnia dla cięcia	61.3 a	70.8 b	
Summaric length of shoots with diameter ≥0.5 cm, m Sumaryczna długość długopędów o średnicy ≥0.5 cm, m	fibre sheets – włóknina	2.1 a	2.4 a	2.2 a
	mown grass – skoszona trawa	2.1 a	2.4 a	2.3 a
	mean for pruning – średnia dla cięcia	2.1 a	2.4 b	

*Means indicate by the same letter do not differ significantly at $P \leq 0.05$. Statistical analysis was made separately for each characteristic.
*Średnie oznaczone tą samą literą nie różnią się istotnie przy $P \leq 0.05$. Analiza statystyczna została wykonana oddzielnie dla każdej cechy.
**TCSA – trunk cross sectional area (cm^2)
** PPPP – powierzchnia przekroju poprzecznego pnia (cm^2)

Heading-back performed in spring 2006 resulted in several changes in tree crowns. In the autumn topped trees were by 0.4 m lower (2.4 m) than unpruned trees (2.8 m). At that time trees mulched with fibre sheets were taller (2.7 m) than those mulched with mown grass (2.5 m, tab. 1). After the seasons of 2007 and 2008 neither the pruning procedure nor the type of mulch had an effect on the height of tree crown. Trees mulched with mown grass were finally higher than mulched fibre sheets (tables 2 and 3).

Table 2. Effect kind of mulch and trees pruning on growth of nectarine 'Fantasia' (2007)
Tabela 2. Wpływ rodzaju ściółki i cięcia drzew na wzrost nektaryny 'Fantasia' (2007)

Rootstock – Podkładka		Method of trees pruning Sposób cięcia drzew		Mean for mulch Średnia dla ściółki
		control – not pruned kontrola – nie cięte	pruned cięte	
Tree crown height, m Wysokość koron drzew, m	fibre sheets – włóknina	2.8 b*	2.4 a	2.6 a
	mown grass – skoszona trawa	2.8 b	2.4 a	2.6 a
	mean for pruning – średnia dla cięcia	2.8 b	2.4 a	
Tree crown projection, m^2 Projekcja koron drzewm^2	fibre sheets – włóknina	5.9 ab	5.6 ab	5.7 a
	mown grass – skoszona trawa	6.3 b	5.3 a	5.8 a
	mean for pruning – średnia dla cięcia	6.1 a	5.5 a	
Increase of TCSA, cm^2 Przyrost PPPP, cm^2**	fibre sheets – włóknina	15.3 ab	11.7 a	13.5 a
	mown grass – skoszona trawa	25.8 ab	15.6 ab	20.7 b
	mean for pruning – średnia dla cięcia	20.6 b	13.6 a	
Number of shoots with diameter ≥0.5 cm Liczba długopędów o średnicy ≥0.5 cm	fibre sheets – włóknina	3.7 a	3.8 a	3.8 a
	mown grass – skoszona trawa	3.7 a	3.6 a	3.7 a
	mean for pruning – średnia dla cięcia	3.7 a	3.7 a	
Mean length of shoots with diameter ≥0.5 cm, cm Średnia długość długopędów o średnicy ≥0.5 cm, cm	fibre sheets – włóknina	38.2 a	39.8 a	39.0 a
	mown grass – skoszona trawa	42.6 a	44.7 a	43.7 a
	mean for pruning – średnia dla cięcia	40,4 a	42,3 a	
Summaric length of shoots with diameter ≥0.5 cm, m Sumaryczna długość długopędów o średnicy ≥0.5 cm, m	fibre sheets – włóknina	1.4 a	1.5 a	1.5 a
	mown grass – skoszona trawa	1.5 a	1.6 a	1.6 a
	mean for pruning – średnia dla cięcia	1.5 a	1.6 a	

* and ** Explanations, see Table 1.

In the autumn 2006 crown projection area of unpruned and pruned trees did not differ significantly. However, trees mulched using fibre sheets had a bigger crown projection area of 4.7 m^2, while that of trees mulched with grass was only 4.2 m^2 (tab. 1). In the two successive seasons no effect of pruning or the type of mulch on crown width of trees was found (tables 2 and 3).

In 2006 the trunk cross-sectional area increment depended neither on pruning type nor the type of mulch (tab. 1). In contrast, after the year 2007 a bigger increment of trunk cross-sectional area was found in unpruned trees (20.6 cm^2) than in pruned trees (13.6 cm^2). A bigger increment of trunk cross-sectional area was also recorded for trees mulched with mown grass (20.7 cm^2) than those mulched using fibre sheets (13.5 cm^2).

In 2007 spring frosts totally damaged flowers and fruit sets, so trees generally grew stronger than year before (tab. 2). After the following season differences in the value of this parameter were non-significant, but generally trees grew weaker because of their high yielding (tab. 3).

Table 3. Effect kind of mulch and trees pruning on growth of nectarine 'Fantasia' (2008)
Tabela 3. Wpływ rodzaju ściółki i cięcia drzew na wzrost nektaryny 'Fantasia' (2008)

Rootstock – Podkładka		Method of trees pruning Sposób cięcia drzew		Mean for mulch Średnia dla ściółki
		control – not pruned kontrola – nie cięte	pruned cięte	
Tree crown height, m Wysokość koron drzew, m	fibre sheets – włóknina	2.9 a*	3.0 a	3.0 a
	mown grass – skoszona trawa	3.2 a	3.1 a	3.2 a
	mean for pruning – średnia dla cięcia	3.1 a	3.0 a	
Tree crown projection, m^2 Projekcja koron drzew, m^2	fibre sheets – włóknina	7.8 a	7.7 a	7.7 a
	mown grass – skoszona trawa	8.8 b	7.6 a	8.2 a
	mean for pruning – średnia dla cięcia	8.3 a	7.7 a	
Increase of TCSA, cm^2 Przyrost PPPP, cm^2 **	fibre sheets – włóknina	11.6 a	11.0 a	11.3 a
	mown grass – skoszona trawa	11.1 a	8.8 a	10.0 a
	mean for pruning – średnia dla cięcia	11.4 a	9.9 a	
Productivity index, kg cm^{-2} Współczynnik plenności kg/cm^{-2}	fibre sheets – włóknina	0.8 ab	0.8 ab	0.8 a
	mown grass – skoszona trawa	0.7 a	0.9 b	0.8 a
	mean for pruning – średnia dla cięcia	0.8 a	0.8 a	

* and ** Explanations, see Table 1.

Heading-back of trees had an advantageous effect on changes in the fruit-bearing zone of trees in the first year. In pruned trees the most productive long shoots with a diameter of ≥0.5 cm were longer, since their mean length was 70.8 cm, while in unpruned trees it was only 61.3 cm. Their total length on the evaluated branch was 2.4 and 2.1 m, respectively (tab.1). Norton [2002] after tree tops had been slightly topped, had more fruiting shoots than after standard pruning or after summer shoot removal. As it was reported by Marini [2002], in peaches unbranched long shoots with a length of 30–70 cm and diameter of ≥0.5 cm are most productive. In this experiment the elimination of apical domination in the first season after pruning resulted in stronger shooting of valuable long shoots in the fruit-bearing zone of tree crowns. After the season of 2007 the number, length and total length of long shoots with a diameter of ≥0.5 cm did not differ significantly (tab. 2).

In the conducted experiment in 2006 trees did not yield fruits due to the considerable damage of 1-year shoots and their flower buds. In the spring of 2007 flowers were completely destroyed by spring frost and as a result there was no crop either. Only in the 3rd year after heading-back, i.e. in 2008, trees gave their first, abundant crop. The highest yield (48.1 kg $tree^{-1}$; t ha^{-1}) was obtained from unpruned trees mulched with mown grass. In contrast, the poorest yields were produced by unpruned nectarines mulched with fibre sheets (40.1 kg $tree^{-1}$; t ha^{-1}) (fig. 1).

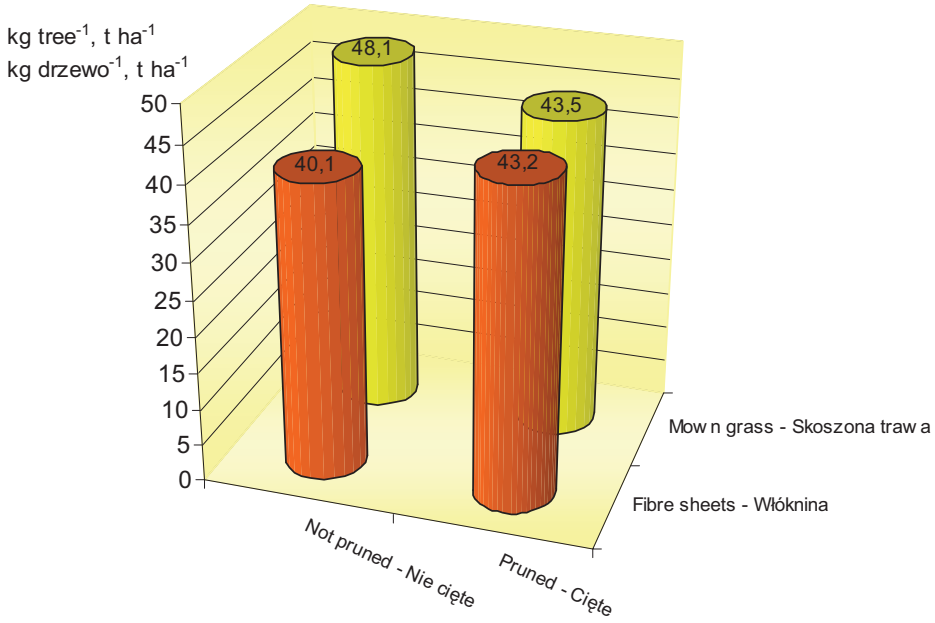

Fig. 1. Effect of kind of mulch and trees pruning on yielding of nectarine 'Fantasia' (kg tree^{-1}, t ha^{-1})
Ryc. 1. Wpływ rodzaju ściółki i cięcia drzew na plonowanie nektaryny 'Fantasia' (kg drzewo^{-1}; t ha^{-1})

The highest productivity index was found in pruned trees mulched with mown grass (0.9 kg cm^{-2}). The lowest value of productivity index was recorded for unpruned trees, mulched using the same material (0.7 kg cm^{-2}) (tab. 3). In the experiment conducted by Radajewska and Szklarz [2008] intensive regeneration pruning of peach cv. 'Harbinger' resulted in a considerable reduction of yielding in the 3rd year after this procedure. Because mown grass is less expensive mulch and trees are more productive, so this solution can be recommended for commercial orchards.

CONCLUSIONS

1. Heading-back of young nectarine trees was a measure advantageous for the limitation of their crown height, but its effect was observed for a short time, i.e. only one year.

2. In the year following the heading-back procedure growth stimulation was observed for the fruit-bearing zone of trees, manifested in the bigger length and total length of long shoots.

3. Three years after heading-back the highest yield was produced by unpruned trees mulched with mown grass, while the poorest yields were yielded by unpruned trees mulched using fibre sheets.

4. The highest yielding rate 3 years after heading-back was recorded for pruned trees mulched with mown grass, while the lowest value of this index was found for unpruned trees mulched using the same material.

5. Mown grass mulch is lees expensive than fibre sheets and is proecological so it should be used in nectarine orchards.

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WPŁYW RODZAJU ŚCIÓŁKI I CIĘCIA NA WZROST I PLONOWANIE NEKTARYNY (*Prunus persica* L.) 'FANTASIA'

Streszczenie. Badania przeprowadzono w latach 2006–2008 w Przybrodzie koło Poznania. Przedmiotem badań były drzewa nektaryny 'Fantasia' o koronie kotłowej, posadzone wiosną 2004 roku na podkładce brzoskwini 'Mandżurskiej' w rozstawie 4,0 × 2,5 m (1000 drzew ha^{-1}), silnie uszkodzone przez mróz w czasie zimy 2005/2006. W badaniach uwzględniono 2 rodzaje ściółki w rzędach drzew: włókninę i skoszoną trawę. Wiosną 2006 roku wierzchołki drzew przycięto o 35–40 cm. Celem badań była ocena wpływu cięcia oraz ściółek na wzrost i plonowanie drzew. Jesienią 2006 r. drzewa cięte były niż-

sze o 0,4 m od drzew niecietych. Badania wykazały, że w tym czasie drzewa ściółkowane włókniną były wyższe, a ich korony miały większą projekcję od drzew ściółkowanych skoszoną trawą. Natomiast w 2 roku po cięciu większy był przyrost pppp drzew w kombinacjach ściółkowanych skoszoną trawą w porównaniu z włókniną, a także drzew niecietych w porównaniu z ciętymi. Przycięcie drzew spowodowało także wybijanie w strefie owoconośnej drzew dłuższych długopędów o średnicy ≥0,5 cm, ale tylko w pierwszym roku po przycięciu. W 3 lata po cięciu najwyższy plon uzyskano z drzew niecietych i jednocześnie ściółkowanych skoszoną trawą, natomiast najsłabiej plonowały drzewa niecięte, ściółkowane włókniną. Najwyższym współczynnikiem plenności po 3 latach od cięcia wyróżniły się drzewa cięte, ściółkowane skoszoną trawą, a najniższą wartość wskaźnika miały drzewa niecięte, ściółkowane w ten sam sposób.

Słowa kluczowe: włóknina, skoszona trawa, cięcie wierzchołków drzew, współczynnik plenności

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