Journal of Applied Horticulture, 7(2): 117-120, July-December, 2005

Effect of partial ringing on the shoot growth, fruit yield and quality of peach

A.B.M. Sharif Hossain, Fusao Mizutani, Justus M. Onguso, Ali R. El-Shereif and Hisashi Yamada

The Experimental Farm, Faculty of Agriculture, Ehime University, Hattanji, Matsuyama 799-2424, Japan

Abstract

The aim of this study was to understand the effects of partial ringing (bark removal) on tree size control and fruit quality of peach (*Prunus persica* Batsch cv. 'Hikawahakuho'). Partial ringing (PR) was performed on the bark, 2 cm long leaving a connecting strip 2 mm width on trunk. Bark was cut once (2 cm x 2 mm) or (8 cm x 2 mm) in experiment 1, cut once and weekly (2 cm x 2 mm) in experiment 2. Shoot growth was lower in the partially ringed trees than the control. The bark growth resembled with the pattern of shoot growth. Flower bud and fruit-set were higher in ringed trees than control trees. Tree circumference was higher above the ringed portion than the lower part of the partially ringed trees. Moreover, pruned shoot weight was lower in partially ringed trees than control trees (unringed). Fruit weight and maturity degree were higher in ringed trees than unringed ones. The results show that 97% ringed bark strip can be effectively used to make peach trees dwarf and good fruit quality.

Key words: Bark width, dwarfing, flower bud, partial ringing, shoot growth, fruit quality

Introduction

Among the several techniques used to make the fruit tree dwarf, partial removal of bark strip is an important one. Small, compact, dwarfed or size controlled fruit trees provide easier pruning, thinning, spraying and harvesting, high production of high-grade fruit with lower cost of production (Tukey, 1964). 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 (De Jong *et al.*, 2001). Onguso *et al*. (2004) stated that in peach, shoot growth was lower in bark ringed trees than the control. Jose (1997) found lower vegetative growth in all the treatments of ringing (girdling) to control mango trees. Arakawa *et al.* (1997) reported that in apple tree, trunk girth above the girdling significantly increased. Onguso *et al.* (2004) recorded that trunk circumference was higher above the ringed portion. They also reported that sugars and starch content was higher in the bark above ringed than the portion below ringed stem.

Arakawa *et al.* (1997) stated that in apple flowering in the following spring significantly increased by girdling. Girdling also changed the fruit quality *i.e.* increased SSC and reduced acid concentration (Elfving *et al.*,1991; Greene and Lord, 1983). Schneider (1954) stated that girdling blocks the translocation of photsynthates from leaves to the root zone through phloem bundles. The block decreases starch content in root system and accumulation of sucrose in the leaves (Plaut and Reinhold, 1967). Hossain *et al.* (2004) found that N and Ca content were higher in bark ringing treated than the control trees. Johnson (1998) reported that photosynthates produced in the leaves are partially and completely stopped from reaching the roots by girdling. A new partial ringing technique (the removal of a ring of bark 2 cm long to leave only a 2 mm connecting strip) was used. There is limited literature on the aspect and therefore, forms the basis of this research. The objectives of this research were to study the influence of different types of bark ringing on shoot growth, bark width, tree circumference, flower bud formation and the relationship between bark width and shoot growth.

Materials and methods

Experiment 1

Site: The experiment was carried out at Ehime University Farm located in southern Japan, 33° 57′ N, 132° 47′ E at an elevation of about 20 m above sea level. There is mild temperate climate characterized by hot humid summer and cold dry winter. The soil is sandy loam with a pH of 5.7.

Plant material: Two-year-old peach (*Prunus persica* Batsch cv. 'Hikawahakuho') trees grafted on wild form peach seedling stocks were used in this experiment in May 2001. The trees were spaced at 1.1 x 2.0 m in a completely randomized design. Fertilizers were applied to transplanted tree at the rate of 10g each, N, P and K per tree in the first year. Weeding and irrigation were applied at 7 days intervals. Ringing was done by removing a partial ring (2 cm or 8 cm long) with a knife to leave a connecting bark strip 2 mm width on the trunk 15 cm above the ground level. There were three treatments and replicated four times. The treatments were control (no ringing), partial ringing cut once (2 cm length x 2 mm width of bark) and partial ringing cut once (8 cm x 2 mm). Shoot growth rate and bark width were measured weekly. Total shoot length and tree circumference were measured after tree growth stopped. Winter pruning was done and pruned shoot weight was measured.

Experiment 2

The experiment was carried out at the same site as in exreriment 1.

Plant material: Three-year-old peach (*Prunus persica* Batsch cv. 'Hikawahakuho') trees grafted on peach seedling stocks (wild

form) were used in this experiment in May 2001. The trees were spaced at 1.1 x 2.0 m in a completely randomized design. Weeding and irrigation were done at 7 days intervals. N, P and K fertilizers were applied at the rate of 10g each, per tree, respectively in the first year. Partial ringing was done by removing a partial ring 2 cm long (with a knife) leaving a connecting strip 2 mm width of bark. There were 3 treatments each with 4 replications used in the experiment. The treatments were control (no ringing), partial ringing (cut once) and partial ringing (cut weekly). Winter pruning was done and pruned shoot weight was measured. The experiment was continued until 2005 to know the residual effect on tree growth and trunk circumference. But the treatments were applied only in 2001. Percent flower bud, fruit set, fruit yield, fruit number, fruit weight and maturity degree were recorded.

Maturity degree: After harvesting, the fruits were kept in the boxes according to the replications. The fruits were scored into two groups (full ripen fruit was evaluated as score 5, and green fruit was evaluated as score 1 by visual observation). Scores of all replications were recorded, averaged and expressed as maturity degree.

Results and discussion

Experiment 1: The effect of 2cm x 2mm and 8cm x 2mm ringing on new shoot growth was recorded (Fig. 1). In ringed trees, growth was lower than control (unringed) trees, while there was no difference in growth between 2cm x 2mm and 8cm x 2mm ringed treatments. However, new shoot growth increased from the 1st-12th week (May-August) in the control, 2cm x 2 mm and 8cm x 2 mm treated trees. There was a difference in growth between control and treatments from week 2-8 weeks. Bark growth was measured for 14 weeks (May-August) to determine the relationship between bark and shoot growth (Fig. 2). Bark growth was higher in the 2cm x 2 mm ringed trees. But in later stages, there was no difference in growth between 2cm x 2 mm and 8cm x 2 mm ringed trees. Total shoot length and pruned shoot weight were measured at the end of the active growth period (Table 1). The lowest total shoot length was recorded in the 8cm x 2 mm ringing treatments. There was very little difference in shoot length between control and treatments. The lowest shoot weight was in 2cm x 2 mm ringed trees and the highest was in control trees. Increase in bark width

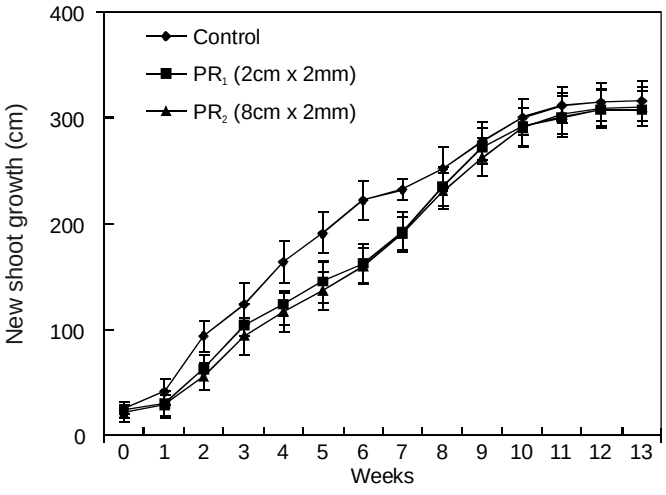

Fig. 1. New shoot growth in peach trees as influenced by different ringing treatments. Vertical bars indicate SE (n=4). PR = Partial ringing.

Table 1. Total shoot length and pruned shoot weight of peach trees as affected by partial ringing of different sizes

Treatment	Total shoot length (cm)	Pruned shoot weight (g)
Control	601.5±32.3	450.00±17.6
PR_1 (2cm x 2mm)	595.2±21.2	443.33±24.5
PR_2 (8cm x 2mm)	581.6±20.1	434.23±8.03

PR_1 and PR_2 are partial ringing treatments

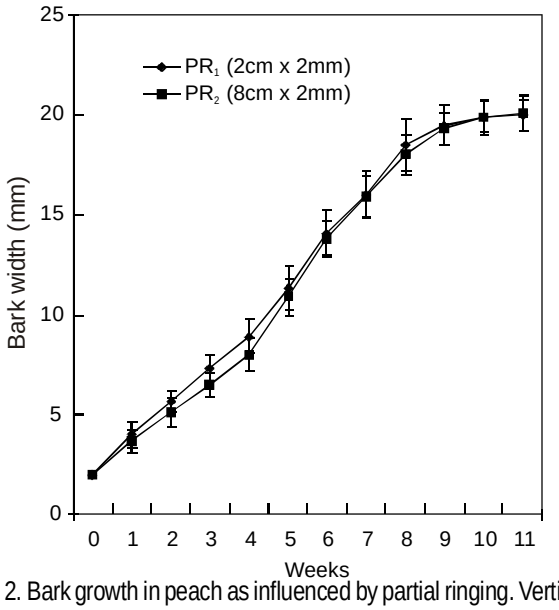

Fig. 2. Bark growth in peach as influenced by partial ringing. Vertical bars indicate SE (n=4). Weeks are (0: May 25, 11: August 9). PR = Partial ringing.

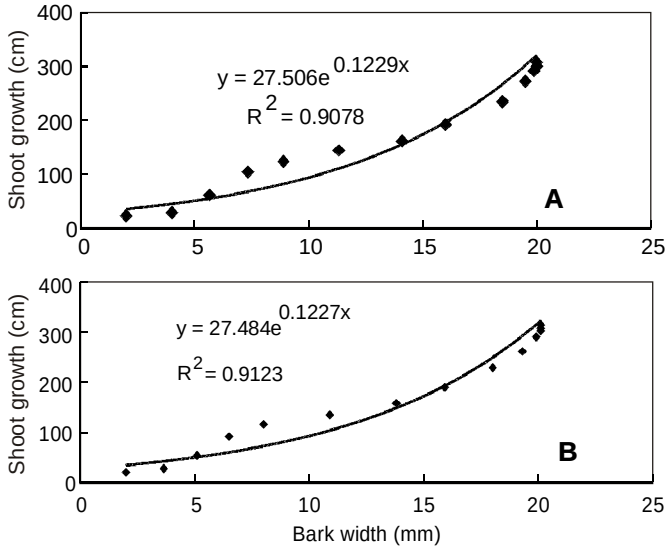

Fig. 3. Correlation between shoot growth and bark width of peach trees. A = Partial ringing cut once (2 cm x 2 mm), B = Partial ringing cut once (8 cm x 2 mm).

and shoot growth exhibited positive relationship (Fig. 3). Fig. 4A shows initial bark ringing structure (2 cm long x 2mm wide) in peach trunk and 4B photos show the final bark width and trunk circumference above and beneath the ring. It was observed that trunk circumference was more above the ringed portion than below the ring.

Experiment 2: The effect of partial ringing (cut once) and partial ringing (cut weekly) on total shoot length was recorded in 2001 and 2004 (Fig. 5). In partially ringed trees, it was lower in partially

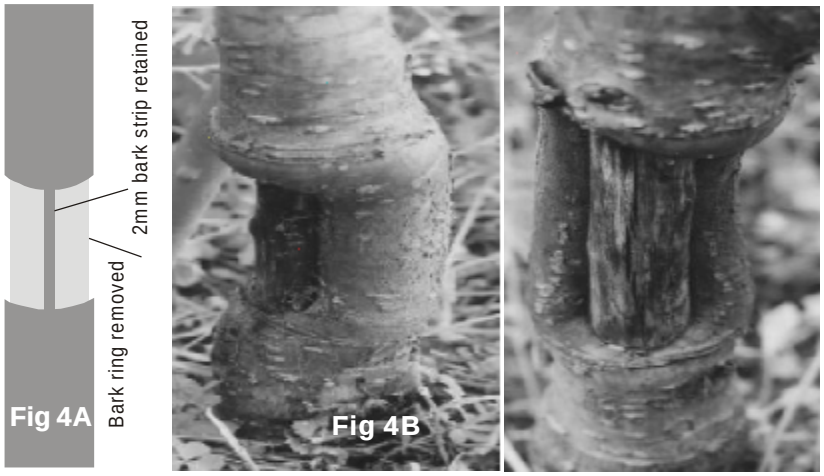

Fig.4A. Bark ring structure (2cm length x 2mm width) at initial stage. Fig. 4B. Photo shows the bark ring structure and trunk circumference (upper ring and lower ring) at final stage after 4 months of ring application

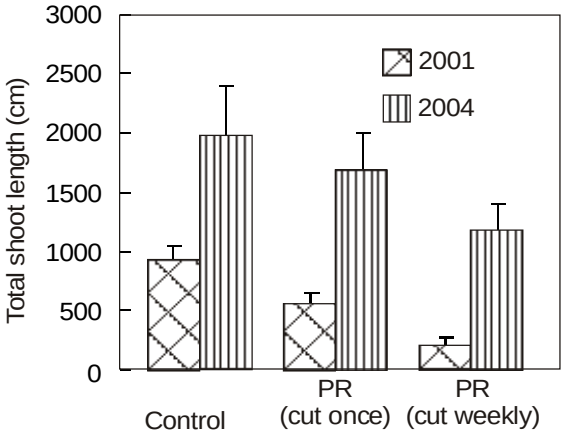

Fig. 5. Effect of partial ringing on total shoot length in 2001 and 2004. Vertical bars indicate SE (n=4). PR = Partial ringing.

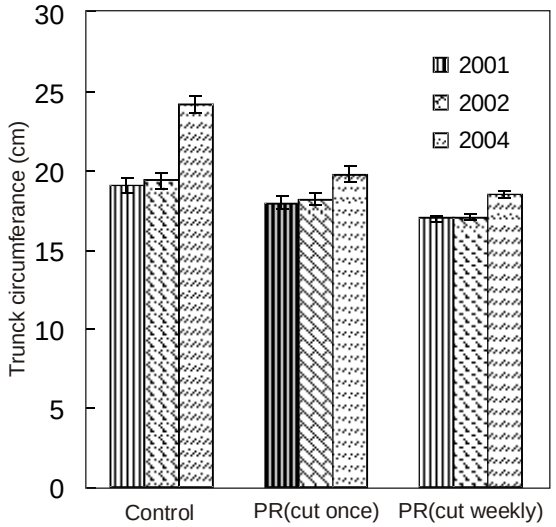

Fig. 6. Effect of partial ringing on trunk circumference (lower part from ringing) of peach trees in different years. Vertical bars indicate SE (n=4)

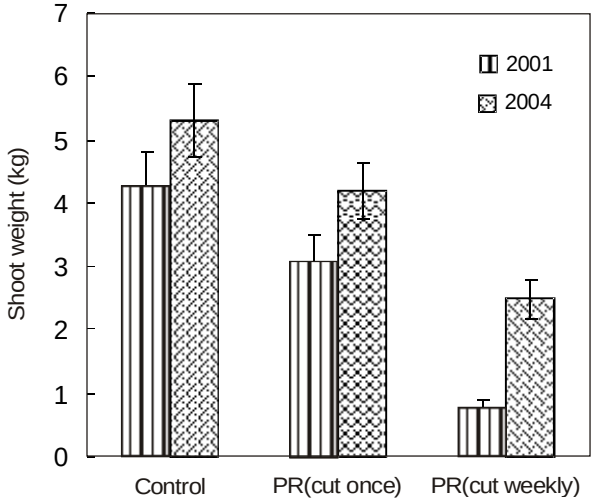

Fig. 7. Effect of partial ringing on pruned shoot weight of peach trees in 2001 and 2004. Vertical bars indicate SE (n=4).

ringed trees than the control trees (unringed) in both years. It was clear that there were differences between treatments in total shoot length until 2004. Trunk circumference was observed in 2001, 2002 and 2004 (Fig.6). Moreover, after the trees were pruned as slender spindle bush types, the pruned shoots were weighed and measured in 2001 and 2004 (Fig. 7). The lowest pruned shoot weight was in ringed trees and the highest was in control in both the years.

Flower bud and fruit set were higher in ringed trees than unringed (control) trees (Fig. 8). It was observed that there was difference in tree size among the treatments and flowering was greater in the partially ringed (cut weekly) and partially ringed (cut once) trees than control. Fruit yield and number of fruits was lower in ringed trees than control. Whereas, weight per fruit and maturity degree were higher in ringed trees than control trees (Table 2).

Table 2. Effect of partial ringing on fruit yield and quality of peach

Treatment.	Fruit number tree^{-1}	Yield (kg) tree^{-1}	Fruit weight (g)	Maturity degree
2001				
Control.	6.25±1.2	0.75±0.13	120±4.8	2.3±0.24
PR_1	5.25±1.3	0.65±0.10	125±5.2	3.0±0.27
PR_2	4.11±1.0	0.51±0.11	124±5.0	3.5±0.28
2005				
Control	13.4 ±2.3	1.79 ±0.20	134.2 ±6.0	2.5 ±0.23
PR_1	18.5 ±3.2	2.45 ±0.26	132.5 ±5.6	3.2 ±0 25
PR_2	17.5 ±3.1	2.25 ±0.24	129.0 ±5.4	3.7 ±0 27

The results show that partial ringing is effective as dwarfing component in peach trees It was observed that new shoot growth, total shoot length, pruned shoot weight were lower in the ringed

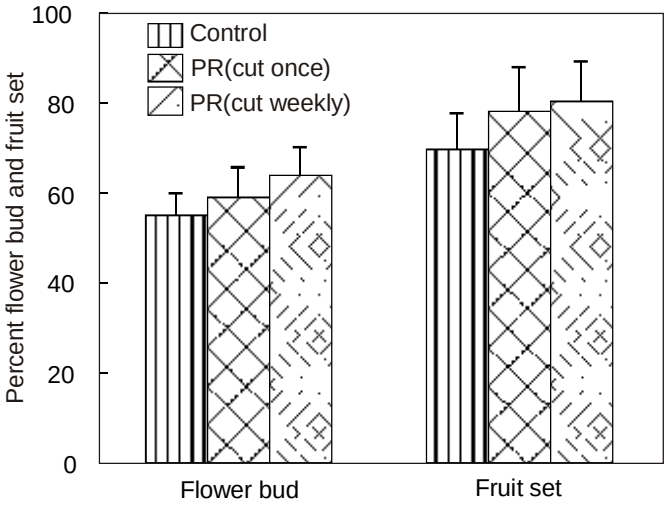

Fig. 8. Effect of partial ringing on percent flower bud and fruit-set.

trees than the control. This might be due to suppression of the cambial layer (phloem) in the bark. It has been reported that nutrient sap may diffuse laterally or vertically if normal phloem transport is checked by ringing (Tukey, 1964). This was observed when cambium layer was suppressed by ringing and new shoot growth, total shoot growth, pruned shoot weight and bark growth were reduced. This demonstrates a clear relationship between shoot and bark growth. Schneider (1954) stated that girdling blocks the translocation of sucrose from leaves to the root zone through phloem bundles.

In the present investigation, more effective treatment was partial ringing (cut weekly) than partial ringing (cut once) for reduction in shoot growth. It might be due to less suppression of food movement between shoot and root by bark ringing. Carbohydrate transport from leaves to roots smoothly through the phloem was suppressed because the phloem was reduced in width by ringing. Onguso *et al.* (2004) stated that shoot growth was lower in bark ringing treated trees than the control in peach trees. The result also was similar to Jose (1997). We found trunk circumference was higher above the ringing and lower below the ringing. Arakawa *et al.* (1997) reported that trunk growth above the girdling was significantly increased and below the treatment was reduced in apple trees. Onguso *et al.* (2004) reported that trunk circumference was higher above the bark ringing and lower below the ringing. They also reported that sugars and starch content was higher above the bark ringing than the portion below the ring. The block decreases starch content in root system and accumulation of sucrose in the leaves (Plaut and Reinhold, 1967). Hossain *et al.* (2004) found that N and Ca content were higher in bark ringing treated trees than the control trees. It was observed that flower bloomed was higher in the ringed trees than the control.

Flower bud and fruit-set were higher in ringed trees than unringed trees. Arakawa *et al.* (1997) stated that flowering in the following spring in apple was significantly increased by girdling. Per fruit weight and maturity degree were higher in ringed trees than unringed trees. Onguso *et al.* (2004) found that fruit quality was higher in ringed trees than control.

The results show that the residual effect of ringing treatments was for 3 days. In citrus, girdling caused a significant decrease in gibberellins level in the root system (Wallerstein *et al.*, 1974) and since gibberellins are presumed to synthesize partly in the roots (Kende and Sitton, 1967) the decrease may be attributed to the limited supply of photosynthates as a result of girdling. It might be that the reduced level of gibberellins lower α–amylase activity and thus prevents the hydrolysis of starch. The metabolic systems might be involved in respiration, accumulation of 3-phosphoglyceric acid and pyrophosphorylase activity (Beevers, 1969).

The results show that it is possible to make peach tree dwarf on vigorous rootstock by applying bark ringing. The technique includes bark ringing and retaining a bark stripe (2mm), which allows the plant to survive as well as remain dwarf. Although the technique was able to explain that by applying 90% ringing plant can be survived and dwarfed. Some differences were highlighted including bark ringing maintained weekly more effective than bark ringing maintained once. Fruit quality can be improved by using this technique. In addition, bark ringing reduces cost of tree spraying and labour and thus fruit tree growers can use this dwarfing technique easily to make tree size small.

Acknowledgements

The authors are grateful to Ministry of Education, Culture, Sports, Science and Technology, Japan for providing fund for this research.

References

Arakawa, O., K. Kanno, A. Kanetsuka and Y. Shiozaki, 1997. Effect of girdling and bark inversion on tree growth and fruit quality of apple. *Acta Hortic.*, 45: 579-586.

Beevers, H. 1969. Metabolic reactions in sinks. In: Physiological aspect of crop yield. Madson, Wisconsin, pp. 172-179.

De Jong, D.T. M., A. Weibel, W. Tsuji, J.F. Doyle, R.S. Johnson and D. Ramming, 2001. Evaluation of size controlling rootstocks for California peach production. *Acta Hortic.*, 557: 103-110.

Elfving, D.C., E.C. Lougheed and R.A. Cline, 1991. Daminozide root pruning, trunk scoring and trunk ringing effects on fruit ripening and storage behaviour of McIntosh apple. *J. Amer. Soc. Hort. Sci.*, 116: 195-200.

Greene, D.W. and W.J. Lord, 1983. Effect of dormant pruning, summer pruning, scoring and growth regulators on growth, yield and fruit quality of Delicious and Cortland apple trees. *J. Amer. Soc. Hort. Sci.*, 108: 590-595.

Hossain, A.B.M.S., F. Mizutani, and J.M. Onguso, 2004. Effect of partial and complete ringing on carbohydrates, mineral content and distribution pattern ^{13}C- photoassimilates in young peach trees. *Asian J. Pl. Sci.*, 3: 498-507.

Johnson, G. 1998. Plant health care update. A Newsletter. Minnesota University, Extension Service, Glenwood Avenue, Minneapolis, 1.

Jose, A. 1997. Effect of girdling treatments on flowering and production of mango. *Acta Hortic.*, 455: 132-134.

Kende, H. and D. Sitton, 1967. The physiological significance of kinetin and gibberillin-like root hormones. *Annals of the New York Academy of Science*, 144: 235-243.

Onguso, J.M., F. Mizutani and A.B.M.S. Hossain, 2004. Effects of partial ringing and heating of trunk on shoot growth and fruit quality of peach trees. *Bot. Bull. Acad. Sin.*, 45: 301-306.

Plaut, Z. and L. Reinhold, 1967. The effect of water stress on the movement of ^{14}C-sucrose tritiated water within the supply of leaves of young bean plants. *Aus. J. Biol. Sci.*, 20: 297-307.

Schneider, H. 1954. Effect of trunk girdling on phloem of trunk of sweet orange trees on sour orange rootstocks. *Hilgardia* 22: 593-601.

Tukey, H.B. 1964. Tree structure, physiology and dwarfing. Dwarf Fruit Trees, Macmillan, New York, 95p.

Wallerstein, I., R. Goren and S.P. Monselise, 1974. The effect of girdling on starch accumulation in sour orange seedlings. *Can. Jour. Bot.*, 52: 935-937.