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Effect of Summer Pruning on Shoot Growth and Fruit Quality in Peach Trees Trained as Slender Spindle Bush Type

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Abstract

Summer pruning experiments were carried out to maintain slender spindle bush type in ‘Hikawahakuho’ peach (*Prunus persica* Batsch) trees grafted on wild form vigorous rootstocks. In the first experiment in which five-year-old trees were used, summer pruning was performed in mid-July after fruit were harvested, while winter pruning in mid-March as the control. Summer pruning produced regeneration of terminal and lateral shoots. Terminal shoot growth was greater than lateral shoot. Leaf chlorophyll content (SPAD value) was greater but the percentage of flower buds was lower in summer-pruned than winter-pruned trees. In the following season, the total shoot length was greatly reduced in summer pruned trees. Fruit maturation seemed to be accelerated in summer-pruned trees, which resulted in higher soluble solids content (SSC) and lower titratable acidity (TA) in the fruit. Furthermore, in the second experiment, effects of two successive years of summer pruning were determined. The weight of pruned shoots was lower in the two-successive-year-summer-pruned (SPⅡ) trees than single-year-summer-pruned (SPⅠ) trees. This suggests the gradual reduction in the vegetative growth of trees by annual summer pruning. SSC of fruit was slightly higher in SPⅡ than SPⅠ trees. Thus, summer pruning in mid-July after fruit harvest is a useful practice for maintaining slender spindle bush type of peach trees grafted on vigorous rootstocks.

Key words: Dwarfing, Flower bud, Shoot growth, Slender spindle bush, Summer pruning.

Introduction

Slender spindle bush types are commonly applied on compact-sized fruit trees. Peach trees grafted on *Prunus tomentosa* and some other *Prunus* species can be dwarfed but show graft-incompatibility (Ferree, 1988; Andrews and Serrano, 1992). It is difficult to maintain trees grafted on vigorous rootstocks as slender spindle types by winter pruning. The growth of current-year shoots is so great that the inner parts of the trees are shaded resulting in poor growth and even death of shoots near the trunk. Such poor light penetration also causes poor fruit pigmentation. Moreover, the vigorous shoot growth competes with fruit growth eventually affecting the quality of harvested fruit. A number of reasons have been given to support the practice of summer pruning in peach. Summer pruning was reported to reduce vegetative growth, improve light penetration, enhance fruit quality, concentrate fruit maturation and increase the number of flower buds (Hyden and Emerson, 1976; Ritter, 1983; Rom and Ferree, 1984). Summer pruning has been regarded as less invigorating than dormant pruning (Hyden and Emerson, 1976; Utermark, 1977).

Summer pruning has recently received much attention as a potential method of controlling tree size and reducing pruning costs in orchard operations (Taylor and Ferree, 1984). It may, however, alter tree physiological processes in ways that are not yet fully understood (Rom and Ferree, 1984; Taylor and Ferree, 1986; Marini, 1985). Summer pruning of woody plants has resulted in altered levels of endogenous growth regulators and shoot carbohydrates (Rom and Ferree, 1984). In the previous work, we reported that summer pruning was a useful practice for maintaining slender spindle bush type by using an early maturing selection (‘Akatsuki’ x unknown ‘Banto’) peach trees grafted on vigorous rootstocks (Hossain et al., 2004). Here we further studied the usefulness of summer pruning for maintaining slender spindle bush type by using another early maturing peach cultivar ‘Hikawahakuho’ grafted on vigorous wild form peach rootstocks.

Materials and Methods

Experiment I

Site

The experiment was carried out in an orchard in the Ehime University Farm located in southern Japan, 33° 57′, N, 132° 47′, E at an elevation of about 20 m above sea level. The area has a mild temperate climate characterized by hot humid summers and cold dry winters. The average annual temperature and precipitation are 14.5℃ and 1,200 mm, respectively.

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Plant materials, treatment and measurement

Five-year-old peach (*Prunus persica* Batsch cv. 'Hikawahakuho') trees grafted on wild form vigorous peach rootstocks and planted at a spacing of 2 x 3 m were used. They had been trained as slender spindle bush type by winter pruning before the experiment started. Eight trees were randomly selected and four trees each subjected to summer and winter pruning respectively. Summer pruning consisted of heading back of current shoots to about 10 cm length and removal of vigorous shoots, which was conducted after fruit harvest on July 15, 2003. On the other hand, winter pruning was done in early March 2004. The number of regenerated shoots was recorded starting after summer pruning and the terminal and lateral shoot length was measured for four months. The other parameters such as leaf drop percent, vegetative and flower bud number were determined. Leaf chlorophyll was measured in early September and early November 2003 using a SPAD chlorophyll meter (SPAD-502, Minolta Co. Japan). Leaves were selected in the middle part of regenerated shoots in the summer-pruned trees and of current-year shoots in the winter-pruned trees. In 2004, the total shoot length was measured before summer pruning. Fruit were harvested on June 28, 2004. Fruit number per tree and fruit weight were recorded immediately after harvest. Ten fruit per tree were randomly selected and used to determine total soluble solids content (SSC) and titratable acidity (TA).

Experiment II

Plant materials, treatment and measurement

In 2004, another group of six-year-old 'Hikawahakuho' peach trees grafted on vigorous wild form peach rootstocks were selected from the same plots of Experiment Ⅰ and a similar experiment was conducted again. Summer pruned trees were designated as SPⅠ and winter pruned trees as WPⅠ. Moreover, the trees used in Experiment Ⅰ were successively summer and winter pruned in the second season. These trees were designated as SPⅡ and WPⅡ, respectively. In 2004, summer pruning was conducted on July 15 after fruit harvest, while winter pruning in early March 2005. The number of regenerated shoots was counted after summer pruning, and the weight of pruned branches was also recorded. Fruit were harvested on June 29, 2005. Fruit number per tree and fruit weight were recorded immediately after harvest and SSC and TA were determined.

Results

Experiment I

The pruned shoot weight was higher in summer-pruned than in winter-pruned trees (Fig. 1). Shoot regeneration started one week after pruning and stopped by mid-September (Fig. 2). The growth of regenerated shoots was observed to continue up to mid-October (Fig. 3). There was no difference in leaf chlorophyll content (SPAD values) in September but in November the content was higher in summer-pruned than in winter-pruned trees (Fig. 4). Leaf drop started two months earlier in winter-pruned than in summer-pruned trees (Fig. 5). There were fewer flower buds in summer-pruned trees than winter-pruned trees (Table 1). In the following year, the total shoot length of summer-pruned trees was approximately half of that of winter-pruned trees (Table 1). There were no significant differences in fruit number per tree, fruit weight, or yield between the two treatments (Table 2). However, soluble solids content (SSC) of harvested fruit was greater and titratable acid content (TA) lower in

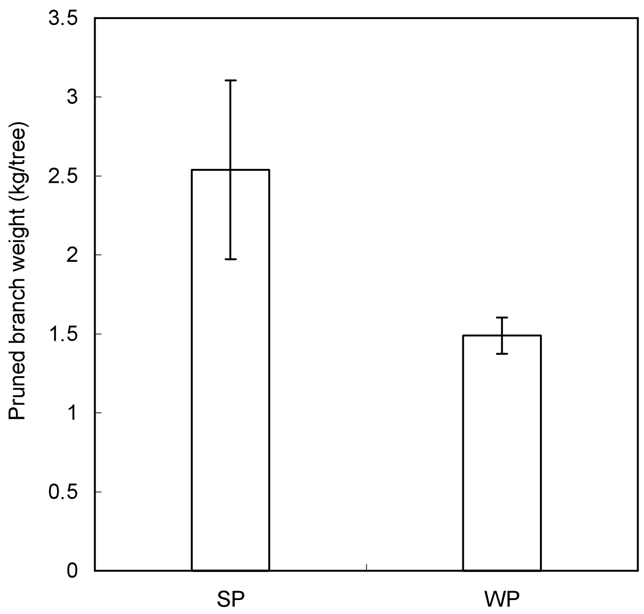

Fig. 1. Effect of summer pruning on pruned branch weight of peach trees in 2003－2004. SP＝summer pruning; WP＝winter pruning. Vertical bars represent SE (n＝4). Summer-pruned branches include leaves.

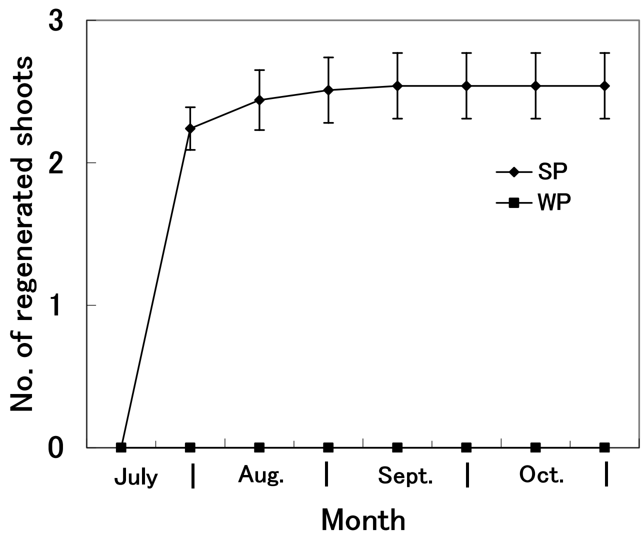

Fig. 2. Effect of summer pruning conducted in mid-July on regenerated shoot numbers of peach trees in 2003. Vertical bars represent SE (n＝4).

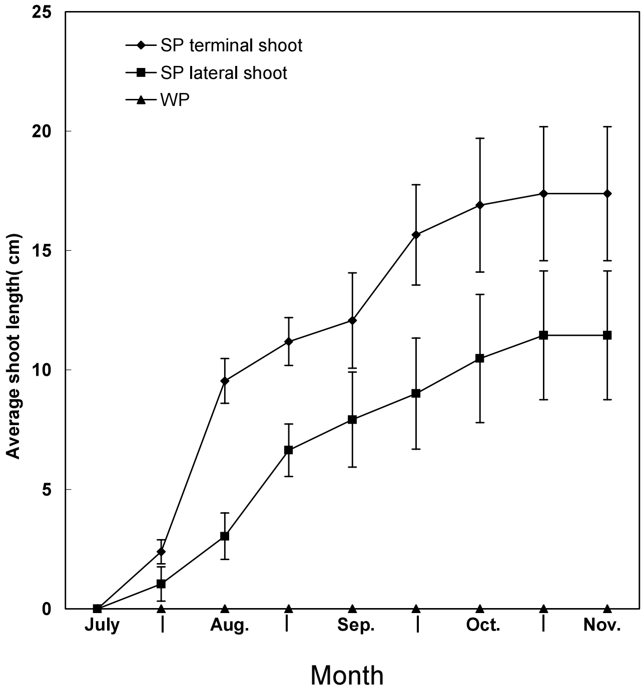

Fig. 3. Effect of summer pruning on average regenerated shoot length of peach trees in 2003. Vertical bars represent SE (n=4).

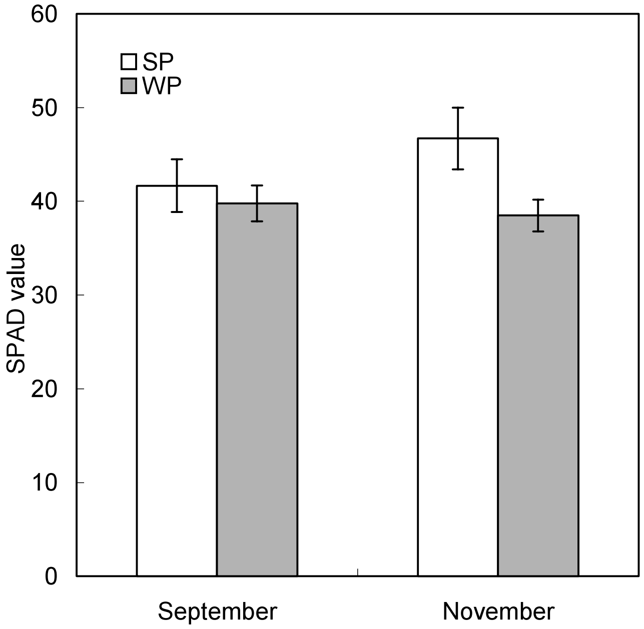

Fig. 4. Effect of summer pruning on leaf chlorophyll of peach trees in September and November in 2003. Vertical bars represent SE (n=4).

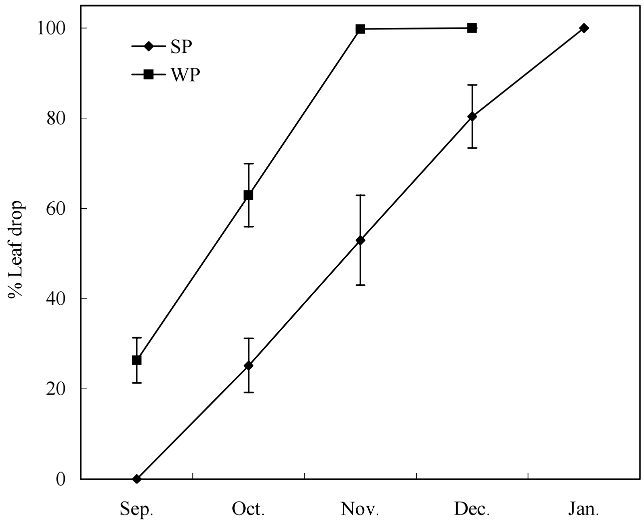

Fig. 5. Effect of summer pruning on leaf drop in peach trees from late September to late January in 2003−2004. Vertical bars represent SE (n=4).

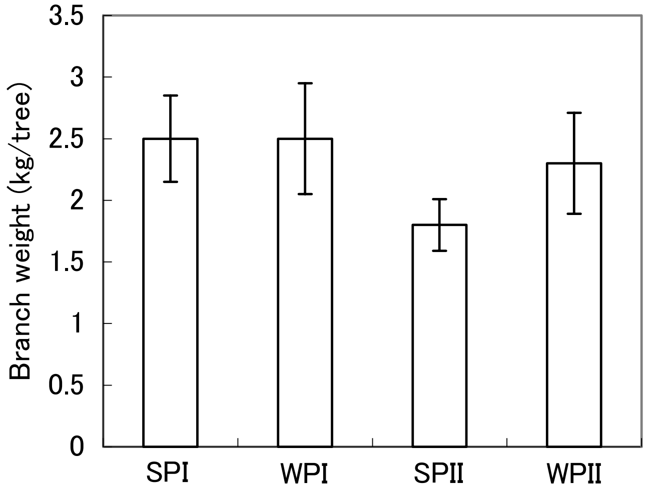

Fig. 6. Effect of summer and winter pruning on pruned shoot weight of peach trees in 2004. Vertical bars represent SE (n=4). SP=Summer pruning, WP=Winter pruning. Summer-pruned branches include leaves. SPⅠ, WPⅠ and SPⅡ, WPⅡ indicate single-year and two-successive-year pruning, respectively.

summer-pruned than in winter-pruned trees (Table 2).

Experiment II

In 2004, there was little difference in pruned shoot weight between SPⅠ and WPⅠ. However, the pruned shoot weight was lower in SPⅡ than SPⅠ (Fig. 6). Fruit number per tree was a little lower in summer-pruned than in winter-pruned trees in both single-year and two-successive-year treatments (Table 3). However, the fruit diameter was slightly greater in summer-pruned trees but

Table 1. Effect of summer pruning on flower bud formation and total shoot length of peach trees in the following year 2004.

Treatment	Flower buds (%)	Total shoot length (m)
SP	17.2±4.5[z]	21.8±4.9
WP	65.7±8.7	45.0±9.0

[z] Mean ± SE (n=4)

Table 2. Effect of summer pruning on yield and quality of peach fruit in the following year 2004.

Treatment	Fruit No./tree	Fruit weight (g)	Yield (kg/tree)	Soluble solids content (%)	Titratable acidity (%)
SP	10.8±5.8 [z]	146.5±12.9	1.66±0.84	11.04±0.26	0.37±0.05
WP	15.7±1.1	137.4± 5.4	2.18±0.08	10.25±0.26	0.54±0.04

[z] Mean ± SE (n=4)

Table 3. Effect of summer and winter pruning on fruit yield and quality of peach in 2005.

Treatment	Fruit No./tree	Fruit weight (g)	Fruit diameter (mm)	Fruit length (mm)	Yield (kg/tree)	Maturity degree[z]	Soluble solids content (%)	Titratable acidity (%)
SPⅠ[y]	28.1±4.1[x]	131.0±0.5	62.8±0.6	61.7±0.6	3.7±0.7	3.5±0.4	12.8±0.24	0.27±0.03
WPⅠ	41.1±5.8	128.1±0.4	60.5±0.4	59.6±0.3	5.3±1.0	2.7±0.2	11.8±0.21	0.39±0.03
SPⅡ	22.2±3.6	136.2±6.0	63.6±0.7	62.8±0.6	3.0±0.6	3.9±0.3	13.7±0.25	0.24±0.02
WPⅡ	30.4±4.3	128.6±0.4	60.6±0.5	59.7±0.4	3.9±0.8	2.9±0.3	12.7±0.20	0.38±0.03

[z] Maturity degree was determined visually by giving a score of 0 (green skin color) to 5 (red fully ripen) depending on fruit maturity.
[y] SP=Summer pruning, WP=Winter pruning. SPⅠ, WPⅠ and SPⅡ, WPⅡ indicate single-year and two-successive-year pruning, respectively.
[x] Means ± SE (n=4).

there were no significant differences in yield per tree. Table 3 shows that SSC of harvested fruit was greater and TA lower in summer-pruned than in winter-pruned trees, when compared within single-year treatments (SPⅠ and WPⅠ) and two-successive-year treatments (SPⅡ and WP Ⅱ). Furthermore, SSC was greater and TA was lower in SPⅡ than SPⅠ.

Discussion

In ExperimentⅠ, the pruned shoot weight was higher in summer-pruned than in winter-pruned trees (Fig. 1). This is probably because summer pruning was conducted for the first time, and because summer-pruned branches included leaves. The growth of regenerated shoots continued up to mid-October reaching a mean length of 14.7cm. Marini (1984) reported that only 2% of the shoots in summer-pruned peach trees exhibited re-growth with mean re-growth length being 7.3 cm. It seems that the growth of regenerated shoots depends on the time of summer pruning. Mizutani et al. (2000) reported that the earlier summer pruning resulted in the greater shoot length and shoot numbers in apple trees. Summer pruned trees showed greater leaf chlorophyll content (SPAD values) in November (Fig. 4). Mierowska et al. (2002) also reported that in apple spur leaves total chlorophyll content was higher in summer-pruned than in non-pruned trees during November-March.

Summer pruning caused the reduction in flower bud formation (Fig. 6). Mizutani et al. (2000) reported a decrease in flower bud formation with delayed summer pruning in apple trees. Hossain et al. (2004) stated that flowers were less in summer-pruned than in winter-pruned trees, and that bud-break occurred three to four days earlier in summer-pruned compared with winter-pruned trees. Erez (1982) observed that in a mechanized meadow orchard system of peach trees, four to five months are required for sufficient shoot regeneration and flower bud formation. Therefore, he insists that the system can be applicable to only early maturing cultivars, with a long enough growing season after fruit harvest.

Ferree et al. (1984) reported that re-growth increases when pruning is done early in the growing season. This observation may be due to changes in phytohormone levels with time within the growing season. We reported that SSC was higher and TA was lower in summer-pruned than in winter-pruned trees by employing ‘Akatsuki’ x unknown ‘Banto’ peach selection (Hossain et al. 2004). The increasing SSC and lowering TA were found in trees after two-successive-year summer pruning in this experiment (Table 3). This tendency was also observed in the previous work (Hossain et al., 2005).

In conclusion, summer pruning in mid-July after harvest may be a useful practice for controlling tree size in early maturing cultivar peach trees grafted on vigorous rootstocks in which slender spindle bush type training is applied.

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References

Andrews, P.K. and C.M. Serrano (1992). Graft incompatibility. Hort. Rev. 15: 183-232.

Erez, A. (1982). Peach meadow orchard: two feasible systems. HortSci. 17: 138-142.

Ferree, D.C., S.C. Myers, C.R. Rom and B.H. Taylor (1984). Physiological aspects of summer pruning. Acta Hort. 146: 243-252.

Ferree, D.C. (1988). Role of rootstocks and spur-type scions for controlling vegetative growth of apple and peach trees. HortSci. 23: 464-467.
Hossain, A.B.M.S., F. Mizutani and J.M. Onguso (2004). Effect of summer pruning on maintaining the shape of slender spindle bush of peach tree grafted on vigorous rootstock. J. Japan. Agr. Tech. Man. 11: 55-62.
Hossain, A.B.M.S., F. Mizutani, J.M. Onguso and H. Yamada (2005). Effect of summer and winter pruning of peach as slender spindle bush type on growth, yield and quality. J. Appl. Hort. 7: 11-15.
Hyden, R.A. and F.H. Emerson (1976). The case of summer pruning. Amer. Fruit Grower 95: 27-28.
Marini, R.P. (1984). Vegetative growth of peach trees following the pruning treatments. Acta Hort. 146: 287-292.
Marini, R.P. (1985). Vegetative growth, yield and fruit quality of peach as influenced by dormant pruning, summer pruning and summer topping. J. Amer. Soc. Hort. Sci. 110: 133-139.
Mierowska, A., N. Keutgen, M. Huysamer and V. Smith (2002). Photosynthetic acclimation of apple spur leaves to summer pruning. Sci. Hort. 92: 9-27.
Mizutani, F., T. Kogami, D.G. Moon, R.C. Bhusal, K.L. Rutto and H. Akiyoshi (2000). Effects of summer pruning on the number of apical buds near the trunk in slender-spindle-trained apple trees grafted on semi-dwarfing rootstocks. Bull. Exp. Farm Coll. Agr., Ehime Univ. 22: 1-10.
Ritter, C.M. (1983). Summer pruning of peach trees. The Mountainer Grower 448: 16-19.
Rom, C.M. and D.C. Ferree (1984). The influence of summer pruning current season shoots on growth, floral bud development and winter injury of mature peach trees. HortSci. 19: 543-545.
Taylor, B.H. and D.C. Ferree (1984). The influence of summer pruning and cropping on growth and fruiting of apple. J. Amer. Soc. Hort. Sci. 109: 17-24.
Taylor, B.H. and D.C. Ferree (1986). The influence of summer pruning and fruit cropping on the carbohydrate, nitrogen and nutrient composition of apple trees. J. Amer. Soc. Hort. Sci. 111: 342-346.
Utermark, H. (1977). Summer pruning to control growth and maintain fruiting in mature apple trees. Compact Fruit Trees 10: 86-90.

摘　　要

A.B.M. シャリフ　フセイン・水谷房雄・J.M. オングソ・A.R. エル-シェリフ・K.L. ルット：細型紡錘形に仕立てた強勢台モモ樹における枝の生長，果実品質に及ぼす夏季剪定の効果

強勢台木の野生モモに接いだ５年生の‘日川白鳳’を用いて，樹形を細型紡錘形に維持するために，夏季剪定の実験を行った．果実が収穫された後，７月中旬に夏季剪定を行った．一方，対照区として冬季剪定は３月中旬に行った．夏季剪定によって，頂芽や側芽からの２次新梢の発生が見られた．側芽からの２次新梢に比べて頂芽からの２次新梢のほうが生長が良かった．冬季剪定に比べて，夏季剪定区のほうが葉のクロロフィル含量（SPAD値）が高かったが，花芽の割合が低かった．翌年，夏季剪定区で全枝長が小さくなった．果実の成熟は夏季剪定区で促進される傾向が見られ，その結果，夏季剪定区で果実の糖度は高く，酸度は低かった．さらに，続いて２年連続の夏季剪定の効果を調査した．２年連続して夏季剪定をすると，剪定枝重は単年だけの夏季剪定区に比べて，小さくなった．これは，連年の夏季剪定によって樹体の栄養生長が抑制されていることを示すものと思われる．また，連年の夏季剪定によって果実の糖度はやや高くなる傾向が認められた．したがって，果実収穫後の７月中旬の夏季剪定は，強勢台木に接いだモモを細型紡錘形に維持するのに有効な管理だと思われる．