THE INFLUENCE OF TIME OF FLOWERS' AND FRUITLETS' HAND THINNING OF APPLE TREES 'ŠAMPION' ON QUANTITY AND QUALITY OF YIELD

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(Received August 10, 2006/Accepted October 5, 2006)

A B S T R A C T

This study was conducted on apple trees, cv. 'Šampion' grafted on M.26 rootstock, planted in a commercial orchard situated in eastern Poland close to Lublin in 1992. During the years 1997-1999 the effect of four hand thinning treatments were compared. These were at the pink bud stage, at the end of flowering stage (two weeks after full bloom), and after the June drop. These were compared to the total yield and internal quality, (dry matter, sugar, soluble solids, and acid content) of the fruit of the control trees, on which thinning practices had not been carried out. Thinning flowers or fruitlets in the two consecutive seasons did not influence the quantity of yield, as compared to that of the control trees. Thinning practices, done during the third season of study, resulted in significantly lower total yield than that of the control trees. The dry matter and soluble solids content in the fruit varied from year to year. The values of these characteristics were at their highest in 1998. Soluble solids and sugar content, in the fruit of thinning treated trees, was at its highest in the last year of the trial. There were no significant influences on the acid content in the fruit from the thinning practices, except in the last season, when thinning carried out after the June drop increased acid content.

Key words: hand thinning, thinning time, total yield, internal fruit quality

INTRODUCTION

Research has pointed out that many different horticultural practices influence fruit quality, which is determined by size, skin colour and shape, as well as by other features claimed as internal quality of fruit(Skrzyński, 1998; Sams, 1999; Miszczak and Szymczak, 2000).

The quality of fresh fruit changes during the period between harvest and sale to the consumer. However, many studies have shown that some of the major attributes which influence the attractiveness of fruit are flavour, aroma and texture. The thinning of flowers or fruitlets, among horticultural practices, significantly influences the quality of yield. Besides regulating the yield in subsequent vegetative seasons, thinning also affects the content of dry matter, soluble solids, sugar and flesh firmness. Thinning of apple flowers or fruit clusters stimulates cell division and cell expansion within fruit and consequently increases their size at harvest, which enhances their commercial value (Sharples, 1968). The aim of this study was to evaluate the effect of timing of hand thinning of flowers or fruitlets on the aforementioned fruit characteristics of 'Šampion'.

MATERIAL AND METHODS

The trees were planted in 1992 in a bed system with a double row spaced 1 metre apart. The distance between the beds was 4 metres. The trees were trained as free spindle of 3.0 metres in height. All the usual cultural practices were carried out in accordance with standard commercial orchard procedures. The orchard floor consisted of 150 cm wide herbicide strips along the tree rows with mowed grass alleyways between.

Thinning was administered to 50% of the total flower clusters at the pink bud stage and at the end of the flowering stage (two weeks after full bloom). After the June drop the trees were thinned to one fruitlet a cluster, with a spacing of about 20 cm between fruiting clusters (Tab. 1). Trees without any thinning treatment were left as control trees. The fruit were harvested when the starch index was within 4-5. To determine the internal quality of the apples, 75 fruit from each treatment were sampled at harvest and analyzed for dry matter, soluble solids, sugar and acid content. The chemical measurement samples were taken individually from every replicate. The dry weight percentage was estimated indirectly by determining the loss of moisture. The percentage of soluble solid content, in the juice squeezed from fresh apple flesh, was determined by measuring refraction index with Abbe's refractometer, at 22°C. The reducing sugar's percentage was determined by the Luft-Schoorl method.

Table 1. The procedure of the experiment was as follows

Symbols of treatment	Time of thinning
T1	Pink bud stage: the removal of 50% of the flower clusters
T2	End of flowering: the removal of 50% of the flower clusters
T3	Two weeks after full bloom: the removal of 50% of the fruit clusters
T4	After the June drop: 1 fruitlet left per cluster with 20 cm spacing between clusters
T5	Control – no thinning

The acidity was measured in the homo-genate. The solution was titrated with 0.1 n NaOH to a pH of 8.1; – this value being accepted as the neutrality level. The results are given in percentage values calculated into malic acid.

A split block design was used, with three replicates of eight trees per experimental unit.

The data were statistically collated using the analysis of variance. Tukey's multiple range test was used for means separation at a significance level of 5%.

RESULTS AND DISCUSSION

The quality of fruit is expressed by their size and other senoric attributes such as skin colour, texture, flovour and aroma (Płocharski, 1996). The degree of sweetness and tastiness are affected by the total content of, and proportions between, the soluble solids (especially sugars and acids). One of the main aims of thinning is to improve the quality of fruit, which greatly depends on crop load. In the first year of this study (1997), the yield of the thinned trees did not differ from that of the control ones (Tab. 2). The trees chosen for this experiment were characterized by the similarities in their flowering intensity. The lack of differences between the treatments may be as a result of a more intensive natural drop of fruitlets from the control trees. Whereas the flowers left after thinning developed into strong fruit, which in the greater amount remained up until their harvest. The drop is always the result of strong competition between fruit (Magein, 1989). Some researchers have stated that fruit set increased at the higher source strength, and decreased at the large sink strength (Marcelis and Hauvelink, 1999). In 1998, the subsequent year of the study, the beneficial effects of the previous year's thinning on the intensity of current year bloom and cropping were observed. The highest yield of 28.8 kg per tree resulted from the T1 treatment, and was significantly higher than that of the control trees. The later terms of fruit thinning did not have a significant affect on the quantity of yield, as compared to that of the control trees. One of the first who pointed to the possibility of tree yielding regulations by flower thinning, was Crow (1920). He found that in apple trees of the 'Wealthy' and 'Duchess of Oldenburg' cultivars, only thinning practices performed before full bloom promoted fruit bud initiation. The present explanation of this being that gibberellins, in the young developing friutlets, limit the initiation of flower buds. Therefore later in the season, the gibberellins source decreases and has less influence on the number of flower bud sets. In 1999, the last year of the study, each term of thinning practices produced a significant decrease in the quantity of yield, in comparison to that of the control trees. The smallest yield of 20.8 kg per tree was harvested from trees with flowers thinned during the pink bud stage (T1).

Table 2. Effect of timing of thinning practices on 'Šampion' apple trees on cropping (1997-1999)

Time of thinning		Total yield [kg per tree]		
		year		
		1997	1998	1999
T1	Pink bud stage	31.3 ab*	28.8 b	20.8 a
T2	End of flowering	32.1 b	22.0 a	30.2 b
T3	Two weeks after full bloom	28.1 a	22.0 a	32.0 b
T4	After the June drop	29.4 ab	17.9 a	31.4 b
T5	Control trees without thinning practices	29.5 ab	21.1 a	44.2 c

*Means marked with the same letters do not differ significantly at P=0.05 according to Tukey's multiple range t-test

Table 3. Effect of timing of thinning practices on 'Šampion' apple trees on dry matter content in fruit (1997-1999)

Time of thinning		Dry matter content [%]		
		year		
		1997	1998	1999
T1	Pink bud stage	13.72 a*	15.42 ab	15.62 c
T2	End of flowering	14.98 b	15.34 a	14.92 bc
T3	Two weeks after full bloom	14.11 ab	15.70 ab	14.09 ab
T4	After the June drop	14.40 ab	16.25 b	14.84 a-c
T5	Control trees without thinning practices	12.67 a	16.06 ab	13.50 a

*For explanation see Table 2

Some researchers pointed out that thinning practices influence the internal quality of the fruit. Indeed Sharples (1968), who was studying the effect of different terms of thinning, stated that fruit from thinned trees had significantly greater dry matter content. In the first and third year of our study, the dry matter content in fruit from trees thinned with T2 treatment was higher, in comparison to that of the control ones (Tab. 3), but in the other three treatments the differences were not significant. The differences in fruit dry matter content were not significant in the 1998 season either. Johnson (1994), stated that higher yield was generally associated with higher dry matter production. However, results obtained by us in 1999 did not confirm that observation and have not since. The greatest fruit dry matter content was in trials, where the yield was qualitatively the poorest. Inversely, the lowest fruit dry matter content was in the fruit from heavily yielding control trees. This data confirms the findings of Palmer et al. (1991) which stated that

the higher yielding control trees had significantly smaller fruit, with lower

Table 4. Effect of timing of thinning practices on 'Šampion' apple trees on soluble solids content in fruit (1997-1999)

Time of thinning		Soluble solids content [%]		
		year		
		1997	1998	1999
T1	Pink bud stage	10.72 a*	13.03 b	12.18 b
T2	End of flowering	10.70 a	12.55 a	11.97 b
T3	Two weeks after full bloom	10.85 a	12.60 ab	11.09 a
T4	After the June drop	10.22 a	13.13 b	11.71 ab
T5	Control trees without thinning practices	9.34 a	12.75 ab	10.93 a

*For explanation see Table 2

dry matter content. In 1999, Marcelis and Hauvelink found that dry matter partitioning into fruit could be explained as a function of the sink strength of a given fruit, in relation to the sink strength of other fruit. The number of fruitlets is of major importance as a stimulus for dry matter partitioning and fruit growth.

In 1997 and 1998 the differences in soluble solids content between fruit from thinned trees, or that from the control trees, were not statistically significant (Tab. 4). In the first year of this study, the thinning practices did slightly influence an increase in the values of the described features, in comparison to those of the control trees. In 1998, following thinning in the earliest and the final terms (T1 and T4), the soluble solids content within the fruit slightly improved. Whereas in the last year of the experiment all of the thinning practices increased the soluble solids content, in comparison to that of the control trees, only in combinations T1 and T2 were the differences statistically significant. The results obtained in the last year confirm the observations of Johnson (1995). He had studied different terms of thinning flowers and fruitlets of cv. 'Cox Pippin's Orange', and stated that thinning in the earliest term, (5 days after full bloom), significantly increased the soluble solids content, in comparison to that of the control trees. Delaying thinning practices had a weaker effect on the improvement of soluble solids content in the fruit. The higher soluble solids content, in the fruit from the early thinned trees, may be a reflection of a higher accumulation of photosynthates.

In the first year of the study only the fruit from trees thinned after the June drop (T4), had significantly lower sugar content than the fruit from all the other treatments. All other differences were not statistically significant (Tab. 5). There were no significant differences between treatments in the following year (1998). In the last year of the

experiment, fruit from trees thinned at T4, T2 and T1 had a higher sugar content, in comparison to that of the control trees.

Table 5. Effect of timing of thinning practices on 'Šampion' apple trees on sugar content in fruit (1997-1999)

Time of thinning		Sugar content [%] year		
		1997	1998	1999
T1	Pink bud stage	6.30 b*	7.68 a	6.65 bc
T2	End of flowering	6.25 b	7.58 a	7.06 c
T3	Two weeks after full bloom	5.86 ab	7.36 a	6.03 ab
T4	After the June drop	5.45 a	7.65 a	7.70 c
T5	Control trees without thinning practices	6.09 ab	7.09 a	5.24 a

*For explanation see Table 2

Table 6. Effect of timing of thinning practices on apple 'Šampion' trees on acid content in fruit (1997-1999)

Time of thinning		Acid content [%] year		
		1997	1998	1999
T1	Pink bud stage	0.305 a*	0.323 a	0.308 a
T2	End of flowering	0.305 a	0.309 a	0.313 a
T3	Two weeks after full bloom	0.293 a	0.311 a	0.313 a
T4	After the June drop	0.310 a	0.310 a	0.362 b
T5	Control trees without thinning practices	0.340 a	0.340 a	0.280 a

*For explanation see Table 2

In Kvĺle's research (1969), the relative crop was considered to be a major contributing factor for the variation, found in the acid content of fruit (Tab. 6). However, in this study, no effect of a reduction in the number of flower or fruitlets, on the values of acid content, was found. In 1997 and 1998 there were no significant differences between the acid content in fruit from the thinned trees or that of the control trees. However, the fruit from the control trees were characterized by a slightly higher acidity. In 1999 the pattern of fruit acidity was quite different. Fruit from the thinned trees had a greater acid content than those from the control trees (but only in trials T4, where the differences were statistically significant).

CONCLUSION

1. The thinning of flowers and fruitlets, in the initial two vegetative seasons, did not affect the size of the yield, as compared to that of the control trees. The thinning practices performed in

the third season of study significantly decreased the yield, in comparison to that of the control trees.

2. Dry matter and soluble solids content in the fruit varied from year to year and were at their highest in the 1998 season. In 1999 fruit from the control trees had the significantly lowest content of dry matter.
3. Thinning treatments conducted in the last year of the experiment significantly increased the fruit sugar content, in comparison to that of the control trees .
1. Generally there was no influence on the acid content from the thinning practices, except in 1999, when thinning after the June drop significantly increased the acid content in the fruit.

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WPŁYW TERMINU RĘCZNEGO PRZERZEDZANIA KWIATÓW I ZAWIĄZKÓW JABŁONI ODMIANY ‘ŠAMPION’ NA WIELKOŚĆ I JAKOŚĆ PLONU

Iwona Szot i Alina Basak

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

W trzech kolejnych latach (1997-1999) porównywano wpływ przerzedzania ręcznego kwiatów w fazie różowego pąka, w końcu kwitnienia, 2 tygodnie po pełni kwitnienia lub zawiązków po opadzie świętojańskim w stosunku do kontroli (drzewa bez żadnych zabiegów przerzedzania) na plon całkowity (kg/drzewo). Doświadczenie założono na jabłoni odmiany ‘Szampion’ na podkładce M.26, posadzonych w 1992 roku w sadzie produkcyjnym w Świdniku Małym niedaleko Lublina.

Zabieg przerzedzania kwiatów lub zawiązków w dwóch kolejnych sezonach wegetacyjnych nie wpłynął istotnie na zmniejszenie wielkości plonu w stosunku do kontroli. Dopiero przerzedzanie w trzecim sezonie zmniejszyło istotnie plon w porównaniu z drzewami kontrolnymi. W pierwszych dwóch latach badań nie było istotnych różnic w zawartości suchej masy, ekstraktu i cukrów w owocach zebranych z drzew poddanych przerzedzaniu zawiązków w stosunku do kontroli. W trzecim roku (1999) zanotowano istotne różnice. Prawie wszystkie kombinacje przerzedzania zwiększyły poziom wymienionych parametrów w stosunku do kontroli. Przerzedzanie zawiązków owocowych w czerwcu spowodowało istotne zwiększenie zawartości kwasów w owocach.

Słowa kluczowe: ręczne przerzedzanie, terminy przerzedzania, plon, jakość owoców