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Monitoring the Residual Effect of Partial Ringing and Heating of Trunk on Shoot Growth and Fruit Quality of Peach Trees Over Three Years Period

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ABSTRACT

Small-sized peach (*Prunus persica* [L.] Batsch.*)* tree for commercial fruit production has not been available due to the lack of suitable dwarfing rootstocks with a wide range of compatibility among cultivars. Effects of partial girdling and trunk heating on the growth, yield and fruit quality of peach were studied over a period of three years. A 4 cm wide partial ring of bark was removed at a height of 20 cm from the graft union leaving a connecting strip of 5 mm. Furthermore, the de-barked spot was heated at 150°C for 15 minutes using an electric heater. The partial girdling was effective in reducing shoot growth and improving fruit quality. The total soluble solids content of fruit in treated trees was higher than that in control ones. There was no significant difference between partial ringing and partial ringing plus trunk heating in terms of fruit acidity.

Key Words: Acid content; Bark width; Brix; Total shoot length; *Prunus persica*

INTRODUCTION

The small, compact, dwarfed or size controlled fruit trees seem to be the natural and obvious answer to many problems for the commercial orchardists. They provide early fruiting, a more rapid turnover in varieties to meet changing market requirements, lower cost of production, higher proportion of high-grade fruit, and easier thinning, pruning, spraying and harvesting (Tukey, 1978). The primary factor limiting the use of size controlling rootstocks in stone fruit production is the lack of suitable rootstocks with a wide range of compatibility among cultivars (Erez, 1984; De Jong *et al.*, 2001). This calls for the need to explore alternative dwarfing techniques.

The application of various forms of girdling in fruit production has been widely investigated and documented. Ebell (1971) used overlapping, half – circumference – band girdles in which 25 mm wide strips of bark and phloem were removed from opposing sides of the stem of cone. Wheeler *et al*. (1985) compared partial – overlapping – band girdles to similar girdles applied with a pruning saw. They found that both methods increased cone yield. Although stem girdling has received substantial attention, there is limited information on the combination of partial girdling and trunk heating on shoot growth and fruit quality. The interaction of bark width and shoot growth in peach has not been thoroughly investigated. Furthermore, no closer observation of such treatments over a long period of time has been reported in peach trees.

MATERIALS AND METHODS

Site. The experiment was conducted at the Ehime University Experimental Farm located in southern Japan, 33° 57' N, 132° 47' E at an elevation of about 20 m above sea level. The region has a mild temperate climate characterized by hot humid summers and cold dry winters. The soil at the experimental site was sandy loam with a pH of 5.7, a bulk density of a 1.08 g cm^{-3} and horizon-A thickness of 0.15 m.

Plant materials. Four-year-old peach (*Prunus persica* Batsch. var. 'Akatsuki x Banto') trees growing in an orchard at the university farm were used in this study. On May 3, 2002, twelve trees were randomly selected and a 4 cm wide partial ring of bark removed from eight of them at a height of 20 cm above the graft union to leave a 5 mm connecting strip. Four of the ringed trees were heated on the de-barked spot at 150°C for fifteen minutes using an electric ribbon heater. The growth of the trees was monitored weekly by measuring lengths of ten selected terminal shoots per tree. Growth of 5 mm bark that was left after ringing was also monitored weekly using vernier calipers. This was repeated in every spring and summer for the subsequent two years.

The fruit diameter was also evaluated weekly using vernier calipers. At harvesting, final fruit number, fruit diameter and weight were recorded. Juice was extracted from the fruits and titratable acidity determined by acid-base titration using 0.1 N NaOH. The soluble solids content (Brix) in the juice was also measured by means of a refractometer (Atago PR-

1). These measurements were repeated in every spring and summer for the subsequent two years.

RESULTS AND DISCUSSION

During 2002, the shoot length of all the trees increased gradually up to the second week of the study. For the control trees, it then increased rapidly up to the 3rd week before rising exponentially up to the 4th week (Fig. 1a). Shoot length was slightly higher in partial ringing than in the partial ringing and heating treatment. After the 9th week, shoot lengths in both treatments were generally the same but higher than the initial levels. The effect of partial ringing and heating was strongly felt in the following year as the overall shoot length of both treatments was below that previously observed (Fig. 1b). A similar trend was observed in 2004 (data not shown) suggesting that partial ringing and heating continue to exert an influence on shoot length in the subsequent years.

Fig. 1a. Effect of ringing and ringing plus trunk heating on the shoot length of peach in the year 2002. Vertical bars indicate SE (n=4).

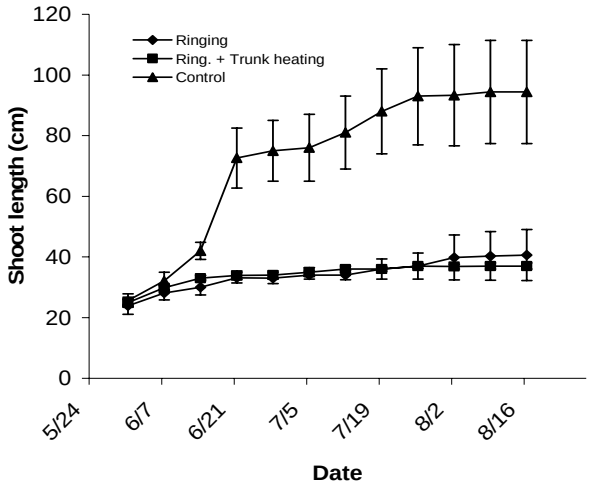


Fig. 1b. Effect of ringing and ringing plus trunk heating on the shoot length of peach in the following year. Vertical bars indicate SE (n=4).

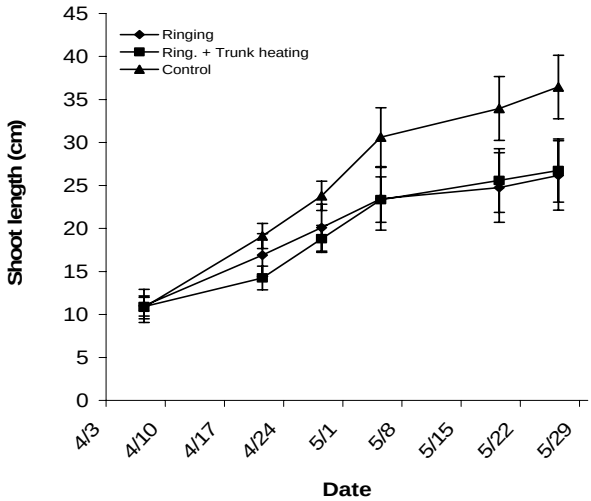
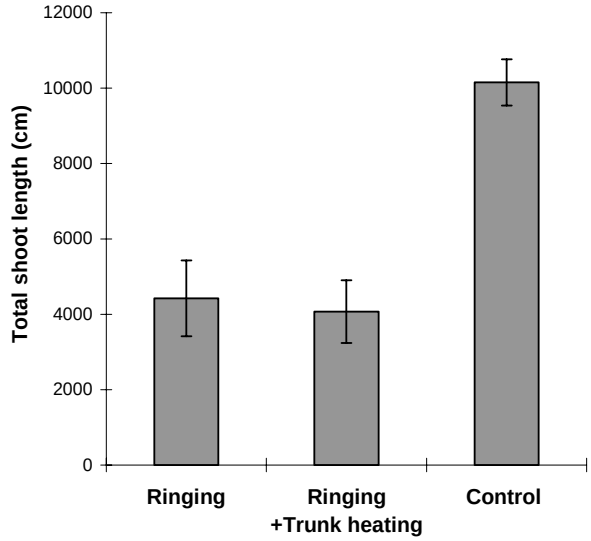


Fig. 2. The total shoot length of peach trees in the 3rd year as influenced by ringing and ringing plus trunk heating. Vertical bars indicate SE (n=4).



The total shoot length of the control trees in the 3rd year was much greater than the treated ones (Fig. 2). There was a slight difference between the partial ringing and partial ringing plus trunk heating treatment with the latter resulting in the lowest length suggesting that trunk heating exerts a minor influence on the shoot length.

The width of the bark that was left after ringing initially increased at the same rate for both ringing as well as ringing and trunk heating for the first three weeks in 2002 (Fig. 3a). Subsequently, the bark width in both treatments rapidly increased up to the 23rd week although the rate of increment was slightly higher in ringing plus trunk heating than in ringing alone. In the following year, the bark width growth was gradual for the first 8 weeks (Fig. 3b). It then slightly increased in the subsequent weeks but at a slower rate than the previous year. The rate of increment was similar for both treatments suggesting that the effect of trunk heating was diminishing with time. A similar trend continued in the year 2004 by which time the bark width had covered more than 50% of the ring in all the treatments. There was a positive correlation between bark width growth and shoot length in the entire study period for both treatments (Fig. 4).

Both treatments were effective in increasing the soluble solids content (Brix) of the fruits in the first two years (Fig. 5a & b). Brix was significantly higher in the fruit whose trees were subjected to partial ringing and trunk

Fig. 3a. Bark width growth of peach trees after being subjected to of ringing and ringing plus trunk heating in the year 2002. Vertical bars indicate SE (n=4).

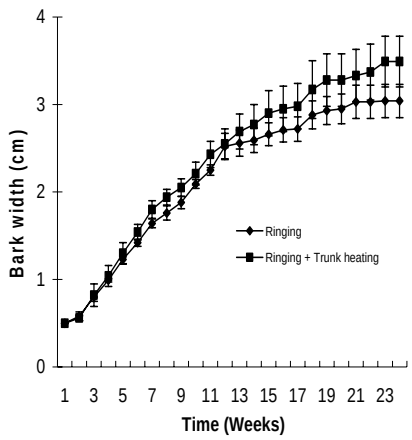


Fig. 3b. Bark width growth in peach trunks in the following year after being subjected to ringing and ringing plus trunk heating. Vertical bars represent SE (n=4).

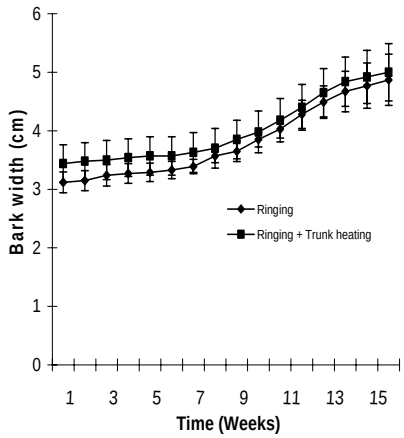


Fig. 4. Relationship between bark width growth and shoot length in peach trees as influenced by partial ringing in 2002 (A) and 2003 (B).

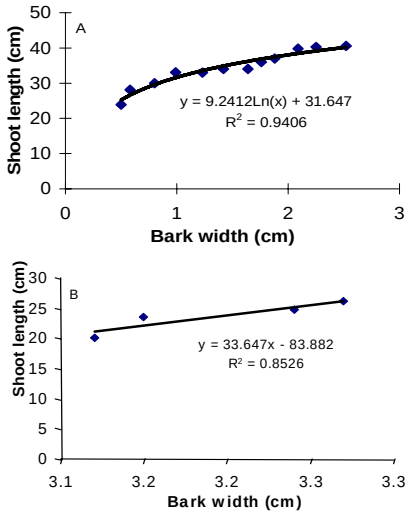


Fig. 4. Relationship between bark width growth and shoot length in peach trees as influenced by partial ringing plus trunk heating in 2002 (C) and 2003 (D).

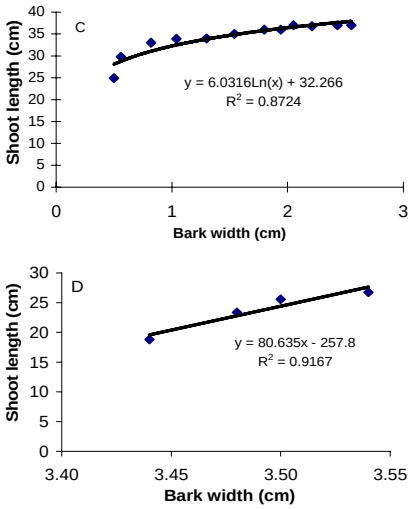
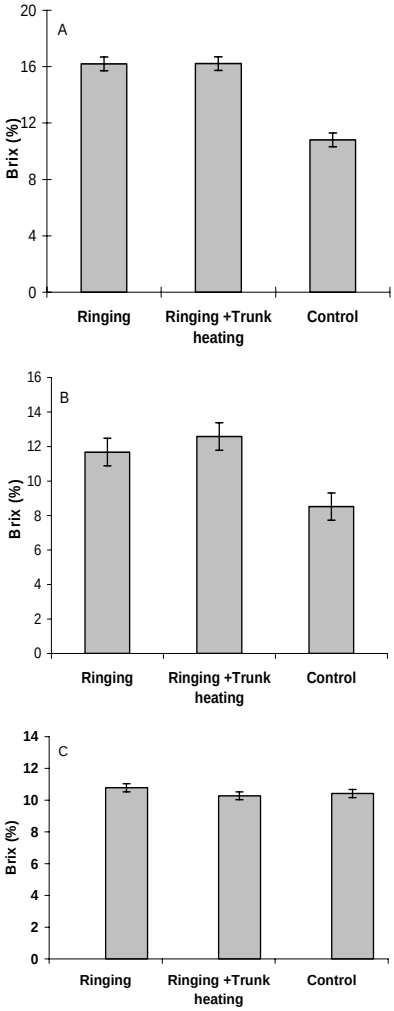


Fig. 5. The Brix of harvested fruit from peach trees in the year 2002 (A), 2003 (B) and 2004 (C). The trees had been subjected to ringing and ringing plus trunk heating in 2002. Vertical bars indicate SE (n=4).



heating than in the control ones showing that partial ringing has a positive effect on fruit quality. Brix was similar in all cases in the 3rd year (Fig. 5c). This might have been due to the fact that bark width growth had almost covered the entire ring hence negating the ringing effect. This implies that it might be more useful to maintain a constant bark width every year by cutting off excess bark growth at the onset of spring.

Both treatments resulted in the reduction of the acid content in the harvested fruit in the year 2002 (Fig. 6a). In the subsequent years, only partial ringing plus trunk heating caused significantly lower acidity than the control (Fig. 6b & c). This might be attributed to bark width recovery. This suggests that partial ringing plus trunk heating had some additive effects over ringing alone.

The weight of pruned branches in both treatments was lower than that of the control though that from the trees subjected to ringing alone was significantly low (Fig. 7a).

Fig. 6. The acid content of harvested fruit from peach trees in the year 2002 (A), 2003 (B) and 2004 (C). The trees had been subjected to ringing and ringing plus trunk heating in 2002. Vertical bars indicate SE (n=4).

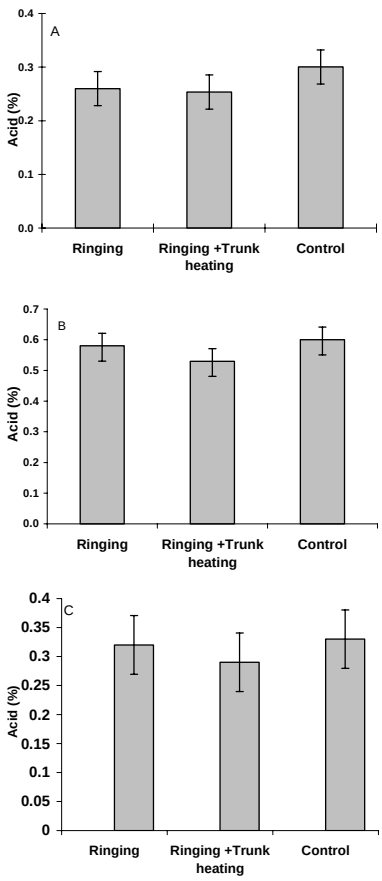


Fig. 7a. The weight of branches pruned from peach trees that were subjected to ringing and ringing plus trunk heating in the previous year. Vertical bars indicate SE (n= 4).

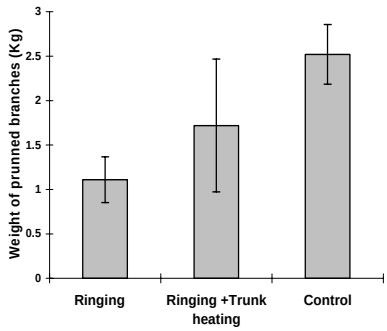


Fig. 7b. The weight of branches pruned from peach trees in the year 2004. The trees had been subjected to ringing and ringing plus trunk heating two years earlier. Vertical bars indicate SE (n= 4).

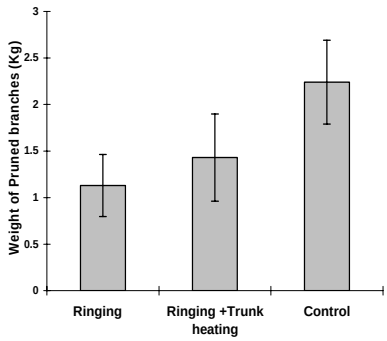


Fig. 8a. Fruit diameter of fruits on peach trees subjected to ringing and ringing plus trunk heating in the year 2002. Vertical bars indicate SE (n=4).

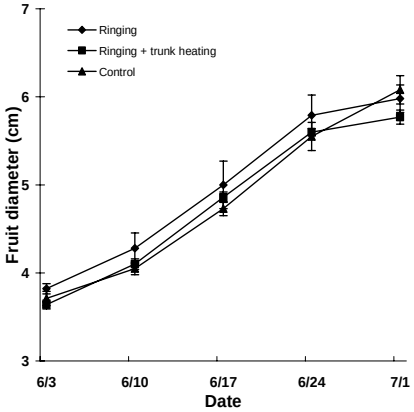
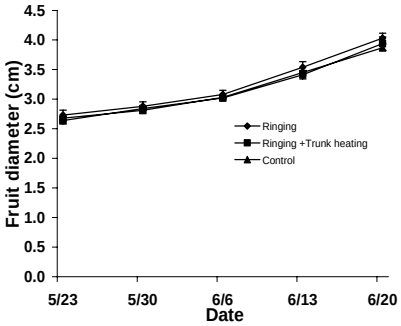


Fig. 8b. Fruit diameter of fruits on peach trees subjected to ringing and ringing plus trunk heating in the following year. Vertical bars indicate SE (n=4).



The weight of prunned branches was progressively lower than was the case in the previous year (Fig. 7b) demonstrating the residual effect of partial ringing and trunk heating on shoot growth. Reduced shoot growth is an effective means of cutting labor costs during pruning.

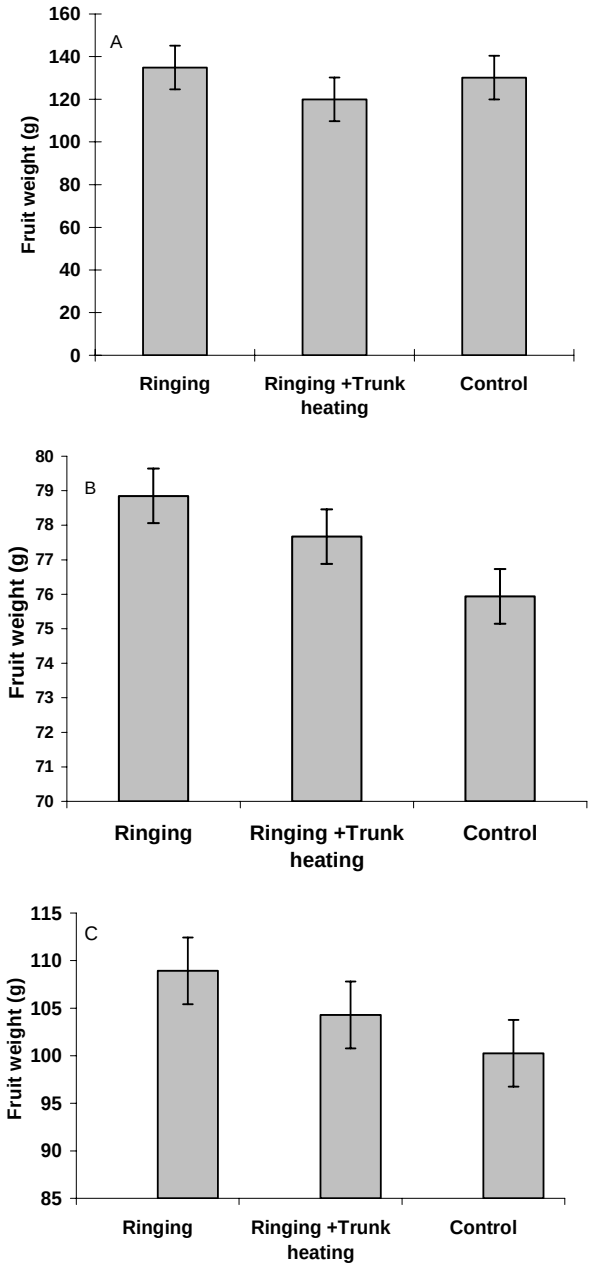
There was no significant difference between experimental and control trees in terms of fruit diameter in all the years (Fig. 8) showing that ringing and trunk heating maintained the normal fruit size whilst improved fruit quality. All the harvested fruit were of acceptable market value (Fig. 9a, b & c). The trees subjected to ringing produced fruit with the highest weight in all the years implying that ringing alone might be sufficient in causing a positive effect on fruit weight. The fresh mass of a fruit mainly depends on the balance between the input from the xylem and phloem transport. As the phloem is accompanied with sugars translocation, its flow relative to the others changes the dry matter content and the quality of the fruit (Huguet *et al.*, 1998).

In a girdling experiment with mango trees, all the treatments showed lower vegetative growth in relation to control ones (Jose, 1997). With girdled apple trees, fruits had significantly higher soluble solids concentration and acidity, while fruit growth was not affected (Arakawa *et al.*, 1997). Onguso *et al.* (2004) found that partial ringing and trunk heating resulted in peach fruit with significantly higher soluble solids content, fruit diameter but lower acidity.

CONCLUSIONS

Both partial ringing and partial ringing with trunk heating were effective in reducing shoot length while improving fruit quality. There was a positive correlation

Fig. 9. The weight of harvested fruits from peach trees in the year 2002 (A), 2003 (B) and 2004 (C). The trees had been subjected to of ringing and ringing plus trunk heating in 2002. Vertical bars indicate SE (n=4).



between bark width growth and shoot length implying that it might be more useful to maintain a constant bark width by trimming off excess bark growth yearly. Since there was no significant difference between the two treatments, partial ringing seems to be the more practical method to employ in commercial peach production.

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