

## EFFECTS OF VARIOUS METHODS OF PRUNING APPLE TREES AFTER PLANTING

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### A B S T R A C T

One-year-old apple trees of 'Jonagored' and 'Fiesta' cultivars grafted on M.26 rootstock were sorted out into two grades: strong feathered and weak unfeathered, and were planted into the experimental orchard at Dąbrowice. Each group of trees was subjected to 6 pruning treatments after planting. Light pruning treatment in each group involved no pruning after tree planting and for 3 years onward. The heaviest pruning of feathered trees included strong heading of the leader and side shoots to 3-5 buds after planting and unfeathered trees to 30 cm above ground followed by the standard training methods. Trees pruned and trained according to the recommendations in commercial orchards served as a control.

Both tree quality and pruning treatments affected significantly growth and cropping of both cultivars in the first two years after planting. Feathered trees produced a greater length of annual shoots and higher yield in the second and third year after planting than those unfeathered. These parameters were also greater for unpruned and lightly pruned trees as compared to those pruned. The differences between treatments in shoot growth lasted for 5 years whereas for cropping, they declined after 3 years from planting. Effect of pruning treatment on fruit quality was negligible.

**Key words:** apple trees, planting, training and pruning

### INTRODUCTION

It was proved in several trials (Preston, 1968; Sanders, 1989) that one-year-old apple trees with side shoots (feathers) or those two-year-

old with side shoots (branches) had a better start after planting in an orchard, came earlier into bearing and produced higher yields than trees planted as "maidens" without side shoots (Polderwaard, 1987; Czynczyk, 1991; Bootsma, 1995). Presently in

Europe feathered (branched) trees are preferred for new plantations because they are able to bear the first crop in the second year after planting. However, unfeathered maidens are also planted because about 20% of trees in a nursery are not able to form side shoots with standard nursery treatments. Traditional method of pruning of newly planted trees in an orchard practised for over a hundred years involved heading back of the leader and side shoots (Baldini, 1974) to assure a proper tree start and stimulate new shoot growth. With actual trends to plant trees very dense in rows, vigorous growth is not necessary. Pruning after planting can be than restricted or abandoned (Mika et al., 1983).

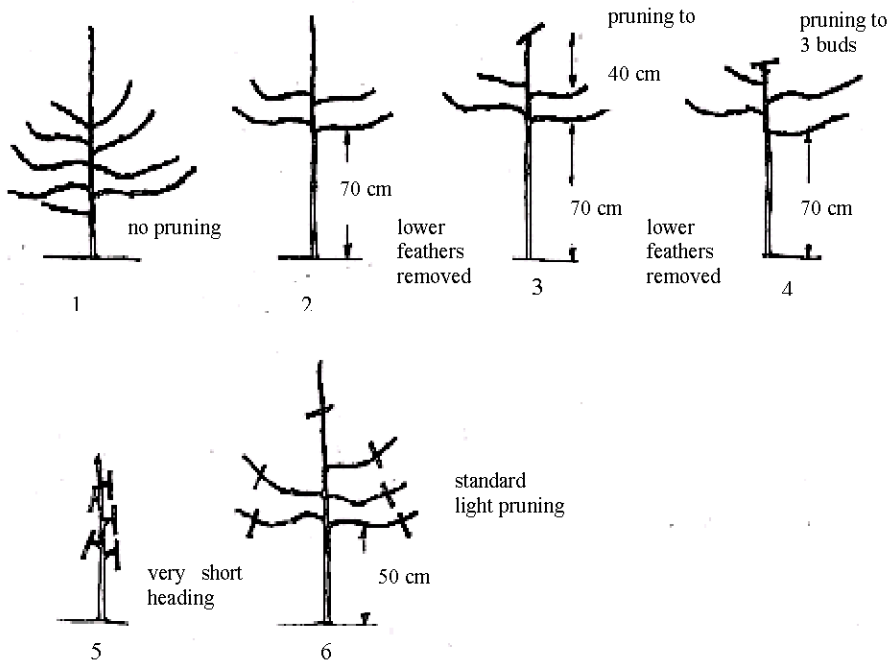
The aim of this trial was to compare several pruning treatments after planting of feathered and unfeathered apple

trees against the standard methods and with no pruning.

## MATERIAL AND METHODS

One-year-old apple trees ‘Jonagored’ and ‘Fiesta’ grafted on M.26 rootstocks were planted in the spring of 1996, on a site after recultivating an apple orchard, at the distance of 4 x 2 m. Planted trees were of two grades. The first consisted of strong feathered trees over 150 cm high, with 3 to 8 feathers and over 12 mm diameter above grafting union. The second grade represented unfeathered trees about 120 cm high with less than 12 mm diameter above grafting union. Each group of trees was pruned and trained by six different methods.

### Pruning treatments of feathered trees (Fig. 1):



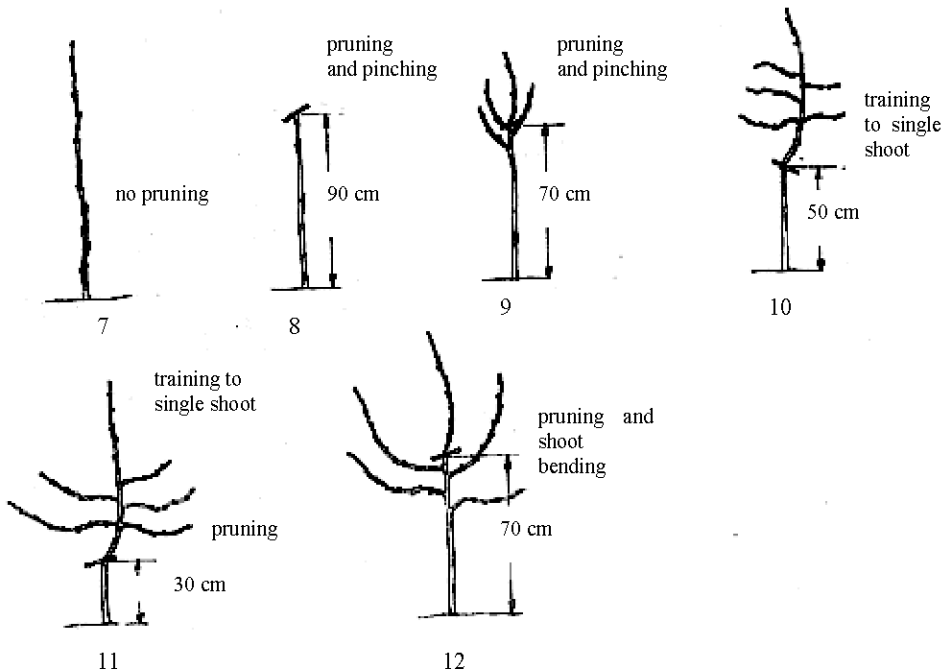
**Figure 1.** Pruning treatments of feathered trees

1. No pruning at all for three years after planting.
2. Only lower feathers removed up to 70 cm to form trunk. No further pruning for 3 years after planting.
3. Lower feathers removed up to 70 cm, leader shortened to 40 cm. New side shoots pinched in May and June to promote the growth of one leader shoot only.
4. Lower feathers removed up to 70 cm, leader shoot headed back to 3 buds in the first year and to 40 cm in the second.
5. Very short heading of the leader and feathers to 3-5 buds in the first year. No pruning in the second and third year.
6. Control treatment for feathered trees. Trees pruned upon the standard method. Lower feathers removed up

to 50 cm, leader shortened to 40 cm, feathers by 1/3 to 2/3. Only a slight corrective pruning in the second and third year. Branch thinning as in treatment one

**Pruning treatments of unfeathered trees (Fig. 2):**

7. No pruning at all for three years after planting.
8. Trees headed back to 90 cm in the first year, then the leader cut to 40 cm in the next two years. Side shoots not pruned.
9. Trees headed back to 70 cm in the first year. In May the three uppermost shoots removed except for the leader. No pruning in the following years.
10. Trees headed back to 50 cm then treated as in 9.



**Figure 2.** Pruning treatments of unfeathered trees

11. Trees headed back to 30 cm, then treated as in 9.
12. Control treatment for unfeathered trees. Trees headed back to 70 cm, then the standard training treatments as recommended in orchards, mainly by shoot bending.

In all pruning systems branch thinning was performed from the fourth year.

The trial was set up in a randomised block system with 3 replications. Each block consisted of 5 trees similarly treated.

In the first year after planting the soil was mechanically clean cultivated. From the second year alleyways were grassed down and leaf active herbicides were applied in tree rows. Mineral fertilizers at the rates of 40 kg N and 60 kg K per ha were applied each year in the spring. No P fertilizer was applied, because of its high content in the soil. A spraying programme against pests and diseases was recommended as for commercial orchards.

Each year trunk diameter was measured 30 cm above ground level, as well as the number and length of annual shoots, yield per tree and mean weight of 100 fruits. Fruit size and colour were recorded in 1998-2000 for 15 kg samples of apples taken from each replication. The canopy development was observed.

Analysis of variance was performed on all data. Differences between treatment means were evaluated using Duncan's multiple range t-test at  $P=0.05$ . The percentage of apple fruit of certain colour and size were estimated

following data transformation according to the Bliss function.

## RESULTS

Both tree quality and pruning systems affected significantly the growth and cropping of 'Fiesta' and 'Jonagored' cultivars in the first two years after planting (Tab. 1 and 2). 'Jonagored' trees having side shoots at planting time, produced in 1996-1997 significantly a greater length of annual shoots than those without such shoots. A similar tendency was observed for 'Fiesta', but significant differences were statistically proved only for one treatment. All trees of both cultivars lightly pruned after planting produced a greater length of annual shoots than those heavily pruned. Unfeathered trees headed back to 30, 50 and 70 cm above ground had to be trained with one top shoot only because the other shoots were emerging to close to the ground, being unsuitable for constructional branches. These shoots were pinched off in May and June so this treatment weakened the trees. Feathered trees in treatment 4 and 5 had the leader cut back to 3-5 buds after planting. Such a short pruning resulted in sprouting 3-4 shoots forming narrow crotch angles that had to be removed in June. This treatment also weakened tree growth. The differences between treatments in the total annual shoot length were flattened in further years but for trees planted without side shoots the significant differences were clear even in the 5th year.

Effects of various of pruning apple trees

Table 1. Effects of pruning and training systems on growth and cropping of 'Fiesta' trees

Pruning treatment	Total length of annual shoots [m]		TCSA* [cm <sup>2</sup> ]		Yield per tree [kg]		Yield efficiency [kg/cm <sup>2</sup> TCSA] 2000	Fruit load [kg/total annual shoot growth] 2000
	1996-1997	1996-2000	1997	2000	1997	1997-2000		
<b>Feathered trees</b>								
1. No pruning after planting	3.0 c**	9.4 cd	2.7 bcd	17.6 c	4.4 c	26.7 c	1.5	2.8
2. Only lower feathers removed	2.6 b	9.5 cd	2.6 bcd	10.9 abc	2.8 b	17.2 abc	1.6	1.8
3. As treat. 2. Leader headed to 40 cm	2.6 b	9.8 de	3.1 d	11.6 abc	2.7 b	12.8 a	1.1	1.3
4. As treat. 2. Leader headed to 3 buds	1.8 a	10.0 de	1.7 a	14.3 bc	3.0 b	16.6 abc	1.2	1.7
5. Leader and side shoots headed to 3-5 buds	1.5 a	13.3 e	1.6 a	10.0 abc	2.2 b	20.8 abc	2.1	1.6
6. Control. Standard pruning	2.6 b	11.3 f	3.1 cd	13.8 abc	3.1 b	24.6 abc	1.8	2.2
<b>Unfeathered trees</b>								
7. No pruning after planting	2.6 b	7.8 b	2.5 bc	14.1 abc	3.0 b	16.2 abc	1.1	2.1
8. Leader headed to 90 cm	2.4 b	10.2 e	2.6 bcd	11.4 abc	2.7 b	17.6 abc	1.5	1.7
9. Leader headed to 70 cm and summer treatments	2.4 b	10.2 e	2.5 b	9.9 ab	2.4 b	15.9 abc	1.6	1.6
10. Leader headed to 50 cm and new leader selected	1.5 a	5.1 a	1.6 a	10.3 abc	1.2 a	15.3 ab	1.5	3.0
11. Leader headed to 30 cm and new leader selected	1.5 a	5.6 a	1.5 a	9.9 ab	0.6 a	18.3 abc	1.8	3.3
12. Control. Standard pruning	2.4 b	9.0 c	2.9 bcd	11.2 abc	2.3 b	26.3 c	2.3	2.9

\*TCSA – Trunk cross-sectional area

\*\*Means followed by the same letters in columns do not differ significantly at P=0.05 according to Duncan's multiple range t-test

Table 2. Effects of pruning and training systems on growth and cropping of 'Jonagored' trees

Pruning treatment	Total length of annual shoots [m]		TCSA* [cm <sup>2</sup> ]		Yield per tree [kg]		Yield efficiency [kg/cm <sup>2</sup> TCSA] 2000	Fruit load [kg/total annual shoot growth] 2000
	1996-1997	1996-2000	1997	2000	1997	1997-2000		
<b>Feathered trees</b>								
1. No pruning after planting	5.3 gh**	12.3 c	4.8 ef	32.7 abc	2.2 f	47.5 c	1.5	3.9
2. Only lower feathers removed	5.2 g	13.6 d	4.2 de	30.0 ab	1.9 ef	38.9 bc	1.3	2.9
3. As treat. 2. Leader headed to 40 cm	5.0 f	13.7 d	4.8 ef	32.1 abc	0.9 abc	32.5 abc	1.0	2.4
4. As treat. 2. Leader headed to 3 buds	3.6 e	13.1 d	2.4 ab	31.7 abc	0.9 abc	27.7 ab	0.9	2.1
5. Leader and side shoots headed to 3-5 buds	3.1 c	11.0 b	2.4 ab	32.0 abc	0.5 ab	30.7 ab	1.0	2.8
6. Control. Standard pruning	5.4 h	15.2 e	5.2 f	27.7 ab	1.5 cdef	36.6 abc	1.3	2.4
<b>Unfeathered trees</b>								
7. No pruning after planting	3.8 e	11.3 b	3.5 cd	31.4 abc	1.8 def	38.3 abc	1.2	3.4
8. Leader headed to 90 cm	3.8 e	16.0 e	2.7 abc	32.0 abc	1.2 bcde	32.2 abc	1.0	2.0
9. Leader headed to 70 cm and summer treatments	3.4 d	15.5 e	3.2 bc	34.1 bc	0.5 ab	27.0 a	0.8	1.7
10. Leader headed to 50 cm and new leader selected	2.8 b	8.8 a	2.1 a	31.7 abc	0.3 a	27.2 ab	0.9	3.1
11. Leader headed to 30 cm and new leader selected	2.5 a	9.3 a	2.0 a	32.5 abc	0.2 a	32.6 abc	1.0	3.5
12. Control. Standard pruning	3.6 e	13.9 e	3.2 bc	35.1 c	0.7 abc	31.7 abc	0.9	2.3

\*,\*\*Explanations see Table 1

Table 3. Effects of pruning and training systems on fruit quality of 'Fiesta' trees

Pruning treatment	Mean weight of apple [g] 1998-2000	Percentage of apple >8.0 cm 1998-2000	Percentage of apple with blush over 75% 1998-2000
<b>Feathered trees</b>			
1. No pruning after planting	194 a**	52 bc	71 abc
2. Only lower feathers removed	180 a	54 bc	71 abc
3. As treat. 2. Leader headed to 40 cm	196 a	43 ab	78 bc
4. As treat. 2. Leader headed to 3 buds	199 a	55 bc	71 abc
5. Leader and side shoots headed to 3-5 buds	188 a	47 abc	68 abc
6. Control. Standard pruning	195 a	54 bc	58 a
<b>Unfeathered trees</b>			
7. No pruning after planting	207 a	54 bc	77 bc
8. Leader headed to 90 cm	184 a	51 bc	69 abc
9. Leader headed to 70 cm and summer treatments	192 a	53 bc	82 c
10. Leader headed to 50 cm and new leader selected	202 a	57 c	75 bc
11. Leader headed to 30 cm and new leader selected	192 a	48 abc	82 c
12. Control. Standard pruning	171 a	37 a	65 ab

\*\*Explanations see Table 1

Table 4. Effects of pruning and training systems on fruit quality of 'Jonagored' trees

Pruning treatment	Mean weight of apple [g] 1998-2000	Percentage of apple >8.0 cm 1998-2000
<b>Feathered trees</b>		
1. No pruning after planting	232 a**	61 a
2. Only lower feathers removed	247 b	73 bc
3. As treat. 2. Leader headed to 40 cm	243 b	72 abc
4. As treat. 2. Leader headed to 3 buds	258 c	68 abc
5. Leader and side shoots headed to 3-5 buds	270 d	78 c
6. Control. Standard pruning	238 a	65 ab
<b>Unfeathered trees</b>		
7. No pruning after planting	245 b	78 c
8. Leader headed to 90 cm	248 b	79 c
9. Leader headed to 70 cm and summer treatments	253 c	74 bc
10. Leader headed to 50 cm and new leader selected	252 c	74 bc
11. Leader headed to 30 cm and new leader selected	250 c	79 c
12. Control. Standard pruning	256 cd	79 c

\*\*Explanations see Table 1

The significant differences in trunk diameter between branched and unbranched trees at planting time were observed during the first two years (1996-1997) on 'Jonagored' and 'Fiesta', but for 'Fiesta' trees they quickly diminished with years. Heavily pruned trees of both cultivars (treat. 4, 5, 10 and 11) showed a weaker trunk growth at the beginning than those lightly pruned. These significant differences between pruning treatments faded away with years.

Trees came into bearing in the second year after planting (1997). Weak growing cultivar 'Fiesta' yielded 1-4 kg per tree, whereas strong growing 'Jonagored' provided hardly half of that. Trees having side shoots at planting time produced higher yields than those without such shoots but not all the differences were statistically proved. The lightly pruned 'Jonagored' and 'Fiesta' trees provided 2-3 times more fruit than those heavily pruned (Tab. 1 and 2).

In the third year after planting (1998) all trees produced a high fruit yield irrespectively to tree quality at planting. Apple crop of 'Jonagored' was around 15 kg per tree and the crop of 'Fiesta' half of that. No significant differences were found between treatments. The same tendency in cropping was found in the next years, 1999 and 2000. Total yield per tree for 1997-2000 was irrespectively of the quality of planted trees and pruning treatments. Trees planted with side shoots produced roughly the same yield as those without such shoots, and heavily pruned trees the

same yield as those lightly pruned (Tab. 1 and 2).

Fruit quality was recorded from full bearing (1998). It showed only slight differences from year to year. In Tables 3 and 4 the results of measurements are presented as a mean for 1998-2000. Mean fruit weight was very high, around 250 g for 'Jonagored' and 190 g for 'Fiesta'. In the case of 'Jonagored' heavy pruning slightly increased mean fruit weight due to a higher proportion of shoots to fruits. On 'Fiesta' trees there was no significant difference in fruit weight between pruning and training systems. In 'Jonagored' crop there was also significantly higher % of larger size apples (over 8 cm) in treatments with heavy pruning. There was no difference in fruit colour of 'Jonagored', but the lightly pruned 'Fiesta' trees had the lower percentage of well coloured fruit (Tab. 4).

## DISCUSSION

Tree growth recordings supported Preston's (1968) and Sanders' (1989) observations that the presence of feathers on trees at planting has a positive effect on the total tree condition afterwards, trunk girth increment, number of new shoots and total shoot growth. In this trial significant differences in shoot growth had been observed for 5 years (1996-2000). The initial differences in trunk girth disappeared mostly after two years. This is in agreement with Mika (1996) who, compared the growth and fruiting of feathered and



unfeathered trees of several apple cultivars and found that feathers had a positive effect in this respect only in the first 3 years after planting. Such a short effect is due to the competition between growth and fruiting (Maggs, 1965). When feathered trees came into bearing in the second year after planting, the first crop had already suppressed their growth. At the same time unfeathered trees unable to crop yet had a chance to produce more shoots and to increase trunk girth. Preston (1968) points out the value of feathered trees with regard to their morphology. Feathers have always wide angles formed with the leader and are very suitable for primary branches. If unfeathered trees are cut back to the required height, new laterals appear with narrow crotch angles. The importance of such angles in tree formation was shown by Jankiewicz et al. (1962).

Results obtained support earlier findings that dormant pruning decreases tree size even when annual shoots are longer on pruned than on unpruned trees. Those pruned usually are not able to restore the removed part and to produce equal shoot growth to unpruned trees. Pruning reduces especially trunk girth and root weight (Maggs, 1965).

In this trial heavy pruning of feathered (treat. 5) and unfeathered trees (10, 11) involved such a drastic reduction of incipient shoots that those trees produced less shoots for 5 years after planting.

From the point of modern methods of tree training more important than number and size of shoots are crotch

angles formed between laterals and leader. Here the widest crotches were on the lightest pruned trees. Leader headed to 3-5 buds (treat. 4, 5) or to 30-50 cm (10, 11) created side shoots with narrow crotch angles and required further treatments. Light leader heading of feathered trees (8, 9) also produced more narrow crotches as compared to those unpruned. Hard leader heading of unfeathered trees (10, 11) resulted in sprouting of several shoots that had to be cut off leaving only one. These results confirm Preston's (1968) suggestion to save all the incipient feathers on a tree if they are not too low to the ground. In spite of that most of planted apple trees are still heavily pruned after planting in order to secure the condition for proper tree establishment.

Influence of pruning on the initial crop found in this trial supports results of many earlier experiments showing that pruning of young apples trees delays and reduces cropping (Mika, 1975; Mika et al., 1983). Lower yield is due to a smaller tree size and an inhibitory effect of pruning on fruit bud formation. As apple trees were pruned mainly only in the first year after planting the effect was not long lasting.

The difference in apple size was related to yield quantity per tree. Higher yield is usually occupied with smaller fruits (Mika and Krzewińska, 1999). Effect of pruning systems on apple colour was not expressed, because trees were young. 'Fiesta' had a small canopy, very well illuminated. 'Jonagored' produced coloured apples even in medium illumination.

## CONCLUSIONS

1. Feathered trees planted in an orchard are able to come sooner into bearing and give higher yield than those unfeathered, but after 2-3 years such differences diminish.
2. Feathered and unfeathered apple trees planted in an orchard should be pruned as little as possible.
3. Both types of trees can be planted in an orchard depending on the relation between price of nursery material and expected capital return.

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## WPL YW RÓŻNYCH METOD CIĘCIA JABŁONI PO POSADZENIU

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

Jednoroczne drzewa jabłoni ‘Jonagored’ i ‘Fiesta’ szczepione na podkładce M.26, posortowano na 2 grupy: dobrze wyrosnięte i rozgałęzione (mające 3-8 pędów w koronie) oraz słabiej wyrosnięte, bez żadnych rozgałęzień. Wiosną 1996 roku drzewa posadzono do Sadu Doświadczalnego w Dąbrowicach. Przez 3 lata po posadzeniu cięcie drzew w poszczególnych grupach było zróżnicowane. Cięcie najslabsze polegało na pozostawieniu drzew bez cięcia przez 3 lata po posadzeniu, a następnie stosowano prześwietlanie koron. Cięcie najsilniejsze polegało na skracaniu po posadzeniu przewodnika i pędów bocznych do 3-5 pąków u drzew rozgałęzionych i do 30 cm od ziemi u drzew nierozgałęzionych. Mocne cięcie wymagało wielu zabiegów formujących po cięciu.

W pierwszych trzech latach po posadzeniu drzewa cięte najslabiej wytworzyły największą sumę przyrostów, miały najgrubsze pnie i wydały najobfitsze plony. Drzewa utworzyły foremne korony bez zabiegów. Drzewa cięte mocno po posadzeniu wytworzyły mniejszą sumę przyrostów, miały najcieńsze pnie, najmniejsze plony i wymagały cięcia formującego w następnych latach. W trzecim roku drzewa we wszystkich kombinacjach zaowocowały obficie. Różnice między kombinacjami w owocowaniu zanikły. Wpływ cięcia po posadzeniu na jakość owoców był nieznaczny.

**Słowa kluczowe:** jabłoń, uprawa, cięcie i formowanie