# A STUDY OF PRUNING ON SEEDLING PEACHES AT LOW LATITUDE

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Abstract

Five-year-old seedling clingstone peach trees were pruned in winter (WP) and spring (SP) at different levels of pruning severity of fruiting shoots (PSFS), and the elimination or not of the weak unmixed fruiting shoots (WUFS) with only floral buds. Yield was not modified significantly ($P \leq 0.05$) by pruning time (PT); however it decreases by 43.35 and 56.08% when the level of PSFS, eliminated 25 and 50% of shoot length, respectively. The PT x PSFS interaction affected significantly ($P \leq 0.05$) fruit size, fruit and shoot growth. Fruits with equatorial diameter > 5.1 cm were increased by WP and remotion of 25 % of shoot length. In a similar way, fruit and vegetative growth were modified. Numbers of fruits with an equatorial diameter smaller than 5.1cm were increased by SP. No combination of pruning factors affected soluble solids. In contrast, fruit firmness and acidity were increased when trees were pruned at 50% of shoot length.

*Résumé*

*Des semis de pavies âgés de cinq ans ont été taillés en hiver (TH) et au printemps (TP) avec différents niveaux de sévérité de taille sur les rameaux fruitiers (STRF), et l'élimination ou non des brindilles fruitières non mixtes (BFNM) portant seulement des boutons floraux. Le rendement n'a pas été modifié significativement ($P \leq 0.05$) par la date de la taille (DT); toutefois il décroît de 43,35 et 56,08% quand le niveau de STRF élimine 25 et 50% de la longueur des rameaux respectivement. L'interaction DT x STRF affecte significativement ($P \leq 0.05$) la taille du fruit, la croissance du fruit et du rameau. Le nombre de fruits d'un diamètre équatorial > 5.1cm était plus important avec TH et enlèvement de 25% de la longueur des rameaux. Le nombre de fruits avec un diamètre équatorial <5,1cm était accru par TP. Aucune combinaison des facteurs de taille n'a affecté les solides solubles. Au contraire, la fermeté des fruits et leur acidité étaient accrues quand les arbres étaient taillés à 50% de la longueur des rameaux.*

## 1. Introduction

In general, pruning of fruit trees improves fruit size and quality, prevents excessive fruiting, promotes vegetative growth, facilitates light penetration into the tree canopy, and extends the tree life span. At high latitudes, pruning time depends on tree training and spacing, cultivar, available labour, the presence of fungal disease and bacterial canker, and weather. However, winter and summer are the most important pruning times regarding to temperate fruit tree production (Daniell, 1975; Marini and Barden, 1982; Marini, 1985 Miller, 1987). At low latitude (22° 54' N), winter pruning is also an extended practice among peach growers; nevertheless, early spring pruning is frequently used, presumably to reduce the risk of spring frost damage. In our region, spring frost damage is an erratic event. It means that it may not occur, and there is no available information regard to winter and spring pruning on production variables of peach trees. In apple as well as peach trees the increase in new shoot growth is influenced by pruning time and severity (Savage *et al.*, 1942; Jonkers, 1982), but it proportionally reduces peach yield (Westwood, 1978). On this respect, Daniell (1975) pointed out that peach yield was significantly increased by spring pruning winter pruning. Except for Daniell's report, little information is available in relation to the effect of spring pruning on fruit size and yield, fruit and vegetative growth and fruit quality. The objective was to compare two PT, and PSFS, and the effect of elimination of the WUFS on seedling clingstone peaches cultivated at low latitudes.

## 2. Materials and methods

### 2. 1. Location characteristics and plant material

The experiment was set up in a commercial orchard in Jerez, Zacatecas, Mexico (22° 51 N'; 102° 57' W). The soil in this orchard is silt loam with a pH of 7.0. Five-year-old seedling clingstone peaches with an average height of 2.71 m were used. Around 160 days are needed to complete the fruit development period. Fruit is processed to make juice, marmalade, peach halves and concentrated paste. Trees were planted at 5 x 5m., trained into an open center system, and received standard cultural practices for local commercial fruit production, including irrigation, fruit thinning, fertilisation, and pest, disease and weed control.

### 2. 2. Observations

Two PT were evaluated on one-year-old fruiting shoots. WP was done in the last week of February just before blooming, while SP was carried out in the second week of April, when fruit had already set (33 days after blooming), vegetative growth had resumed and the probability of spring frost damage was below 12 %. The PSFS consisted in no (0 %), pruning 25% and 50% of original shoot length. This peach germplasm produces a great amount of weak fruiting shoots with only floral buds except one apical vegetative bud (unmixed fruiting shoots). Presumably, these structures increase the demand for photosynthetic products during the growing season, and simultaneously decrease fruit size and shoot growth (Perez and Chan, 1988), but this has not been demonstrated. Therefore, the elimination or not of these structures were also a factor of study. Before pruning treatments were applied all trees were cut upper back and thinned-out.

2. 3. Response variables

2. 3. 1. Fruit size and yield.

Fruits were harvested, separated and weighed into five size classes according to equatorial diameter (1, > 5.1 cm; 2, 5.0 to 4.4cm; 3, 4.3 to 3.8cm; 4, 3.7 to 2.5cm; 5, < 2.5 cm). The first four classes were then grouped as marketable fruit, and all fruit harvested were considered as total yield. Productive efficiency was also calculated (yield in kg/trunk cross-sectional area in $cm^2$). For data analysis, 0.5 was added to the weights into each size class and they were transformed into square root (Fernandez, 1992).

2. 3. 2. Fruit and shoot growth

Measurements of fresh fruit weight (FW) and dry fruit weight (DW) were taken during the growing season. Eleven samples were collected at two week intervals, starting on April 10. Each sample consisted of five fruits per tree picked randomly from the middle part of the tree. The DW was obtained by cutting fruits into halves (including the endocarp) and drying them at 70°C for 48h; however, this variable is not presented as it followed similar pattern to FW. Four young shoots orientated to the North, South, East and West were tagged 1.5m above ground level, and subsequent growth measurements were made twice a month starting on May 14.

2. 3. 3. Fruit quality

Every week, starting on July 29, five fruits per tree were randomly harvested from the middle part of the tree to determine flesh firmness (kg $cm^{-2}$), soluble solids (%), pH and titratable acidity (meq per l). Flesh firmness was measured with a fruit tester (7.5 mm tip) on opposite sides of each fruit. Juice was extracted from five fruits (without skin or core) and a portion of juice was used to determine soluble solids with an American Optical hand refractometer. The juice pH was also measured, 10 ml of juice were mixed with 0.5 ml of bromothymol blue, 30 ml distilled water and titrated to pH 7.0 with 0.1 N NaOH to determine total tritatable acidity.

2. 4. Experimental design.

The experimental design was a split-plot design in which the units were arranged in randomised complete blocks with 12 single-tree replicates. PT represents the main plot, PSFS the sub-plots, and the elimination or not of WUFS the sub-sub-plots. Before treatment set up, blocks were formed by trees with similar trunk cross-sectional area (Pearce, 1976). In addition, three destructive replicates were used to determine fruit growth and maturity data. Based on previous analysis, harvest date in interaction with other factors did not influence significantly any maturity variables; global statistical analysis was performed taking each harvest date as subsampling; standard errors were also calculated.

## 3. Results and discussion

### 3. 1. Fruit size and yield

The analysis of variance detected a significant ($P = 0.05$) interaction between PT and PSFS for the weight of fruit classes 1 and 2. Weight of fruits with equatorial diameter > 5.1 cm (classs 1) increased significantly ($P = 0.05$) when trees were WP at 25 % of shoot length compared to unpruned trees or pruned at 50 % of shôot length (Fig. 1A). In contrast, the tendency of SP trees was an increase weight of fruit class 1, when pruning severity was higher than 25%. Fruit weight class 2 was proportionally reduced by PSFS in both pruning seasons; however SP at 50% of shoot length produced heavier fruits in class 2 (Fig. 1B). No interaction was detected in the other fruit classes; the main effects of PT and PSFS were then studied separately. SP trees produced significantly ($P = 0.05$) higher yields in class 3, 4 and 4 (Table 1) Although marketable yield and productive efficiency had similar patterns, PT did not affect statistically them (Table 1). In contrast, fruit weight was proportionally reduced in all classes by PSFS and so were marketable yield and productive efficiency (Table 2). Data clearly suggests that WP increases the weight of large fruits, with ≥5.1 cm equatorial diameter, when compared to other fruit sizes; this finding confirms previous reports (Savage *et al.*, 1942; Daniell, 1975; Marini, 1985; Therani and Leuty, 1987). However, opposite results were found when peaches were SP due to yield increase, as stated by Daniell (1975). Total yield was reduced proportionally to pruning severiy (Savage *et al.*, 1942; Westwood, 1978) but it increased the weight of the largest fruit size due to less competition among fruits.

### 3. 2. Fresh fruit and vegetative growth

Fresh fruit and vegetative growth were significantly ($P < 0.01$) influenced by the interaction between PT and PSFS. WP trees at 25 % of shoot length producé a significant increase in fresh fruit growth rate, compared to unpruned or SP trees at any PSFS; this effect was stronger in the third phase of fruit growth rate (Fig. 2A). This pattern was similar for the dry fruit growth rates (data not presented). In contrast, vegetative growth rate was significantly ($P = 0.05$) increased in a proportion related to pruning severity, in both pruning times. The highest vegetative growth rate was observed when trees were winter pruned at 50 % of shoot length, compared to unpruned or pruned at 25 % of shoot length. This effect was similar on SP trees, but their growth was lower than in WP trees (Fig. 2B). Interaction between PT and PSFS influenced fruit and vegetative growth up to a certain point, as previous reports indicated (Savage *et al.*, 1942; Jonkers, 1982; Marini and Barden, 1982). Daniell (1975) found that total yield in SP trees was doubled when compared to those WP. Consequently, he detected a negative correlation between yield and fruit size. In this work, the total number of fruits harvested per tree on WP or SP was 481 and 622, respectively, confirming results found by Daniell (1975). Due to the large amounts of fruit produced by SP trees, a large competition for photosynthate reserves in the branches, among fruit and shoot growth, was established (Bangerth, 1989; DeJong, 1997), thus the partitioning of reserves was not enough to build each organ up compared to WP trees.

3. 3. Fruit quality

Fruit quality was significantly affected by harvest date and the main effect of PSFS when global analysis of variance was performed (Table 3). The behaviour of fresh firmness, % soluble solid, titratable acidity, and pH among harvest dates agreed with the well established pattern of each variable (Romani and Jennings, 1971). In contrast, flesh firmness and titratable acidity were proportionally increased by PSFS, but the opposite relation was observed for pH. Trees pruned at 50 % shoot length significantly ($P < 0.01$) increased both fruit quality parameters, this can be explained by less competition levels among fruits. There are large discrepancies effects of pruning time on fruit quality (Marini and Barden 1982, Marini 1985, Miller 1987). All fruit parameters, except pH, seem to be favoured on SP over WP trees (Table 3).

## 4. Conclusions

For this peach germplasm, results of this study indicate that weighs of fruit with an equatorial diameter ≥ 5.1 cm, along with vegetative growth can be increased by the interaction between winter pruning and pruning intensity at 25% of the original shoot length. Limbs of trees should also be cut upper back and thinned-out. Although spring pruning could not be evaluated in relation to spring frost damage, data suggests this practice has more disadvantages than winter pruning particularly because spring frost damage is an erratic event. It is clear that shoot length pruning can not be more than 25%, since it will have very little effect over fruit quality. Results were not significantly modified by the elimination of weak fruiting shoots, with only floral bud; however this structures may have a greater influence on older trees than on young ones.

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Table 1 - Influence of winter (WP) and spring (SP) pruning on some fruit size classes, marketable fruit, yield, and productive efficiency (PE) on seedling clingstone peaches in 1985. z Mean separation in columns by Tukey's LSD, 5 % level. ns, **:non significant or significant at $P = 0.01$, respectively. y Original data plus 0.5 was transformed to square root.

| Pruning time (PT) | | Fruit size distribution (kg) Third (3.8-4.3 cm) | Fourth (2.5-3.7 cm) | Fifth (<2.5 cm) | Commercial (kg) | Yield (kg) | PE (kg/cm$^2$) |
|---|---|---|---|---|---|---|---|
| WP | | 05.54 b$^z$ | 0.38 a | 2.03 b | 21.68 a | 23.71 a | 0.31 a |
| SP | | 10.18 a | 1.38 a | 2.60 a | 23.30 a | 25.90 a | 0.34 a |
| LSD$^z$ | | 4.08 | 1.02 | 0..32 | 5.92 | 6.11 | 0.27 |
| **Analysis of variance$^y$** | | | | | | | |
| Source of variation | df | Mean squares | | | | | |
| EP | 1 | 29.31 ** | 02.11 ns | 01.10 ** | 02.54 ns | 03.51 ns | 00.02 ns |
| Error a | 11 | 02.01 | 00.38 | 00.06 | 02.58 | 02.47 | 00.01 |

Table 2 - Influence of pruning severity of fruiting shoots (PSFS) on some fruit size classes, marketable fruit, yield, and productive efficiency (PE) on seedling clingstone peaches in 1985. z Mean separation in columns by Tukey's LSD, 5 % level. ns, *,***: non significant or significant at $P = 0.05$ or 0.0001, respectively. y Original data plus 0.5 was transformed to square root.

| PSFS (%) | | Fruit size distribution (kg) Third (3.8-4.3 cm) | Fourth (2.5-3.7 cm) | Fifth (<2.5 cm) | Commercial (kg) | Yield (kg) | PE (kg/cm$^2$) |
|---|---|---|---|---|---|---|---|
| 0 | | 16.27 a$^z$ | 01.56 a | 3.25 a | 33.84 a | 37.09 a | 0.49 a |
| 25 | | 04.89 b | 0.89 ab | 2.11 b | 18.93 b | 21.04 b | 0.27 b |
| 50 | | 02.42 b | 0.17 b | 1.57 c | 14.71 b | 16.28 b | 0.22 b |
| LSD$^z$ | | 3.92 | 1.19 | 0.48 | 5.37 | 5.65 | 0.08 |
| **Analysis of variance$^y$** | | | | | | | |
| Source of variation | df | Mean squares | | | | | |
| PSFS | 2 | 61.65 *** | 02.61 * | 03.29 *** | 52.26 *** | 56.78 *** | 00.28 *** |
| PSFS x PT | 2 | 01.97 ns | 00.18 ns | 00.06 ns | 01.22 ns | 01.27 ns | 00.00 ns |
| Error b | 44 | 01.55 | 00.36 | 00.14 | 02.21 | 02.29 | 00.01 |

Table 3 - Seedling peaches fruit quality as influenced by harvest date (HD), pruning time PT and pruning severity of fruiting shoots (PSFS). [z] Mean separation in columns by Tukey's LSD, 5 % level. $^{ns,*,***}$: nonsignificant or significant at $P \leq 0.01$or 0.0001, respectively. Winter pruning (WP) and spring pruning (SP).

| Source | | Fruit quality variables | | | |
|---|---|---|---|---|---|
| Harvest date | HD | Firmness (kg $cm^{-2}$) | SS (%) | TA (Meq $l^{-1}$) | pH |
| 29 July | 1 | 11.30 a | 10.63 f | 68.41 a | 3.74 c |
| 5 August | 2 | 11.22 a | 11.63 e | 60.79 b | 3.75 c |
| 13 August | 3 | 11.04 ab | 11.99 d | 50.50 c | 3.80 c |
| 21 August | 4 | 10.69 bc | 12.57 c | 45.83 d | 3.92 b |
| 27 August | 5 | 10.63 bc | 13.08 b | 43.02 de | 4.02 ab |
| 2 September | 6 | 10.61 c | 14.06 a | 39.87 e | 4.08 a |
| 9 September | 7 | 10.30 c | 14.20 a | 39.28 e | 4.09 a |
| LSD[z] | | 0.43 | 0.34 | 3.80 | 0.12 |
| PT | | | | | |
| WP | | 10.70 a | 12.48 a | 50.04 a | 3.91 a |
| SP | | 10.90 a | 12.51 a | 50.62 a | 3.90 a |
| LSD | | 0.17 | 0.14 | 2.40 | 0.07 |
| PSFS (%) | | | | | |
| 0 | | 10.71 b | 12.63 a | 47.26 b | 3.93 a |
| 25 | | 10.80 b | 12.38 a | 51.10 ab | 3.91 ab |
| 50 | | 11.05 a | 12.45 a | 53.06 a | 3.88 b |
| LSD | | 0.20 | 0.48 | 4.42 | 0.04 |
| | | Analysis of variance | | | |
| Source of variation | df | Mean squares | | | |
| HDM | 6 | 4.65*** | 53.32*** | 4148.33*** | 0.79*** |
| Error | 12 | 0.27 | 0.17 | 21.22 | 0.02 |
| PT | 1 | 0.64 $^{ns}$ | 0.06 $^{ns}$ | 5.54 $^{ns}$ | 0.00 $^{ns}$ |
| Error a | 2 | 0.27 | 0.19 | 53.14 | 0.05 |
| PSFS | 2 | 2.34** | 1.60 $^{ns}$ | 730.80** | 0.05 **$^{S}$ |
| PSFS x PT | 2 | 0.35 $^{ns}$ | 2.62 $^{ns}$ | 150.81 $^{ns}$ | 0.02 $^{ns}$ |
| Error b | 8 | 0.33 | 1.20 | 100.50 | 0.01 |

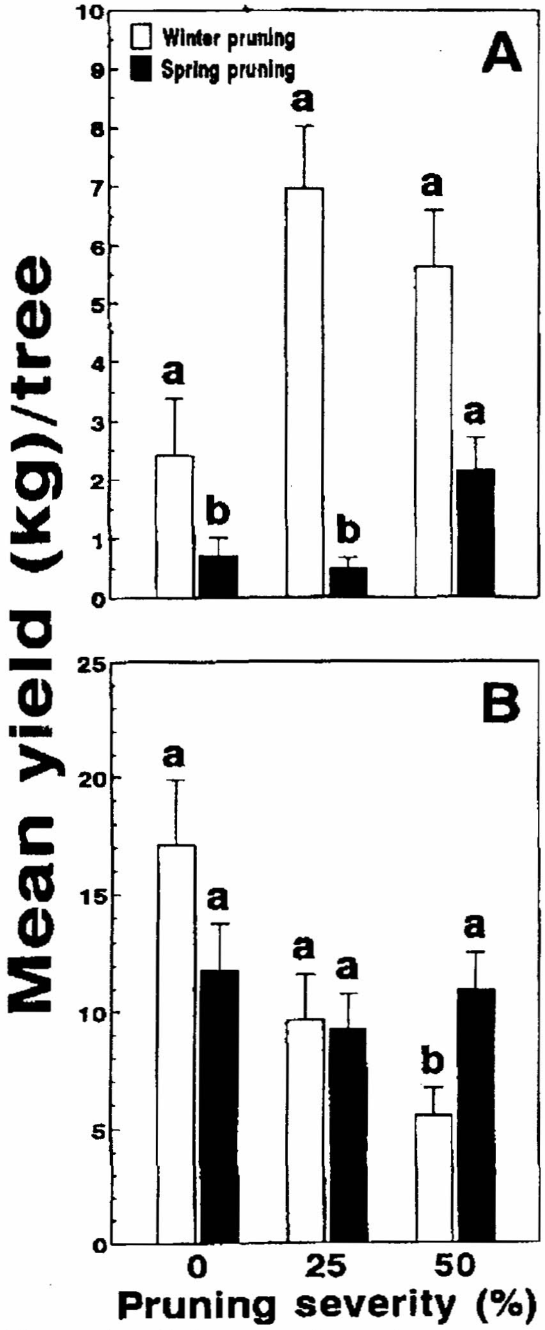


Figure 1 - Influence of the interaction between pruning time and pruning severity of fruiting shoots on fruits with equatorial diameter ≥ 5.1 cm (A), and 4.4 to 5.0 cm (B). Mean response ± SD. Mean separation by Tukey's multiple range test at $P$ = 0.05. Winter () and Spring (----) pruning.

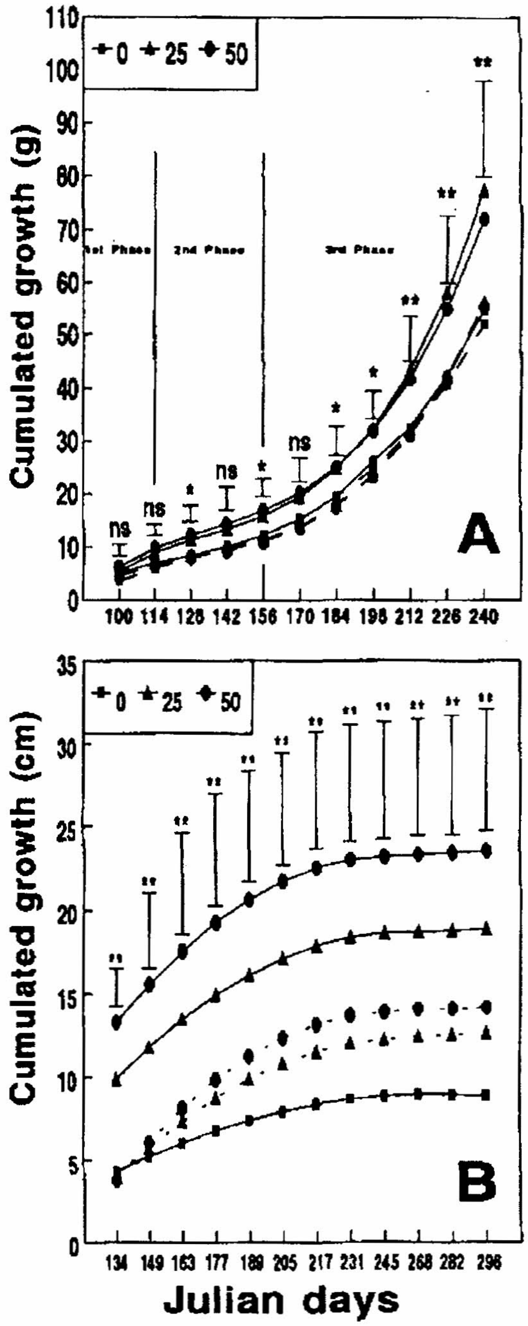


Figure 2 - Influence of the interaction between pruning time and pruning severity of fruiting shoots on fresh fruit (A) and lateral shoot (B) growth. Least significant difference within each date by Tukey's multiple range test, ns, *,**Nonsignificant or significant at 5 or 1 % level, respectively. Winter (—) and Spring (---)pruning.