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APPLE TREES YIELDING AND FRUIT QUALITY DEPENDING ON THE CROP LOAD, BRANCH TYPE AND POSITION IN THE CROWN

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ABSTRACT

The study was conducted from 2013 to 2015 on 10–13-year-old apple trees cv. 'Szampion' (M.9. rootstock) in experimental orchard of Department of Pomology, University of Life Sciences in Lublin. On the trees intensively flowering in 2013, the thinning treatments were performed as follows: thinning at the pink bud stage to the 50% of flower clusters leaving only a king flower in the remaining flower clusters; thinning at the pink bud stage to the 50% of flower clusters leaving only one lateral flower in the remaining flower clusters, thinning 4 weeks after full bloom to the 50% of fruit clusters leaving only a fruit from king flower in the remaining fruit clusters, thinning 4 weeks after full bloom to the 50% of fruit clusters leaving only one fruit from lateral flower in the remaining fruit clusters. Intensively flowering control trees in 2013 and poorly flowering trees in 2013 were left unthinned. The best results in terms of regularity of yielding and high-quality fruits after thinning at pink bud stage to king flower, were obtained. The largest fluctuations in yields were observed with the control tree that flowered poorly in the beginning of the study. It was found that the cultivar 'Szampion' is characterized by equal distribution of fruits in lower and middle parts of crown, however in the top of crown, the amount of fruits is significantly lower. Apples with the largest mean fruit weight were from spurs on wood older than two years. However the best flesh firmness, soluble solids and dry matter content was detected in fruits from brindles.

Key words: quality of apple, yield, fruit and flower thinning

INTRODUCTION

Fruit trees produce fruits regardless of human intervention. In a normal year, an apple tree setting 10% of its blossoms will have a full crop load. Abundant cropping (over-cropping) in one year is followed by a little or no yield in the next year. Apple cultivars differ in their biennial bearing tendency, but from economical point of view, the producer should have regular annual yields. Fruit or flower thinning of apple trees is the most important part of commercial management and is used to reduce the setting to 3–5% of primary blossoms [Dash et al. 2013]. This practice maximizes the crop value by improving the fruit size, yield, fruit color, shape and quality. Size, together with shape and color are the most important fruit characteristics to consumers [Link 2000]. Thinning also promotes return bloom and helps to maintain adequate tree structure. Crop load is one of the orchard factors determining the fruit quality. Crop load is generally defined as the number of fruits per tree [Byers 2003, Wünsche et al. 2005].

Apple fruit size has always been a critical factor in determining the market value. The potential size of a pome fruit is determined early in the season [Goffinet et al. 1995]. Early removal of fruit results in larger fruit size at harvest. Since cell division ceases 4–6 weeks after bloom, fruit from trees thinned near the bloom are larger at harvest and have more cells than from trees thinned progressively later after bloom. Veberic et al. [2017] has shown that fruit diameter differences were linked to the inflorescence position on one, two or three-year-old bearing wood. Blanpied and Wilde [1968] found that fruits set high-

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er in the tree canopy were larger because of their greater number of cells.

There are different methods of thinning: chemical, mechanical, *via* shading or manual. Chemical thinners include different chemicals, but the plant growth regulators and some insecticides or herbicides are used in most cases [Duhanaj et al 2015]. Recently in Poland, due to EU subsidies for conversion of land to organic, the ecological production became very popular. In organic apple production, only hand thinning could be used, because synthetic compounds or growth regulators are allowed [Stopar 2004].

The aim of this study was to evaluate the effect of crop load, hand thinning practices and position in the tree crown on quantity and quality of apple trees cv. 'Szampion'.

MATERIAL AND METHODS

The study was conducted from 2013 to 2015 on 10–13-year-old apple trees (*Malus domestica* Borch.) cv. 'Szampion' (M.9 rootstock) in experimental orchard of Department of Pomology, University of Life Sciences in Lublin. Trees were planted at a spacing 3.5 m × 1.8 m, the alleys were covered by grass. The protection against diseases and pests was carried out according to the recommendations for commercial orchards. Tree training was done according to commercial practices, with general goal of spindle-shaped canopy. The spindle canopy was achieved by pruning to cone with a broad bottom and slender top. The orchard was not irrigated. The experiment was a complete randomized block design with a single tree plot replicated eight times.

The part of the study related to alternate bearing was conducted during two full cycles of yielding (taking into account the possible alternation of fruiting): from 2013 to 2016. On the trees intensively flowering in 2013, the thinning practices were started and were continued in the subsequent three years as is presented in the schedule:

- PB-KF – Thinning at the pink bud stage to the 50% of flower clusters leaving only king flower in the remaining flower clusters.
- PB-LF – Thinning at the pink bud stage to the 50% of flower clusters leaving only one lateral flower in the remaining flower clusters.
- 4WAFB-KF – Thinning 4 weeks after full bloom to the 50% of fruit clusters leaving only fruit from king flower* in the remaining fruit clusters.
- 4WAFB-LF – Thinning 4 weeks after full bloom to the 50% of fruit clusters leaving only one fruit from lateral flower* in the remaining fruit clusters.
- Control intensively flowering in 2013 – Trees with intensively flowering in 2013 without thinning practices.
- Control poor flowering in 2013 – Trees with poor flowering in 2013 without thinning practices.

In years 2013–2015, to determine the influence of fruits position in the crown on their quality, the crown was divided into three parts: top, medium and basal. The top part of the crown were branches growing from the trunk at the height between 1.75 and 2.5 m, the middle – between 1.0 to 1.75 m and bottom: to 1.0 m from the ground surface. Fruits were taken from three types of branches: brindles, spurs on the two-years old wood and spurs on older wood, from each of the three parts of the crown. A spur is defined as a shoot of less than 5 cm; a brindle is a shoot from the preceding year with a length between 5 and 20 cm and typically with a well-developed terminal flower bud [Callesen 1988].

In the years 2013–2015, during harvest time, the following data were taken:

Yield of fruits with diameter bigger than 70 mm (pieces/tree), yield of fruits of diameter above 70 mm (pieces/tree) were taken from every tree individually, including the position of the crown.

Taking into account the crop load, position in the crown and location on the branch, the following features were determined:

Skin color was assessed visually using scale from 1 to 5 (where 1 means no blush, 2 – blush on surface to

*In order to accurately thin to the intended fruit in every second flower cluster, the king flower was marked with a red thread.

Table 1. Mean monthly air temperatures and amount of precipitation in ES Felin in the years 2013–2016

	Year	Month					
		IV	V	VI	VII	VIII	IX
Temperature (°C)	2013	8.1	15.3	18.5	19.2	19.2	11.8
	2014	9.7	13.4	15.6	20.2	17.8	14.1
	2015	7.8	12.5	16.7	19.3	21.9	14.7
	2016	8.8	14.4	18.3	18.9	17.8	15.1
	Mean 1951–2012	7.4	13.0	16.3	18.0	18.0	12.6
Amount of precipitation (mm)	2013	17.4	81.5	87.8	87.0	37.6	129.8
	2014	50.3	242.8	62.74	87.37	93.2	30.7
	2015	29.2	115.1	18.8	47.5	7.4	88.4
	2016	42.9	30.5	58.2	130.0	62.0	11.9
	Mean 1951–2012	39.0	60.7	65.9	82.0	70.7	53.7

25%, 3 – blush on surface between 25–50%, 4 – blush on surface 50–75%, 5 – blush on surface above 75%).

Mean fruit mass (g) evaluated for 100 fruits sample from each treatment.

Flesh firmness measured using Magness-Taylor penetrometer (mod. FT 327) with 11.3 mm probe at 40 replications. It was measured on two opposite sides of the fruit along the longest transversal diameter.

Dry matter content (%) with the oven-drying method.

The percentage of soluble solids content in juice squeezed from fresh apple flesh was determined by measuring refraction index with Abbe's Refractometer at 22°C.

In years 2013 and 2014, the length of terminal shoots (cm) was measured at weekly intervals until the end of their growth.

In 2013, the mean air temperatures in May and July were about 2–3°C higher than in 2014. In May 2014, the precipitation was so high that it was 180 mm higher than the long-term sum.

Experimental data were statistically processed using analysis of variance for two-factorial experiments and Tukey's test at P = 0.05. Data were analyzed by Statistica program.

RESULTS AND DISCUSSION

Based on the results regarding the quantity of the yield, it was found that apple cultivar 'Szampion' is a uniformly fruiting variety, however, the yield is affected by physiological condition of the trees. The control trees intensively flowering in 2013 in each year produced a large crop (Tab. 2), while the poor flowering trees in 2013 were characterized by a distinct biennial fruiting. After a year of low yields, the trees were fruiting intensively. In each research year, the lowest yield was from trees thinned with 4WAFB with leaving the lateral fruit. The best structure of the crop characterized trees, where thinning was performed during flowering. However, the lowest quality of yield was found for control trees regardless of the intensity of flowering in 2013.

Apples from trees thinned during flowering had much larger mass compared to the controls. Fruits from control poorly flowering trees in 2013 had significantly higher mass compared to control of intensively flowering in 2013 (Tab. 3). Cell number is more important contributor to fruit size than cell size [Jakopic et al. 2015]. Exceedingly heavy crops could limit fruit cell number during the following two years. Bergh [1990] stated that heavy pre-blossom thinning increases the fruit size by enhancing the rate of cell division and cell size. Thinning practices 4WAFB resulted in a much lower mean fruit mass as compared to those made during flowering. However, the fruit from trees thinned at 4WAFB had greater mass compared to the control trees intensively flowering in 2013 (Tab. 4). The developing in time of thinning from full bloom until 8 weeks after full bloom reduces the fruit size and cell numbers in the

Table 2. The influence of hand thinning practices on the yield of fruits with diameter below or above 70 mm and total yield (pieces/tree)

Treatment	Yield of fruit below 70 mm (pieces/tree)				Yield of fruit above 70 mm (pieces/tree)				Total yield (pieces/tree)			
	2013	2014	2015	2016	2013	2014	2015	2016	2013	2014	2015	2016
PB-KF	10.7 a*	4.7 a	4.2 ab	66.6 ab	90.8 ab	125.5 b	111.3 ab	79.0 b	101.5 ab	130.2 b c	115.5 ab	145.6 b
PB-LF	13.3 a	0.8 a	1.5 a	6.2 a	49.2 a	63.5 a	59.0 a	8.0 a	62.5 a	64.3 a	60.5 a	14.2 a
4WAFB-KF	61.3 ab	7.8 a b	13.8 ab	139.7 bc	125.2 b	144.7 b	162.2 b	36.8 a	186.5 b-d	152.5 bc	176.0 b	176.5 b
4WAFB-LF	136.3 c	14.5 ab	9.8 ab	115.2 bc	111.7 ab	102.2 ab	109.5 ab	36.5 a	248.0 d	116.7 ab	119.3 ab	151.7 b
Control intensively flowering in 2013	123.0 bc	43.0 d	25.8 b	162.8 c	91.5 ab	143.5 b	169.0 b	29.5 a	214.5 cd	186.5 c	194.8 b	192.3 b
Control poor flowering in 2013	40.5 a	22.3 c	25.5 b	86.5 a-c	80.7 ab	232.2 c	114.8 ab	12.5 a	121.2 a-c	254.5 d	140.3 ab	99.0 ab

*Mean in the columns followed by the same letters do not differ significantly at $\alpha = 0.05$

Table 3. The influence of position in the crown on the yield of fruits with diameter below or above 70 mm and total yield (pieces/tree)

Treatment	Yield of fruit below 70 mm (pieces/tree)			Yield of fruit above 70 mm (pieces/tree)			Total yield (pieces/tree)		
	2013	2014	2015	2013	2014	2015	2013	2014	2015
Top	18.2 a*	4.0 a	11.17 a	26.4 a	37.9 a	25.81 a	44.6 a	41.9 a	36.97 a
Middle	18.6 a	4.4 a	16.03 a	24.8 a	44.7 a b	34.86 b	43.5 a	49.1 a b	50.89 b
Bottom	32.5 a	7.2 a	16.69 a	42.1 b	52.6 b	29.86 ab	74.6 b	59.8 b	46.56 ab

*Mean in the columns followed by the same letters do not differ significantly at $\alpha = 0.05$

Table 4. The influence of hand thinning practices on some external features of apples cv. 'Szampion' quality

Treatment	Mean fruit mass (g)			Skin color (scale 1–5)			Number of seeds (pieces/fruit)	
	2013	2014	2015	2013	2014	2015	2014	2015
PB-KF	203.6 d*	236.15 e	200.0 d	3.8 c	3.0 b	3.8 b	5.3 a	4.6 ab
PB-LF	182.5 c	232.92 d	206.0 d	3.0 a	3.1 bc	3.5 a	7.0 b	5.3 b
4WAFB-KF	164.2 b	186.82 b	170.9 c	3.4 b	3.3 c	4.3 c	7.0 b	5.3 b
4WAFB-LF	131.2 a	200.52 c	167.1 c	2.9 a	2.9 ab	4.0 b	6.0 a	5.3 b
Control intensively flowering in 2013	129.2 a	155.1 a	138.7 a	3.6 bc	3.25 c	3.9 b	6.0 a	5.1 ab
Control poor flowering in 2013	165.6 b	176.35 b	157.2 b	3.4 b	2.7 a	4.0 b	5.9 a	4.4 a

*Mean in the columns followed by the same letters do not differ significantly at $\alpha = 0.05$

cortical region progressively [Forsey and Elfving 1979, Milić et al. 2017]. Most researchers have found negative correlation between mean fruit weight and crop load. Fruit size is mainly determined by the number of cells per fruit and their subsequent enlargement and both factors are dependent on the competition for carbon between developing fruits as crop load increases [Dash et al. 2013, Jakopic et al. 2015]. In this study, trees thinned at PB-LF had almost twice lower yield than thinned at PB-KF (Tab. 2), but apples from those trees had lower mean fruit mass than from trees thinned at the same time to king flower (Tab. 4). Previous results demonstrated that increases in fruit size were proportionally less than the reduction in fruit numbers. The primary effect of fruit thinning on fruit size is more often a reduction in the number of smaller fruits than a dramatic increase in the size of remaining fruits [Forshey and Elfving 1977]. Jakopič et al. [2016] studying the hierarchy among fruitlet in the apple cluster, stated that fruitlets from the central (king) position were rarely abscised (less than 40% incidence), while from lateral position dropped more than 80% of fruitlets. This demonstrates the obvious dominance of the central (king) fruit compared to lateral ones, especially those nearest to the king fruit. In this study, the domination of king flower/fruit was abolished by removal of king fruit, but although thinning was done with the same intensity, the number of fruit from trees thinned with PB-LF was much smaller than from trees thinned at PB-KF (Tab. 2). This proves that not only an adequate supply of carbon determines the final yield. This can be explained by the difference in the rate of king versus lateral flower or fruit development [Milić et al. 2017]. The formation of apple flowers in one cluster does not occur at the same time, because flower located in the central position is initiated first followed by the laterals. This temporal precedence remains at flowering [Bubán 2003]. Racskó and Miller [2010] pointed out that the removal of terminal flower had a great impact on the opening pattern of the remaining lateral flowers, because lateral flowers opened on the same day showing no temporal hierarchy.

Apple skin color is an important consideration for consumer choice and significantly influences on fruit quality [King and Cliff 2002]. Fruit thinning can increase apple coloration by increasing the relative number of leaves per fruit. However, degree of thinning required for optimum color development is not well established. In the present study, generally, fruit from king flowers were better colored than from lateral ones (Tab. 4). Besides genetic factors, a number of external factors also affect the color intensity of apple fruit skin, including light, temperature, mineral nutrition and orchard management practices. Tijskens et al. [2011] stated that the process of apple coloration in the orchard occurs for all cultivars along the same mechanism. They claimed that different factors, for example the hail net or N-fertilization, do not change the mechanism, but rather the stage of maturity of apples and the range, over which the color can change. According to them, the process of coloration is really reflecting the degradation of chlorophyll and not the production of red blush (anthocyanins).

Assessing the effect of the thinning method on the number of seeds, it was stated that fruits from trees thinned during flowering to the lateral bud and 4WAFB to the fruit from king flower had the most seeds in both research seasons. Control fruits from trees poor flowering in 2013 generally had the least seeds (Tab. 4). Fruit size is primarily determined by the number of fruits per tree [Naschitz and Naor 2005]. If the influence of this factor is minimized and the number of evaluated fruits is high enough, there is an unambiguous positive correlation between seed count and fruit weight. The higher the seed count, the higher the sink strength in the fruit, which is reflected by an increase in fruit weight [Keulemans et al. 1996].

Firmness and soluble solids content are important quality attributes that determine the purchase of fresh apple fruit [Campenau et al. 2009]. There was no clear dependence of flesh firmness on the thinning methods. Evaluating the effect of thinning on the soluble solids content in fruits, the highest values of described feature in fruits from trees thinned PB-LF was found. In study of Salvador et al. [2006] on apples cv. ‘Golden Delicious’ and ‘Red Chief’, soluble solids content was higher with heavy cropping trees than with standard cropping trees. In their trial, ap-

ples of the smaller size classes had higher soluble solids content, probably because of lower cell volume and lower proportion of intercellular spaces. In the study of Marguery and Sangwan [1993] on apple cv. 'Golden Delicious', the concentration of main sugars (sucrose, fructose, glucose and sorbitol) were significantly greater in peripheral fruits than in the central ones. In this study, the soluble solids content in two years was significantly higher in fruits from lateral flowers than in fruits from king flower, when trees were thinned at pink bud stage (Tab. 7). However, it was observed that lateral fruits are generally characterized by the significant higher dry matter content as compared to the central ones. It is in contrast to previous study of Szot [2010] on apples cv. 'Rubin', where the central fruits had significantly higher dry matter content. But similarly, lateral apples were characterized by greater flesh firmness then the central ones.

The integrating relationships between vegetative and fruit behaviors are pointed in many research [Lespinasse and Lauri 1996]. Thinning of bearing trees soon after bloom results in a greater tree growth and greater number of spurs with growing bourse shoots when compared with progressively later thinning times. Castro et al. [2015] stated that increasing the crop load had a negative effect on the shoot growth. Previous studies on apples have also found a decrease in vegetative growth as crop load increases [Byers 2003]. They explained it by the higher sink capacity of fruits. In this study in every year, tree thinning was done during flowering with leaving lateral flowers that had the longest terminal shoots (Figs. 1, 2). However, control trees, regardless of the intensity of flowering in 2013, had similar length of shoots. The growth of terminal shoots depended on the growing season. In 2013, the terminal shoots ceased to grow since 24 July, but in 2014 – one month later. The reason for this may be the difference in temperature and rainfall during the intensive growth of the shoots (Tab. 1).

Position in the crown. Estimating the dependence of the yield on the position in the crown, it was observed that in every year the top part of crown produced the smallest number of fruits, but in the middle and bottom, the number of fruits was similar (Tab. 3). Robbie et al. [1993] observed enhanced fruit set on horizontal branches of apple trees of cv. 'Cox's Orange Pippin'. They explained it by greater flower quality from horizontal then from vertical position of branches. They noted greater proportion of healthy ovules at anthesis, an increase in both female fertility and length of effective pollination period for flowers from horizontal branches. The most horizontal branches in present study were in bottom part of the crown. Fruit quality depending on the position in the crown was affected by the season. In 2014, the yield of fruits above 70 mm in every treatment was close to 90%, while in other seasons, it fluctuated from 56 to 70%.

There was no significant influence on the mean fruit mass depending on the position in the crown (Tab. 5).

The skin fruit color largely depended on the position in the crown. Apples in the top part were the best colored, then apples from the middle part of the crowns. The poorest colored fruit were from the basal part of the crown.

Considering the influence of the position in the crown, it was found that fruits at the top of the canopy were firmer, had more soluble solids content and had more intense red color than those in the lower positions (Tab. 8). This confirms the observations of Moran and Rom [1991], who studied haw canopy height affect apple cv. 'Delicious' quality. Warrington et al. [1996] studying the influence of light transmission on fruit quality of apple cv. 'Granny Smith' stated that mean fruit weight, soluble solids content were positively related to light transmission within a canopy.

Sestras et al. [2009] compared soluble solids content in fruits of twelve apple cultivars, among others, depending on their position in the crown. Regardless of cultivars, the fruits position in the crown influenced significantly their soluble solids content. The lowest soluble solids content was registered for the fruits formed in the middle third of the crown (13.9°Bx), while the lower third of the crown determined rich soluble solids content in the fruits (15.0°Bx). It was stated the negative correlations between soluble solids content and weight of the fruits.

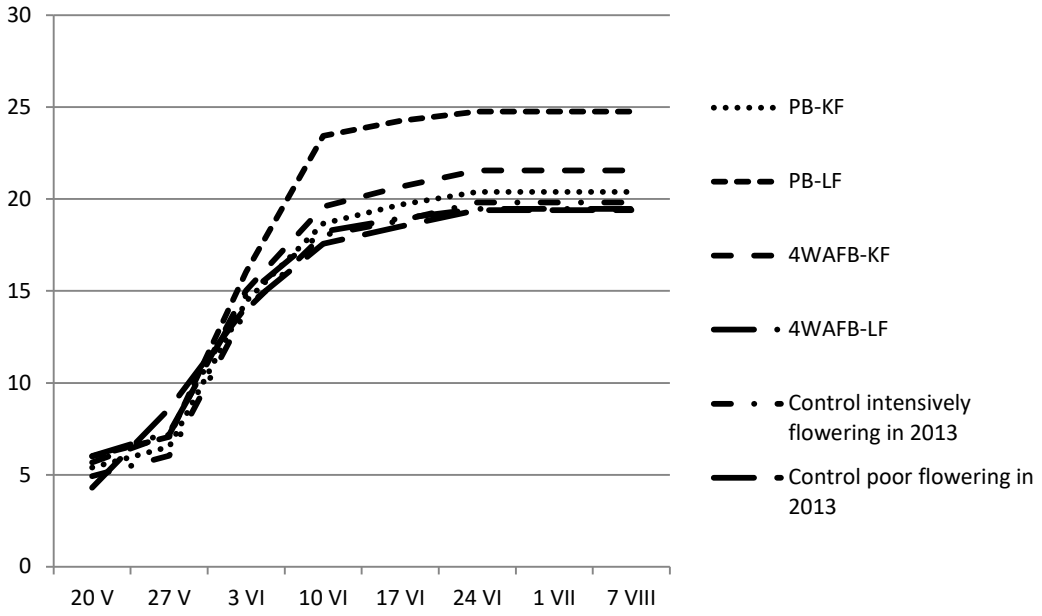

Fig. 1. Effect of thinning methods on the length of terminal shoots in 2013

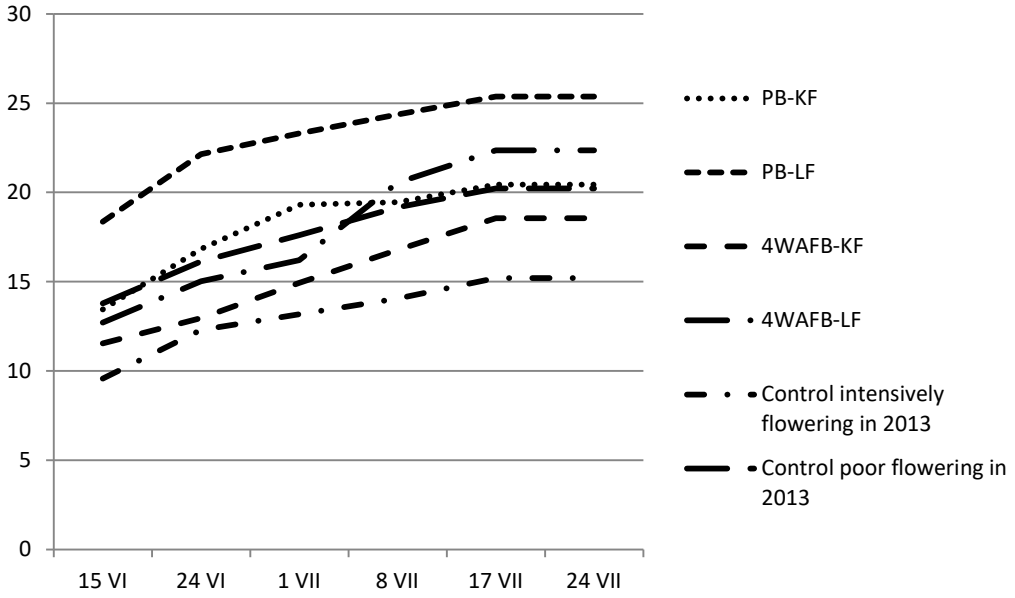

Fig. 2. Effect of thinning methods on the length of terminal shoots in 2014

Table 5. The influence of position in the crown on some external features of apples cv. 'Szampion' quality

Position in the crown	Mean fruit mass (g)			Skin color (scale 1–5)			Number of seeds (pieces/fruit)	
	2013	2014	2015	2013	2014	2015	2014	2015
Top	159.9 a*	200.14 ab	174.6 a	3.8 b	3.50 c	4.5 c	6.7 a	4.7 a
Middle	161.7 a	201.62 b	171.6 a	3.4 ab	3.10 b	3.9 b	6.1 a	5.0 ab
Bottom	165.7 a	192.17 a	173.7 a	2.9 a	2.70 a	3.3 a	5.8 a	5.2 b

*Mean in the columns followed by the same letters do not differ significantly at $\alpha = 0.05$

Table 6. The influence of branch type on some external features of apples cv. 'Szampion' quality

Position on the branch	Mean fruit mass (g)			Skin color (scale 1–5)			Number of seeds (pieces/fruit)	
	2013	2014	2015	2013	2014	2015	2014	2015
Brindle	163.2 ab*	196.44 ab	164.4 a	3.9 c	3.10 a	4.1 c	6.2 a	4.7 a
Spurs on the two-years old wood	159.4 a	192.6 a	174.3 b	3.3 b	3.00a	3.9 b	6.0 a	5.0 ab
Spurs on the older wood	166.1 b	204.9 b	181.2 c	2,9 a	3.02 a	3.7 a	6.3 a	5.2 b

*Mean in the columns followed by the same letters do not differ significantly at $\alpha = 0.05$

Table 7. The influence of hand thinning practices on some internal features of apples cv. 'Szampion' quality

Treatment	Flesh firmness (N/cm^2)			Soluble solid content (%)			Dry matter content (%)		
	2013	2014	2015	2013	2014	2015	2013	2014	2015
PB-KF	67.4 ab*	62.0 b	72.0 a	14.3 b	13.60 b	12.7 c	17.1 b	16.1 bc	15.8 d
PB-LF	70.8 b	67.1 c	72.0 a	14.2 b	15.15 c	13.4 d	18.5 c	17.7 c	16.6 e
4WAFB-KF	66.3 a	69.2 d	74.0 ab	13.4 a	13.18 b	12.2 b	16.1 ab	14.9 a	14.9 b
4WAFB-LF	67.2 a	74.4 e	73.0 ab	13.3 a	13.60 b	12.0 ab	16.1 ab	16.7 bc	15.3 c
Control intensively flowering in 2013	67.5 ab	70.4 d	75.0 b	13.4 a	13.24 b	11.6 a	15.5 a	15.5 ab	14.3 a
Control poor flowering in 2013	69.5 ab	59.4 a	79.0 c	13.9 b	12.72 a	12.1 b	17.0 b	14.4 a	15.3 c

*Mean in the columns followed by the same letters do not differ significantly at $\alpha = 0.05$

Table 8. The influence of position in the crown on some internal features of apples cv. 'Szampion'

Treatment	Flesh firmness (N/cm^2)			Soluble solid content (%)			Dry matter content (%)		
	2013	2014	2015	2013	2014	2015	2013	2014	2015
Top	69.0 b*	68.4 b	75.0 b	13.9 b	13.70 a	12.8 c	16.8 a	16.1 a	15.9 c
Middle	68.0 ab	66.5 a	75.0 b	13.3 a	13.52 a	12.5 b	16.9 a	15.9 a	15.5 b
Bottom	67.0 a	66.0 a	72.0 a	14.0 b	13.51a	11.8 a	16.4 a	15.5 a	14.8 a

*Mean in the columns followed by the same letters do not differ significantly at $\alpha = 0.05$

Table 9. The influence of position on the branch on some internal features of apples cv. 'Szampion'

Position on the branch	Flesh firmness (N/cm^2)			Soluble solid content (%)			Dry matter content (%)		
	2013	2014	2015	2013	2014	2015	2013	2014	2015
Brindle	68.0 c*	69.0 c	76.0 c	13.8 b	13.58 c	12.5 b	16.8 b	16.2 a	15.9 c
Spurs on the two-years old wood	66.4 b	67.4 b	74.0 b	13.6 a	13.42 a	12.5 b	16.5 a	15.6 a	15.4 b
Spurs on the older wood	65.1 a	64.5 a	72.0 a	13.7 ab	13. 51ab	12.0 a	16.6 ab	15.9 a	15.0 a

*Mean in the columns followed by the same letters do not differ significantly at $\alpha = 0.05$

Branch type. Fruits from spurs on the older wood were distinguished by the mean fruit mass among fruits from brindles and 2-year-old wood (Tab. 6). It is in contrast to Rom and Barrit [1990] findings from study on spur development of 'Redspur Delicious' and 'Oregon Spur Delicious'. They stated that fruit size was greatest from 1-year-old spurs and the smallest from 3-year-old spur. AlsoVolz et al. [1994] studying the effect of wood age on fruits size of apples cv. 'Royal Gala', 'Braeburn', 'Granny Smith' and 'Fuji' stated that fruits on 2-year-old spurs and 1-year-old terminal shoots were generally larger at commercial harvest than those on 1-year-old laterals and spurs older than 3 year. However Lee et al. [1994] observed that spur terminal fruits contained more seeds than fruits from 1-year-old wood and were superior in size and shape. They also contained less soluble solids. Considering the influence of the position on the branch on the coloring of the fruit, it was noted that fruits on brindle were the best colored, then those from spurs on two-year-old wood and the least, fruit from spoors on older wood. However, Buban [2003] reviewing factors that affect the apple's phenology, stated that old spurs would produce floral organs with the earliest phenological development, followed by young spurs and then by terminal buds of brindle. Marguery and Sangwan [1993] stated that apples cv. 'Golden Delicious' produced by the younger wood were lighter (in weigh) than those produced by the older wood. This was due to significantly lower cell numbers and smaller cell diameters. They stated that percentage of dry matter contents was higher for apples produced on the younger (1-year-old wood). In the present study considering the influence of the position on the branch on some internal features, it was stated that in each year fruits

from young wood on brindles had the great amount of soluble solids content, dry matter content and were characterized by the best flesh firmness (Tab. 9). Depending on the position of the fruit in the crown or on the branch, no significant difference in the number of seeds was found.

CONCLUSIONS

1. Thinning of flowers improves the regularity of yielding.

2. The regularity of yield depends on the physiological condition of the tree. However, the lowest quality of yield was found for control trees regardless of the intensity of flowering. Apples from trees thinned during flowering had much larger mass compared to these from trees thinned 4 weeks after full bloom and to the controls.

3. The kind of remaining flowers, after thinning, significantly influenced on the yield and fruit quality. The trees thinned with leaving lateral flower had almost twice lower yield than thinned to king flower. Fruit from king flowers were bigger and better colored than from lateral ones.

4. The low crop load and early thinning during flowering contributed to the best soluble solids content. Fruits from trees during flowering with leaving lateral flower were distinguished by soluble solids content.

5. Top part of crown produced the smallest number of fruits, but in the middle and bottom part of the crown, the number of fruits was similar. There was no significant influence on the mean fruit mass depending on the position in the crown. Fruits at the top of the canopy were firmer, had more soluble solids content and had more intense red color than those in the lower positions. The poorest colored fruits were from the basal part of the crown.

6. Fruits from spurs on the older wood were distinguished by the mean fruit mass among fruits from brindles and 2-year-old wood. Fruits from brindles had the great amount of soluble solids content, dry matter content and were characterized by the best flesh firmness.

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